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Status reports of the fisheries and aquatic resources of Western Australia 2015/16. State of the fisheries

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

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State of the fisheries

Fish for the future

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EDITOR'S INTRODUCTION

As part of the transition to ultimately using a web based, hierarchical interface, this years' edition of the *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16* is adopting a more streamlined format. These changes include updates to the summary table which, in addition to displaying the stock and fishery performance levels, now includes current performance and risk levels for each of the other EBFM outcomes (e.g. bycatch, listed species, economics etc.).

The individual resource reports have also been refined and shortened to remove information that was largely repeated among editions. It is planned for that all key resources will have a comprehensive Resource Assessment Reports (RARs) published this year which will include all the relevant available information where more details are required.

The structure of the reports still utilises the Departments' risk based Ecosystem Based Fisheries Management (EBFM) framework which is the basis for management of Western Australia's aquatic resources (Fletcher, *et al*., 2010[1], 2012[2]).

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 meso-scale ecosystems (as determined by the Integrated Marine and Coastal Regionalisation - IMCRA - process[3]) 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.

Consistent with the new *Aquatic Resources Management Act* (2016), the 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 Demersal Finfish) which contains descriptions of all the commercial and recreational activities. Taking this regional 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.

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.

The *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16* provides the general public, interested fishers and other stakeholders with a starting reference source. This meets the reporting requirements of the Department, including the need to annually report to the WA Parliament on "the state of fisheries and aquatic resources managed under this Act"[4].

In addition, with the government initiative to have a number of WA commercial fisheries undergo certification by the Marine Stewardship Council (MSC) this has resulted in some slight changes in the terminology that may be used within some sections of these reports in order to match that used in the MSC assessment criteria and also that presented in the Status of Key Australian Fish Stocks reports[5].

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 this year to Monica Mumme and Fiona Webster who both assisted getting the text ready for this important report.

I would also like to acknowledge that the images depicting the key species for each resource are by Roger Swainston.

It is noted that undertaking the significant changes to the formation of this report has delayed its production - not uncommonly, making it shorter has taken longer! The timing for production of the next (2016/17) edition is expected to be back to normal.

DR RICK FLETCHER
EXECUTIVE DIRECTOR, SCIENCE AND RESOURCE ASSESSMENT

February 2017

1 Fletcher WJ, Shaw J, Metcalf SJ, and Gaughan DJ. 2010. *An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies*. Marine Policy 34 (2010) 1226–1238pp.

2 Fletcher WJ, Gaughan DJ, Metcalfe SJ, and Shaw J. 2012. *Using a regional level, risk-based framework to cost effectively implement Ecosystem Based Fisheries Management (EBFM).* In: Kruse GH, Browman HI, Cochrane KL, Evans D, Jamieson GS, Livingston PA, Woodby D, Zhang CI. (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 266 *Aquatic Resources Management Act.* 2016. Government of Western Australia

5 Flood *et al.* 2016. *Status of Key Australian Fish Stocks*. Fisheries Research & Development Corporation, Canberra

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* 2015/16 to Parliament) and the ecological resource level reports.

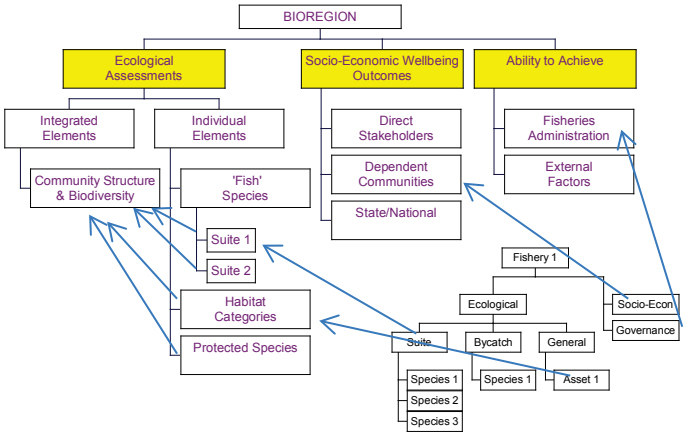
The terms and headings are a combination of the reporting structures first outlined in the National Ecologically Sustainable Development (ESD) reporting structure (Fletcher *et al.* 2002)[6], plus the Ecosystem Based Fisheries Management (EBFM) framework (Fletcher *et al.* 2010, 2012)[7] and the Resource Assessment Framework (DoF, 2011)[8]. 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 reports[9].

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.

Ecosystem Based Fisheries Management

The Department has fully adopted EBFM, which is a risk based management approach. EBFM recognizes the social, economic and ecological values at a regional level and the links between the individual exploited fish stocks, direct effects on habitats and protected species (which collectively form the broader marine ecosystem), to ensure the sustainable management of all fisheries resources into the future. EBFM provides a mechanism for assessing and reporting on the regional level risk status of all WA's aquatic resources and therefore the effectiveness of the aquatic resource management arrangements in delivering community outcomes.

Given the potential complexity and to avoid duplication of processes that could occur by applying the EBFM concept, we use a practical, step-wise, risk-based approach to integrate all the fishery level assessments and management systems into a form that can be used for whole of agency level planning by the Department (Introduction Figure 1).



INTRODUCTION FIGURE 1. *The high level EBFM component tree framework showing how each of the fishery level issues are mapped into cumulative, regional-level individual assets and outcomes. Furthermore, how the ecosystem elements are composed of the integrated set of individual elements.*

Each set of bioregional level risks is made up of the individual ecological risks at the species/stock and social/economic risks at fishery level. The consolidation process into broader asset categories utilises the branch structure of the EBFM component trees. Each of these represents groups of 'like risks' that can be managed collectively. For example, the status of the entire suite (e.g. Demersal Finfish) is evaluated based on the risk status of indicator species which have been chosen to be representative of the most vulnerable species within the suite.

A similar process is applied to consolidate the items across the other EBFM components. Furthermore, the assessment of ecosystem status recognizes that community structure & biodiversity within an ecosystem can, at a minimum, be effectively assessed as the 'integrated' sum of the status of the 'individual' ecological elements.

6 Fletcher WJ, Chesson J, Fisher M, Sainsbury KJ, Hundloe T, Smith ADM, 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.

7 Fletcher WJ, Shaw J, Metcalf SJ, and Gaughan DJ. 2010. *An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies*. Marine Policy 34 (2010) 1226–1238

Fletcher WJ, Gaughan DJ, Metcalf SJ, and Shaw J. 2012. U*sing 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 .

8 Department of Fisheries. 2011. *Resource Assessment Framework for Finfish Resources in Western Australia.* Fisheries Occasional Publication. No. 85.

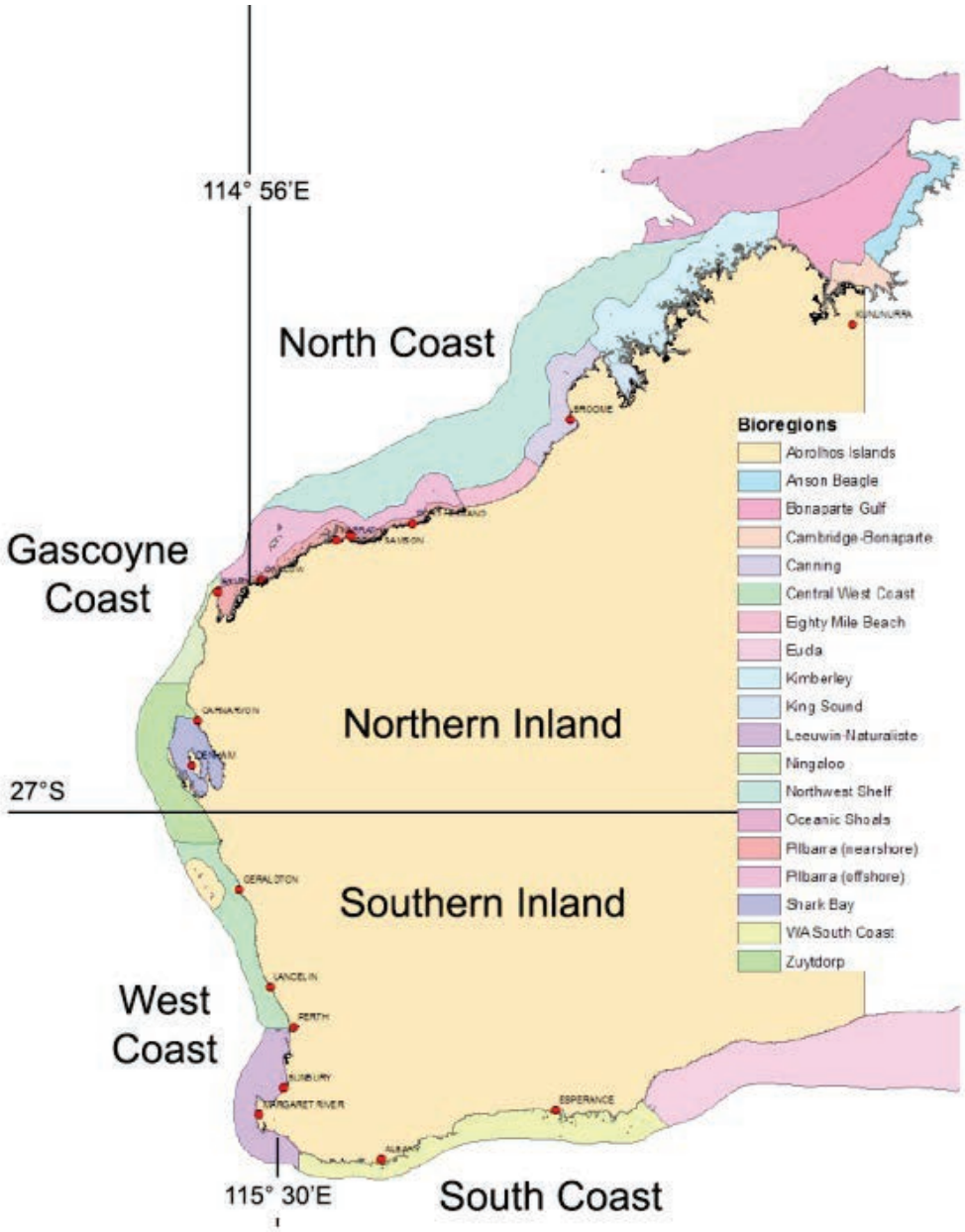
9 Flood *et al.* 2016. *Status of Key Australian Fish Stocks.* Fisheries Research & Development Corporation, Canberra. 420 pp.

Finally as we manage the set of ecological assets to generate economic and social benefits for the community, each of the ecological assets is used as the unit to integrate its associated ecological, social and economic values and risks using a simple multi-criteria function. The shifts in these priority scores among years for each of the 80 regional level ecological assets is integral for the annual planning cycle used for assigning priorities for all resource related activities across the Department (see Fletcher *et al;,* 2010, 2012 for full details).

Bioregions

With the adoption of the EBFM approach, a fully bioregional structure is used for the Annual Status 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.

Each individual Bioregion has 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 Introduction Figure 2).



INTRODUCTION FIGURE 2: *Map of WA showing the boundaries of the Bioregions and IMCRA ecosystems.*

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

The ecological resources/assets in each Bioregion include the ecosystems and their constituent habitats, captured species and listed species.

Captured Fish: The captured fish are subdivided into finfish, crustaceans and molluscs with each of these further divided into estuarine/embayments, nearshore, inshore/offshore demersal and pelagic (finfish only) suites (see DoF, 2011).

Listed (protected) species: This category, which includes Endangered, Threatened and Protected Species (ETPS) under State or Commonwealth Acts, was subdivided into listed 'fish[10]' (e.g. White Sharks, Corals) and listed 'non-fish' (e.g. mammals) as defined in the Fish Resources Management Act 1994.

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.

Ecosystems: Within each Bioregion, one or more meso-scale ecosystems, as defined by the IMCRA process (Introduction Figure 2) were used as the starting point, but merging of these or further division into separate estuarine/embayment and marine components was undertaken where relevant.

Risk Assessment

The Department's primary objective is to manage the sustainability of the community's ecological assets to generate economic or social outcomes. The risks associated with each individual ecological asset and community outcomes are therefore examined separately using formal qualitative risk assessment (Consequence x Likelihood) as detailed in Fletcher (2015)[11].

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 internationally accepted definition of risk is "*the uncertainty associated with achieving objectives*" (ISO, 2009), therefore uncertainties are explicitly incorporated into the assessment enabling the calculation of risk to be completed with whatever data are available. All risk scoring therefore considers the current level of management activities and controls already in place or planned. The management and reporting implications for each of the different risk categories are outlined in Introduction Table 1 (see below).

The various ecological, social and economic risks and values associated with the ecological assets are integrated using a multi-criteria analysis to generate approximately 80 Departmental-level priorities across the six Bioregions.

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 2014/15 or the calendar year 2015, whichever is more appropriate.

Similarly, the statistics on compliance and educational activities are also for 2014/15, 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 2016.

Ecological Assets

Captured Fish

Commercial Fishing Estimates

There is a legislative requirement for information to be submitted by various sectors of the fishing industry including; commercial fishers, fish processors, charter operators aquaculturists.

Monthly returns or, in some selected commercial and charter fisheries, daily/ trip returns, are provided that include information on the composition, quantity and location of catches and fishing effort that was used. Monthly returns from fish processors request quantity and price paid for fish product. Quarterly reports submitted by aquaculture licensees cover the quantity of species produced/sold and the farm gate price received.

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

10 Under the FRMA and ARMA, fish include all aquatic organisms except birds reptiles mammals and amphibians.

11 Fletcher WJ. 2015. *Review and refinement of an existing qualitative risk assessment method for application within an ecosystem-based management framework*. ICES Journal of Marine Research 72:1043-1056pp.

approach for obtaining annual estimates of recreational catch by boat-based fishers at both the state-wide and bioregional levels. These surveys utilise the Recreational Fishing from Boat Licence (RFBL) as the basis for sampling 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 state-wide 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 state-wide and bioregional levels from the second survey presented in Ryan *et al.* (2015[12]) provide the data for the catch and effort by the recreational sector throughout this report.

The state-wide 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.

Stock Assessment Methodologies

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	Description
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 (WoE), 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).

Breeding Stock Status

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

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

Sustainable-Recovering: reflects situations where the egg production has previously been depleted to unacceptable levels by fishing or some other event

12 Ryan KL, Hall NG, Lai EK, Smallwood CB, Taylor SM, and Wise BS. 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.

(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.

By-Catch and Listed Species

These two categories include those species caught during a fishing operation that are not retained by the fishing operation. This covers the potential impact on unwanted 'bycatch' species and also any captures or interactions 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 covered in the assessments of retained species.

Habitat and Ecosystem Effects

These two categories refer to the potential indirect impacts generated direct physical interactions of fishing gear with the sea floor and by the removal of fish from the ecosystem (food chain effects). Each fishery or resource is considered in terms of its potential/relative effects on habitat and the food chain with an outline of the assessment of current ecological risk ('negligible', 'low', 'medium', 'high' or 'significant') provided. More details on the information used within these risk assessments will become available in the Resource Assessment Reports being developed for each bioregion (e.g. Fletcher *et al.* 2011)[13].

Social Effects

The Department has categorised the different level of social amenity generated be each of the aquatic assets. Note, by definition, there is no asset that has no social amenity.

Social Amenity	Description
Level 1	No recreational fishing for the asset and no specific broader community interests.
Level 2	Some caught recreationally &/or some interest to specific sections of the community.
Level 3	Locally important to recreational sector &/or it has some importance to the broader community.
Level 4	Major catch by recreational sector in the region &/or generates major interest for some of the general community.
Level 5	Primary recreational target across the region &/or iconic for general community.

Economic Effects

The Department has 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.

Economic Value	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

13 Fletcher *et al*. 2011. *Ecosystem based Fisheries Management case study report West Coast Bioregion*. *Fisheries Research Report*, WA. No 225.

Governance Systems

Harvest Strategy

A Harvest Strategy Policy for the aquatic resources of WA has now been completed (DoF, 2015[14]). 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.

Annual Catch (or effort) Tolerance Range

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) 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.

Annual catch tolerance range: For many 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 catch tolerance range.

Annual effort tolerance 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 was anticipated. For these reasons, an appropriate tolerance range of fishing effort to take the TAC has also been incorporated for assessing the performance of quota-managed fisheries.

External Audits

Many of the State's significant fisheries achieved environmental certification for more than a decade under the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Where relevant, this report includes specific performance measures required to meet any EPBC Act requirements.

Similarly, as more WA fisheries move through the full MSC process, this report provides a valuable input to the annual audit process for these fisheries.

External Factors

This refers to known factors outside of the direct control of the fishery legislation which impact on aquatic resources or activities. 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.

14 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.

INTRODUCTION TABLE 1. *Links between the Risk Category and the likely reporting and management response*

Risk Category	Description	Likely Reporting Requirement	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

OVERVIEW OF THE STATUS OF KEY ECOLOGICAL RESOURCES (ASSETS)

ECOLOGICAL ASSETS

Captured Species (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 and recreational fisheries and harvested fish stocks in WA (Overview Table 4). 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 2015/16.

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 and recreational fisheries.

Performance is measured as the proportion of fisheries (with sufficient data) where the breeding stocks of each of their target or indicator species are at sustainable levels given current fishing effort and normal environmental conditions; or they are recovering from a depleted state at an appropriate rate following management intervention. The Department's 2015/16 Budget Papers state that the target for the proportion of fisheries with breeding stocks at risk from fishing is to be less than 3%.

For the 2015/16 performance review, 39 fisheries have been reviewed, which includes two recreational-only fisheries. For the 39 fisheries reviewed, breeding stock assessments for the major species are available for 38 (97%) of these fisheries. The fishery where there was insufficient data to make a critical assessment on the target species has not operated for more than five years.

Within the group of 38 assessed fisheries, 31 were considered to have adequate breeding stock levels and a further three fisheries (the West Coast Demersal Scalefish Fishery [WCDSF]; the Shark Bay Crab Fishery and the Shark Bay Scallop Fishery) had breeding stocks considered to be recovering at acceptable rates (collectively 90% 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 in Shark Bay, combined with the conservative Total Allowable Commercial Catch (TACC) limits now imposed, are enabling the recovery of both the scallop and crab stocks from the impact of the heat-wave event five years ago. Of the remaining 10% of fisheries, only two fisheries have been assessed as having some stocks at inadequate levels to maintain usual effort levels (garfish in the West Coast Nearshore Fishery and cobbler within Wilson Inlet in the South Coast Nearshore Fishery). A further two fisheries were also assessed as having in adequate breeding stocks solely resulting from the negative impacts of environmental influences, not fishing.

The poor recruitment levels observed for scallops in the Abrolhos Islands region since the 2011 marine heat-wave have continued with the fishery still remaining closed. Similarly, with environmental factors still having an impact on the growth of crabs in Cockburn Sound and the stock's recruitment, this fishery has also remaining closed. Therefore, while a total of 10% of fisheries have stock levels that are not considered adequate, only stocks in two fisheries (or 5% of those assessed) are considered inadequate largely as a result of exploitation with revised management arrangements needed to deal with these issues (Overview Table 1).

Between 2006/07 and 2015/16 the percentage of acceptable fisheries was consistently high at approximately 80% or higher. In 2015/16, 95% of fisheries have acceptable breeding stock levels, with only 5% of fisheries at risk due to fishing, which was slightly higher than the target value of 3%.

OVERVIEW TABLE 1: *The proportion (%) of fisheries in which breeding stocks of the major target species are both assessed and considered to be at risk due to fishing.*

Year	Percentage of fish stocks considered at risk by fishing (%)	Target value as per budget (%)
2006/07	21	Not applicable
2007/08	23	Not applicable
2008/09	14	18
2009/10	11	15
2010/11	6	17
2011/12	6	14
2012/13	3	9
2013/14	3	6
2014/15	3	6
2015/16	5	3

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 commercial management plans and regulatory activities in keeping fish catches at appropriate levels (including those in a recovery phase). For most of the commercial fisheries in WA, each management plan seeks to directly control the amount of fishing effort applied to stocks, with the level of catch taken providing an indication of the effectiveness of the plan. Where the plan is operating effectively, the catch by the fishery should fall within a projected range. The extent of this range reflects the degree to which normal environmental variations affect the recruitment of juveniles to the stock which cannot be 'controlled' by the management plan. Additional considerations include market conditions, fleet rationalisation or other factors that may result in ongoing changes to the amount of effort expended in a fishery which will in turn influence the appropriateness of acceptable catch ranges for certain fisheries.

A target catch or effort range has been determined for each of the major commercial fisheries (see the 'Stock Status and Catch Ranges for Major Fisheries' section of the Annual Report) by the Department's Science and Resource Assessment Division. The Department's 2015/16 Budget Papers state that the target is ninety five percent (95%).

For quota-managed fisheries, the measure of success of management arrangements is that the majority of the Total Allowable Commercial Catch (TACC) is achieved, and additionally, that it has been possible to take this catch using an acceptable amount of fishing effort. If an unusually large expenditure of effort is needed to take the TAC, or the industry fails to achieve the TACC by a significant margin, this may indicate that the abundance of the stock is significantly lower than anticipated. For these reasons, an appropriate range of fishing effort to take the TACC has also been incorporated for assessing the performance of quota-managed fisheries (see 'Stock Status and Catch Ranges for Major Fisheries' section of the Annual Report).

The major commercial fisheries which have target catch or effort ranges account for most of the commercial value of WA's landed catch. Comparisons between the actual catches (or effort) with the target ranges have been undertaken for 29 of the 37 commercial fisheries referred to in 'Stock Status and Catch Ranges for Major Fisheries. There is still a relatively high number of fisheries not assessed which is due to a combination of ongoing environmentally induced stock issues in some regions (see above) and poor economic conditions for some fisheries which meant a number of fisheries were either closed or did not have material levels of catches during this reporting period. This includes two fisheries (Cockburn Sound crabs, Abrolhos Islands and mid-west (scallops) trawl) affected by unusual environmental conditions continue to have their recruitment impacted to the extent that the scallop fisheries were again set to zero (0) catches. The setting of zero or very limited catches in these fisheries highlights the significant management interventions of the Department to facilitate recovery and rebuilding of these stocks. These stocks continue to be closely monitored to allow the fisheries to reopen when stocks have rebuilt to levels that support sustainable fishing.

Of the 29 fisheries where 'target ranges' were available and a material level of fishing was undertaken in the relevant reporting period, 11 were catch-quota managed with 18 subject to effort control management.

Nine (9) of the 11 Individually Transferable Quota (ITQ) managed fisheries operated within their target effort/catch ranges or were acceptably below the effort range (e.g. 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 will occur in the 2016 season and the decline in catch rate for Shark Bay snapper has triggered a review. In the 18 effort-controlled fisheries, 10 were within or acceptably above (1) or below (6) their target catch ranges. For effort controlled fisheries, the current catch level of cobbler in Wilson Inlet is too high and discussions with licence holders regarding

suitable adjustments to management have already been initiated.

In summary, 26 of the 29 commercial fisheries assessed (90%) were considered to have met their performance criteria, or were affected by factors outside the purview of the management plan/arrangements. This figure is close to the target level of 95% (Overview Table 2).

OVERVIEW TABLE 2: *The proportion (%) of commercial fisheries in which the catch or effort reported is acceptable relevant to the target management range being applied.*

Year	Percentage of fisheries with acceptable catch/effort	Target value as per budget
2006/07	80	Not applicable
2007/08	96	Not applicable
2008/09	96	85
2009/10	93	90
2010/11	94	90
2011/12	100	94
2012/13	97	88
2013/14	89	92
2014/15	89	95
2015/16	90	95

The proportion of recreational 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 by the recreational sector at appropriate levels for both stock sustainability (including those in a recovery phase) and to meet integrated fisheries management objectives.

Previously, WA's aquatic resources were shared mainly on an implicit basis, with no explicit setting of catch shares within an overall total allowable catch or corresponding total allowable effort. The Department is now implementing an Integrated Fisheries Management (IFM) approach where the aggregate effects on WA's aquatic resources by all fishing sectors are taken into account. This involves the use of a framework in which decisions on optimum resource use are determined (i.e. allocation and re-allocation of fish resources) and implemented within a total sustainable catch for each fishery or fished stock. IFM is being progressively phased in and it is anticipated it will take around 10 years to bring the majority of the State's shared fisheries under this new framework.

The Department is beginning to determine an annual tolerance catch or effort range for each of the major recreational fisheries. This indicator has only been measured since 2013/14 and the Department's 2015/16 Budget Papers state that the target is 80%.

For the purposes of this indicator, 13 fisheries or stocks have been identified as having a 'material' recreational catch share. Over time, the indicator may need to expand to include reference to fisheries or stocks for which there are other 'material' sectoral shares (e.g. customary fishing). Of these 13, only five currently have explicit catch tolerance ranges developed and another eight have implicit ranges that can be used to assess acceptability. Of these 13 stocks or fisheries, all had catch levels that were within an acceptable catch range. Consequently the percentage of recreational fisheries with acceptable catch levels was 100%, which exceeds the target level of 80%. This has improved from last year where the percentage of recreational fisheries with acceptable catch levels was 85% (Overview Table 3).

OVERVIEW TABLE 3: *The proportion (%) of recreational fisheries in which the catch or effort reported is acceptable relevant to the target management range being applied.*

Year	2013/14	2014/15	2015/16
Percentage of fisheries with acceptable catch/effort	77	85	100
Target value as per budget	80	80	80

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 subsequently reduced the incidence to acceptable levels. Risks associated with birds and mammals (sea lions) in the South Coast Bioregion were also assessed as moderate and appropriate

management measures continuing to be undertaken to mitigate these risks. The level of entanglements of whales in pot ropes has successfully been reduced following completion of research that, in collaboration with industry, identified appropriate and practical mitigation techniques[1].

Ecosystems and Habitats

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 chapter. 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.

EXTERNAL 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 have been identified as a global problem, second only to habitat change and loss in reducing global biodiversity (Millennium Ecosystem Assessment, 2005)[2].

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.

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.

In recognition of an increasing risk presented by aquatic pests to WA associated with increasing international travel, transport and trade, the Department has developed the capacity for rapid detection and identification of aquatic pests. Rapid detection of introduced aquatic pests is important in preventing their spread and establishment. The Department working with our Port stakeholders have developed a state-wide marine biosecurity surveillance system to try and detect any introduced species that arrive in Australian port waters.

Additional to this the Department undertakes risk based marine pest surveillance in high value assets such as the Swan River system, Cockburn Sound and the Houtman Abrolhos. Details the introduced species details the introduced species and pests detected in 2015/16 surveillance are provided in Overview Table 5.

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

The Department coordinates the fish kill response program within Western Australia. This program forms part of a national program endorsed by Primary Industries Standing Committee and Natural Resource Management Standing Committee in December 2006. The number and cause of fish kills is also a key indicator in the "State of the Environment Report" (SOE) issued from time to time by the environmental protection authority (IW19 Number and location of significant fishkills). The number of total number of significant fish kills and fish kills investigated in Western Australia since the last SOE report is shown in Overview Table 6.

1 How et al., (2015) Effectiveness of mitigation measures to reduce interactions between commercial fishing gear and whales. FRDC Project 2013/037 Fisheries Research Report, WA. 267.

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

OVERVIEW TABLE 4
Stock Status, Catch & Effort Ranges for WA's Major Commercial and Recreational 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] 2014/15 or 2015	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)	Sustainable: Adequate	Commercial: 6000 (TACC) Recreational: 401 t (TARC)	Commercial: 6086 (t) Recreational: 267-394 t	Acceptable Due to the conservative nature of the TACC, egg production and catch rates have been at record high levels in recent years. The TARC and recreational catch are likely to increase in the next few years as the strong recruitment pulse passes through the fishery.
Roe's abalone	Catch Rates & Direct Survey (Level 4)	Sustainable: Adequate (some areas)	Commercial: 87 (Q) (530 – 640 days) Recreational: 20t	Commercial: 51 t (467 days) Recreational: 15-25 t	Acceptable Area 8 still closed due to catastrophic mortality following a marine heat wave. Area 7 (Perth area) survey abundance of recruitment and spawning stock at low levels which required additional management actions being implemented including the TARC being reduced to 20 t.
Octopus	Catch Rates (Level 2)	Sustainable: Adequate	Commercial 50 – 250 Recreational: Not Developed	Commercial: 274t Recreational: 2t (boat only)	Acceptable The fishery is in a new interim management phase. An increase in allowable trap use has resulted in an increased catch for 2015. The catch tolerance range will be reviewed in 2016.
Abrolhos Islands and mid west trawl	Direct Survey & Catch Rates (Level 4)	Environ. Limited	Commercial: 95 – 1,830 (set to 0 for this year) Recreational: NA	Commercial: 0 t	NA The continued low abundance is due to the ongoing effects of the extreme marine heat-wave in the summer of 2010/11 and above-average water temperature in the following two summers. The low recruitment has resulted in a very low spawning stock despite no fishing activity for three years.

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] 2014/15 or 2015	Catch (or effort or catch rate) level acceptable and explanation if needed
Cockburn Sound crab	Direct Survey (Level 4)	Environ. Limited	Commercial: Under Revision Recreational: Under Revision	Commercial: 0 t Recreational: 0t	NA The 2013/14 egg production and juvenile indices were both below their limit reference points and the commercial fishing season ceased in April 2014. Juvenile and egg production indices for 2014/15 remain below their limits and the commercial and recreational fisheries remain closed.
Peel-Harvey West Coast Crab	Commercial Catch Rates (Level 2)	Sustainable: Adequate	Commercial: 45-105 t Recreational: Not formal	Commercial: 95 t Recreational: 50-66 t (boat only)	Commercial catch rates and catch within allowable range. Both the commercial and recreational crab fishery in this region achieved third-party Marine Stewardship Council certification in 2016. The commercial standardised catch rates are used as a proxy for the recreational sector in the assessment of stock sustainability.
West Coast Nearshore and Estuarine finfish	Yes (Level 2)	Inadequate (actions taken)	Commercial: 75 – 220 (Peel-Harvey only) Recreational: Not Developed	Commercial: 130 t Recreational: 69-87 t (boat only)	Acceptable The high levels of shore based recreational fishing require an index of this catch. Status of herring stock resulted in reduction to recreational bag limit and closure of commercial south coast trap net fishery.
West coast beach bait and south west beach seine	Catch (Level 1)	Sustainable: Adequate	Commercial: 60 – 275 (whitebait only) Recreational: Not applicable	Commercial: 97t	Acceptable Annual whitebait catch has fluctuated in response to normal environmental variations. Low catches in previous three years followed exceptionally warm ocean temperatures with the 2014/15 catch being consistent with the recent levels being environmentally driven.
West coast purse seine	Catch (Level 1)	Sustainable: Adequate	Commercial: 0 – 3,000 (Q) Recreational: Not applicable	Commercial: 1,253 t (scaly mackerel and pilchard combined)	Acceptable Total catch for all zones combined is the highest since the mid-2000s while the nominal catch rate remains within the range observed since the mid-1990s.

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] 2014/15 or 2015	Catch (or effort or catch rate) level acceptable and explanation if needed
West coast demersal scalefish	Annual (Level 1) Periodic: Fishing Mortality (F) (Level 3)	Sustainable:Recovering	Commercial: < 450 t Recreational < 250 t	Commercial: 283 t Recreational: 139-166 t(boat only) 45 t (charter)	Acceptable The total catch of the demersal suite by all commercial and recreational fisheries in the West Coast Bioregion were within the allowable ranges. Management changes introduced in 2015 to the West Coast Demersal Scalefish Interim Managed Fishery successfully reduced catches of snapper by this fishery to acceptable levels.
GASCOYNE COAST BIOREGION					
Shark Bay prawn	Direct Survey/Catch Rate (Level 4)	Sustainable: Adequate	Commercial: 1,350-2,150 Recreational: Not Applicable	Commercial: 2067t	Acceptable Brown tiger prawn annual landings were within their acceptable range while western king prawn landings were above their allowable range as result of good recruitment.
Exmouth Gulf prawn	Direct Survey/Catch rate (Level 4)	Sustainable: Adequate	Commercial: 771 – 1,276 Recreational: Not Applicable	Commercial: 1076 t	Acceptable The landings of brown tiger prawns were within their acceptable range, western king prawns were below their acceptable range and endeavour prawns were above their acceptable range.
Shark Bay scallop	Catch Rates and Direct Survey (Level 4)	Environ. Limited	Commercial: Trial Quota 500t (Denham Sound Only) Recreational: NA	Commercial: 450 t	Acceptable Limited commercial fishing occurred under a trial quota system in Denham Sound where the stock levels had recovered sufficiently to allow fishing. There was ongoing low recruitment and stock in northern Shark Bay due to the continued influence of the extreme environmental conditions and therefore no fishing was permitted in that part of the fishery.
Shark Bay Crabs	Catch Rates & Direct Survey (Level 4)	Sustainable: Recovering	Commercial 450 t (Q) Recreational: NA	Commercial: 341 t	Acceptable Increased levels of recruitment and spawning biomass were observed during 2014, which led to an increase in the TACC to 450 t for the 2014/15 fishing season. Non-achievement of this TACC was largely due to unused quota.

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] 2014/15 or 2015	Catch (or effort or catch rate) level acceptable and explanation if needed
Shark Bay beach seine and mesh net	Annual:Catch Rates (Level 2) Periodic: Fishing mortality (Level 3)	Sustainable: Adequate	Commercial: 235 – 335 t Recreational: NA	Commercial: 164 t	Acceptable Total catch remained below the acceptable range due to a further reduction in effort (lowest on record) and low catches of sea mullet and tailor. Catch of yellowfin bream was above the 10-year average.
West Coast Deep sea crab	Catch Rate (Level 2)	Sustainable: Adequate	Commercial: 154 t (Q); 61 k-101.5 k potlifts Recreational: NA	Commercial: 154 t (68 k 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 (Snapper)	Composite Assessment (Level 5)	Sustainable: Adequate	Commercial 277 (Q) (380 – 540 days) Recreational: Not formal	Commercial: 196 t (446 days): Recreational: 88-110 t (boat only)	Not Acceptable Spawning biomass close to target but catch rate has fallen below the threshold level. Updated stock assessment and review of catch and catch rate to be completed. The recreational catch of spangled emperor has decreased to be within an acceptable range.
NORTH COAST BIOREGION					
Onslow prawn	Catch (Level 1)	Sustainable: Adequate	Commercial: 60 – 180 t Recreational: NA	Negligible	NA Minimal fishing occurred in 2015.
Nickol Bay prawn	Catch (Level 1)	Sustainable: Adequate	Commercial: 90 – 300 t Recreational: NA	87 t	Acceptable The total landings were just below the allowable range but landings of banana prawns, which are the target species, were within their normal catch range and slightly above their predicted catch range.
Broome prawn	Catch (Level 1)	Sustainable: Adequate	Commercial: 55 – 260 t Recreational: NA	0	NA Minimal fishing in 2015.
Kimberley prawn	Catch (Level 1)	Sustainable: Adequate	Commercial: 240 – 500 t Recreational: NA	Commercial: 175 t	Acceptable Banana prawns were below the catch prediction and the allowable range. Endeavour and brown tiger prawns were also below the range because of the early targeting of banana prawns and very low fishing effort in the second part of the season.

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] 2014/15 or 2015	Catch (or effort or catch rate) level acceptable and explanation if needed
North Coast Nearshore and Estuarine	Catch Rates (Level 2)	Sustainable: Adequate	Commercial: 33–45 t (barramundi) Recreational: Not formal	Commercial: 52 t (barramundi) 82 t (total) Recreational: 11-19 t (boat)	Acceptable The catch of barramundi is above the allowable tolerance range but as the catch rate is at its highest level since 1990 this catch was still considered acceptable.
Northern demersal scalefish	Catch and Catch Rates/ Integrated Model (Level 2 & 5)	Sustainable: Adequate	Commercial: Under revision Recreational: Not Formal	Commercial: 1,111 t (total) Recreational: 48-64 t (boat only)	NA While the formal commercial catch range is being revised, the catches of goldband snapper and red emperor were both within their longer-term ranges. The current recreational catch levels are not considered to pose any stock issues.
Pilbara fish trawl	Catch and Catch Rates/ Fishing Mortality/ Integrated Model (Level 2, 3 & 5)	Sustainable: Adequate	Commercial: Under revision Recreational: NA	Commercial: 1172 t Recreational: Covered above	NA Reduced catch levels due to ongoing reductions in effort quota. Full assessment and review of catch range currently under revision.
Pilbara demersal trap and line	Catch and Catch Rates/ Fishing Mortality/ Integrated Model (Level 2, 3 & 5)	Sustainable: Adequate	Commercial: 400 – 600 t (trap) 50 – 115 t (line)	Commercial 510 1 (trap) 97 t (line)	Acceptable Total catch of the trap and line fisheries in 2015 were both within their allowable catch ranges.
Mackerel	Catch (Level 1)	Sustainable: Adequate	Commercial: 246 – 410 t(Q, Spanish Mackerel) Recreational: Not formal	Commercial: 302 t Recreational: 22-37 t (boat only)	Acceptable The commercial catch is at the average even with lower effort. Current recreational catch levels do not pose any stock issues.
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)	Sustainable: Adequate	Commercial 667,350 oysters (Q) (14,071 – 20,551 hours) Recreational: NA	Commercial: 627,634 oysters (12,976 dive hours)	Acceptable Low catch rates contributed to relatively high effort level, but still within tolerance range. Oysters at relatively low abundance levels in 2015 due to low spat settlement, but predicted to significantly increase in 2016. Quota not achieved due to economic reasons as vessels switched to seeding operations.

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] 2014/15 or 2015	Catch (or effort or catch rate) level acceptable and explanation if needed
Sea cucumber	Catch Rate (Level 2)	Sustainable: Adequate	Commercial: Sandfish 20 – 100 Redfish 40 – 150 Recreational: NA	Commercial: Sandfish 37 t Redfish 0 t	Acceptable No fishing for redfish in 2015. Catch rate for sandfish above the performance target.
SOUTH COAST BIOREGION					
South Coast crustacean	Standardised Catch Rate (Level 2)	Sustainable: Adequate	Commercial: 50 – 80 (southern rock lobster) Recreational" NA	Commercial: 44 t	Acceptable Commercial catch of southern rock lobster below the tolerance range but the catch rate remained in the targeted region and is therefore acceptable. Catch and catch rates of deep sea crabs are currently being assessed.
Abalone (greenlip/ brownlip)	Standardised Catch Rate plus Fishing Mortality (Level 3)	Sustainable: Adequate	Commercial: 170 t (Q) (3440 - 5270 hours) Recreational: Not formal	Commercial: 152 t (5293 hours)	Not Acceptable Commercial effort exceeded tolerance range due to lower abundance with TAC reduced in 2016 for both species. Current recreational catch levels not considered to pose a stock issue.
South Coast Nearshore and Estuarine finfish	Catch Rates (Level 2)	Inadequate (cobbler in Wilson Inlet)	Commercial: Under review Recreational: Not formal	Commercial: 157 t (salmon) 230 t (other) Recreational: 19-27 t (boat only)	NA Cobbler in Wilson Inlet is inadequate, but cobbler from other regions and other key species considered adequate. Recent commercial catches of salmon still low relative to historic levels, due to low effort and limited market demand. High level of shore-based recreational fishing requires an index developed.
Albany/King George Sound purse seine	Catch (Level 1)	Sustainable: Adequate	Commercial: 2,683 t (Q) Recreational: NA	974 t	Acceptable Catch and effort higher than in 2013/14.
Bremer Bay and Esperance purse seine	Catch (Level 1)	Sustainable: Adequate	Commercial: 3000 t(Q) Combined Recreational: NA	Commercial: 741 t	Acceptable In Bremer Bay the catch was similar to 2013/14 with the effort slightly lower. In Esperance the catch was higher than in 2013/14 with the effort similar.

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] 2014/15 or 2015	Catch (or effort or catch rate) level acceptable and explanation if needed
South Coast Demersal	Gummy and Whiskery shark - CPUE (relative to previous Level 5 assessment) Dusky and Sandbar shark - CPUE (relative to previous Level 4 assessment) Demersal finfish: Level 3 Age Structure SPR	Gummy and whiskery sharks and Demersal finfish: Sustainable: Adequate. Dusky and sandbar sharks: Recovering.	Commercial: shark725 – 1,095 Finfish: under Development Recreational: Not formal	Commercial: 880 t (key species only) Recreational: 31-38 t (boat only)	Acceptable Total commercial catch of key shark species within allowable tolerance range. Gummy shark catch slightly above (<10%) its range but catch rates are high so the catch is still considered acceptable. Stock assessments indicate that indicator demersal finfish species have acceptable stock levels.
NORTHERN INLAND BIOREGION					
Lake Argyle catfish	Catch (Level 1)	Sustainable: Adequate	Commercial: 93 – 180 t Recreational: NA	91 t.	Acceptable The catch was slightly below the allowable 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 5: *Detection of introduced and pest species in 2015/16 resulting from surveillance activities.*
(Shading indicates species has been detected in that Bioregion. Y or N indicates if species was detected in recent surveillance in that bioregion. * indicates species was detected on vessel and is not known to be established in wild).

Common Name	Scientific Name	Type of Organism	Pest status	Year first detected	Bioregion			
					North Coast	Gascoyne Coast	West Coast	South Coast
Mediterranean fanworm	*Sabella spallanzanii*	Polychaete	Pest	2012/13			Y	Y
Scallop	*Scaeochlamys livida*	Mollusc	Introduced species	2012/13			Y	N
Aeolid nudibranch	*Godiva quadricolor*	Mollusc	Introduced species	2013/14			Y	Y
	Alexandrium catanella	Dinoflagellate	pest-like if in bloom	2012/13			N	
	Alexandrium sp.	Dinoflagellate	pest-like if in bloom	2014/15			N	
Ciona	*Ciona intestinalis*	Ascidian	Introduced species	2013/14			Y	Y
Asian paddle crab	*Charybdis japonica*	Crab	Pest	2013/14			N	
Ivory barnacle	*Balanus improvisus*	Barnacle	Pest	2013/14*			N	
	Balanus pulchellus	Barnacle	Introduced species	2013/14*			N	
	Amphibalanus amphitrite	Barnacle	Introduced species	2014/15			N	
Asian green mussel	*Perna viridis*	Mussel	Pest	2011/12*	N		Y*	
Asian date mussel	*Arcuatula senhousia*	Mussel	Pest	2012/13			Y	Y
	Didemnum perlucidum	Ascidian	Introduced species pest-like characters	2012/13	Y	Y	Y	Y
Striped Sandgoby	*Acentrogobius pflaumi*	Goby	Introduced species	2014/15			Y	
	Theora fragilis	Mollusc	Introduced species	2012/13	N			
Dead man's fingers	*Codium fragile subsp. fragile*	Algae	Pest	2014/15				Y

OVERVIEW TABLE 6: *The total number of fishkills in Western Australia and the total number of fish kill investigated by the Fish Health Laboratory since the last SOE report.*

Year	Total Number of Fish Kills	Number of fish kill investigated
2007	23	11
2008	36	21
2009	18	6
2010	18	9
2011	29	12
2012	34	12
2013	25	5
2014	21	6
2015	18	8
2016	27	9

ECOSYSTEM MANAGEMENT

There is a high degree of ecosystem management and protection for the ecological assets that are located within each of the Bioregions. A variety of management measures have been developed and implemented to appropriately mitigate the potential impacts, influences and activities on WA's aquatic resources and ecosystems which now extend to explicitly dealing with the cumulative impacts of fishing activities at a bioregional level. These include:

Climate Change

A three-year FRDC-funded project[17] that examined the potential effects of climate change on the marine environment and key fisheries, as well as management implications has now been completed. The project identified historical trends in environmental variables and their effects on fisheries. Using these trends in combination of projected climate changes trends, a risk ranking for each fo the key fish and invertebrate species was generated that can be used to undertake strategic planning for each of these fisheries. The study identified that climate changes such as decadal shifts and extreme events were already having a major impact on fish stocks that required significant shifts in management. Meeting the challenge of climate changes will require management systems that can detect and respond rapidly to future changes. Existing management arrangements will therefore need to be progressively reviewed to examine their robustness to climate change effects and new management policies will be developed in consultation with stakeholders to deal with climate change effects on fish stocks.

The Department is also a key collaborator in the National RedMap (Range Extension Database & Mapping project) project (www.redmap.org.au) which uses a citizen-science approach to document range extensions of a number of key identified climate-change affected species. Understanding shifts in populations is likely to be increasingly important to adaptive fisheries management.

Spatial Closures

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

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

- Spatial closure to trawl-based fisheries under the Fish Resources Management Act 1994 (IUCN management category IV);
- Establishment of Fish habitat Protection Areas (FHPAs; IUCN management category I);
- Closures to fishing under section 43 of the Fish Resources Management Act 1994 (IUCN management category III);
- Establishment of marine parks through the Conservation and Land Management Act 1984 (CALM Act) and the Fish Resources Management Act 1994 (IUCN management categories I-VI); and
- 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 Ecosystem Management Table 1.

17 Caputi *et al.* .2015a,b. *Management implications of climate change effect on fisheries in Western Australia*. FRDC Project 2010/535. *Fisheries Research Reports*, WA- 260 and 261.

ECOSYSTEM MANAGEMENT TABLE 1 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 km)	Area of shelf equivalent to IUCN marine protected area ≤Category IV (sq km) (%)	Maximum area of Actual trawling activity (sq km)	Total area of habitat effectively protected (sq km) (%)
West Coast	67,226	37,729 (56%)	1029	66,197 (98%)
Gascoyne	54,192	19,207 (35%)	3,773	50,420 (93%)
North Coast	338,188	139,597 (41%)	36,014	302,174 (89%)
South Coast	109,071	-	1,715	108,042 (98%)
TOTAL	568,677	196,533 (35%)	42,531	525,804 (92%)

Management of Commercial Fisheries

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).

Each of the commercial fisheries operates under a specific set of management arrangements with many being formalised into a management plan, which are currently implemented through the legislative framework provided by the Fish Resources Management Act 1994 (FRMA) but this will now begin to be transitioned to the new Aquatic Resources Management Act (ARMA, 2016). The FRMA (and ARMA) 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 except mammals, birds, reptiles and amphibians).

In WA, comprehensive controls on commercial 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 an appropriate proportion of the overall stock biomass. This approach maintains relatively high spawning biomass levels for all harvested species compared to their unfished situation and therefore ensures that recruitment is only affected by environmental conditions and 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.

The annual levels of acceptable effort and catch have recently been formalised within the Departments Harvest Strategy Policy[18]. Key refinements outlined in this policy include the use of indicator species for multi-species resources and establishing appropriate tolerance levels to determine the acceptable range of annual deviations in catch/effort that meet the levels specified by the harvest control rules or sectoral allocation decisions.

The State has also employed an innovative bioregional approach[19] to complete the pre-assessment of all its fisheries for potential third party certification according to the sustainability criteria developed and administered by the Marine Stewardship Council (http://www.msc.org/). The progression of a number of fisheries to full certification is now underway. This process will ensure independent assessment of the sustainability and effective management of

18 DoF. 2015. *Harvest strategy policy and operational guidelines for the aquatic resources of Western Australia. Fisheries Management Paper* No. 271, Department of Fisheries, Western Australia. 44 pp.
19 Bellchambers, et al. 2016. Adopting Marine Stewardship Council certification of Western Australian fisheries at a jurisdictional level: the benefits and challenges. *Fisheries Research* 183:809-616.

assessed fisheries to an internationally recognised standard.

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 commercial fisheries within the Bioregions include:

- Limited entry;
- Harvest Strategies and control rules;
- 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;
- Acceptable Annual Tolerance catch ranges;
- Minimum commercial size limits;
- Protection of berried females; and
- Monitoring of fishing activities using the Vessel Monitoring System (VMS).

Management of Recreational Fisheries

Recreational fishing is also covered by the FRMA (ARMA) and 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. All recreational fishing activities, including those of the charter sector, are subject to the closures associated with marine protected areas detailed above. A number of fisheries require a specific recreational license (e.g. abalone and rock lobster) and some rules which are specific to different bioregions. The comprehensive details of recreational fishing rules can be found on the Departmental website at: http://www.fish.wa.gov.au/Fishing-and-Aquaculture/Recreational-Fishing/Recreational-Fishing-Rules.

In 2010, a statewide recreational 'fishing from boat' license was also introduced. A number of recreational fishing surveys have been undertaken, including a recent statewide recreational fishing from boat survey in 2013/14 (Ryan *et al.*, 2016)[20]. 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.

Management of Aquaculture Activities

The risks associated with aquaculture include: disease, the potential introduction of marine pest species, water quality and waste management and the impact of escapes. 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).

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 that has now established an aquaculture zone in the Kimberley and one is being developed for the Mid West with the aim of encouraging investment in sustainable finfish aquaculture through providing streamlined approval processes.

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.

The Department is working closely with the Commonwealth Government and other jurisdictions to develop and implement the National System for the Prevention and

20 Ryan *et al*. 2015. State-wide survey of boat based recreational fishing in Western Australia 2013/14. *Fisheries Research Report,* 268.

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.

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 have their own ministerial guidelines to ensure marine and coastal resources are protected. These developments undertake 'proof of freedom' pest monitoring to ascertain they have no pests present.

The Marine Biosecurity Research and Monitoring group have implemented a series of biosecurity related projects during 2013 – 2014. All projects aim to detect the presence of introduced marine pests (IMPs) using a suite of tools including ongoing background monitoring and large-scale port monitoring. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful.

Surveys have been implemented that have informed the Department of the status of IMPs in most major WA ports. Background monitoring programs are also continuing with assistance from the relevant Port Authority. This work complements introduced aquatic organism incursion and fish kill incident response programs already in place for each Bioregion. In addition the group has analysed the likelihood of IMPs being introduced into ports in each of the Bioregions as a result of commercial vessel movements.

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 subject to the same regulation as private recreational fishers.

Management of other activities

Marine habitats in 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 North Coast Bioregion. 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. The Department also provides advice to the Western Australian Department of Mines and Petroleum (DMP) and the Commonwealth National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) in relation to oil and gas exploration and development. Significant recent developments include ports in the Pilbara region, oil and gas extraction projects in the Kimberley and Pilbara, the Gorgon Gas Development at Barrow Island.

The Department also continues to actively engage with the natural resource management groups within each bioregion to promote sustainable use of the aquatic environment.

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.

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. The Integrated Marine and Coastal Regionalisation for Australia (IMCRA V 4.0) scheme divides this Bioregion into three meso-scale regions: Abrolhos Islands, Central West Coast and Leeuwin Naturaliste (West Coast Overview Figure 1).

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.

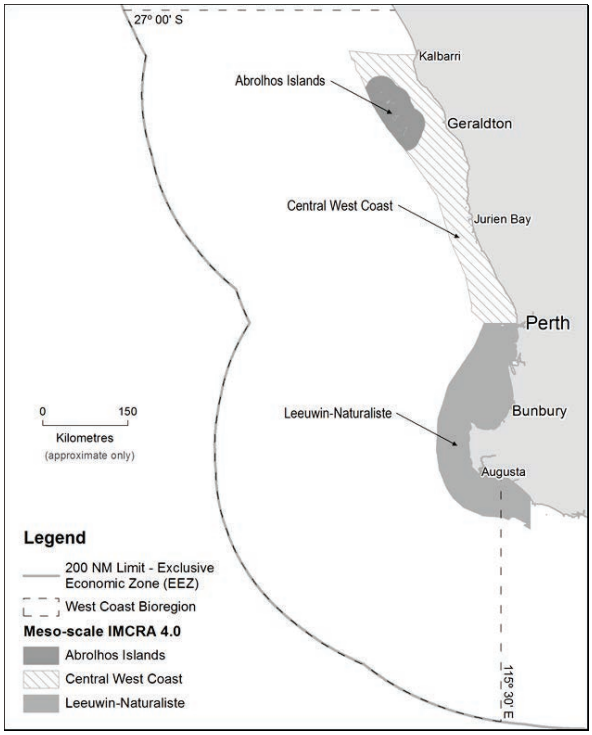
The most significant impact of the clear, warm, low-nutrient waters of the Leeuwin Current is on the growth and distribution of the temperate seagrasses. These form extensive meadows in protected coastal waters of the West Coast Bioregion, generally in depths of 20 m (but up to 30 m), and act as major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

The ecosystem boundaries as defined by IMCRA (V 4.0) in the bioregion are depicted in West Coast Overview Figure 1. The potential threats and risks to these ecosystems are often similar. For simplicity risk ratings were allocated by grouping the ecosystems into two broad groups, estuarine or marine. However, if a particular ecosystem is unique and/or is exposed to different or significant threats, risk was allocated to these ecosystems separately.



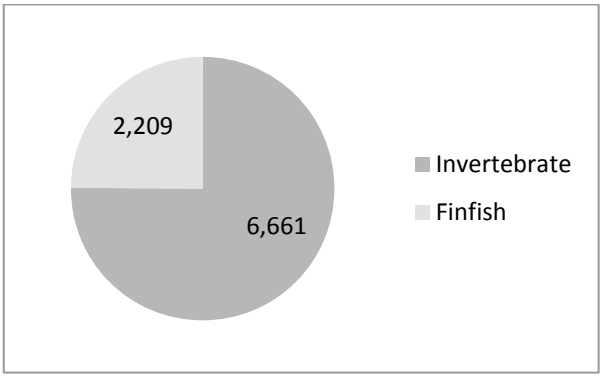
WEST COAST OVERVIEW FIGURE 1

Map showing the three main IMCRA (V4.0) ecosystems in the West Coast Bioregion: Abrolhos Is.; Central West Coast and the Leeuwin-Naturaliste.

SUMMARY OF ACTIVITIES POTENTIALLY IMPACTING THE BIOREGION

Commercial Fishing

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 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.

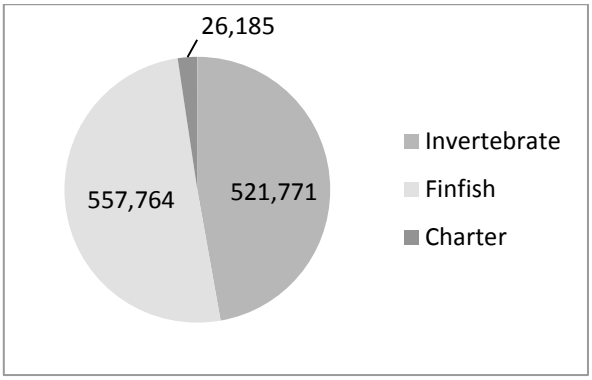


WEST COAST OVERVIEW FIGURE 2

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

Recreational Fishing

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.



WEST COAST OVERVIEW FIGURE 3

The West Coast Bioregion finfish and invertebrate catch numbers as assessed in the integrated survey of boat-based recreational fishing in WA 2013/14, and the charter boat catch numbers for the same period.

Aquaculture

The principal aquaculture development activities in the West Coast Bioregion are the production of blue mussels (*Mytilus galloprovincialis*), marine algae (*Dunaliella salina*) for beta-carotene production and the emerging black pearl industry based on the production of *Pinctada margaritifera* at the

Abrolhos Islands. The main mussel farming area is in southern Cockburn Sound, where conditions are sheltered and the nutrient and planktonic food levels are sufficient to promote good growth rates. Owing to the generally low productivity of the Western Australian coastline under the influence of the Leeuwin Current, areas outside embayments (where nutrient levels are enhanced) are unsuitable for bivalve aquaculture. Initiatives to expand the number of aquaculture sectors in this bioregion currently include those for octopus, live rock/coral and finfish, the Department of Fisheries is in the process of securing strategic environmental approvals for Mid-West Aquaculture Development Zone.

Tourism

The State capital, Perth, is the principal gateway to more than two million visitors to Western Australia each year and a major international transit point for travellers arriving in Australia from Europe and Asia. The south-west of the state is also an important tourism destination for international and interstate visitors, as well as for Western Australian residents. Beach-going is among the most popular leisure activities for tourists in the West Coast Bioregion. Surfing, fishing, SCUBA diving and snorkelling, windsurfing, whale watching and other marine wildlife experiences are also popular tourist activities.

Shipping and Maritime Activity

The West Coast Bioregion contains several major port facilities, including the State's busiest general cargo port (Fremantle), as well as the Royal Australian Navy's largest base (HMAS Stirling) on Garden Island. In addition to handling most of Western Australia's container trade, significant quantities of non-containerised cargo passes through Fremantle, including: motor vehicles, steel and machinery imports, livestock exports and bulk commodities, such as petroleum, grain, alumina, iron ore, mineral sands, fertilisers and sulphur. Two other major commercial ports at Bunbury and Geraldton, primarily export iron ore, grain, mineral sands and alumina. In addition to commercial and naval shipping, international cruise ship visitations have increased to record levels in recent years and some cruise liners are now home-based in Fremantle.

Major shipbuilding, repair, maintenance and offshore construction support industries are also located at Henderson in the north-eastern corner of Cockburn Sound. Collectively, these enterprises directly employ over 2000 people, indirectly support 3000 more jobs and generate around $700 million annually in trade.

Other Activities

High rates of population growth and boat ownership in Western Australia have strained recreational boating facilities around major population centres, particularly in the Perth metropolitan region. New and upgraded marinas and boat launching facilities have therefore been completed or are planned to accommodate this demand. In addition, major coastal infrastructure developments have been planned for an outer deep-water harbour at Fremantle and for a deep-water iron-ore port at Oakajee, 24 km north of Geraldton. Two large desalination plants at Kwinana and Binningup (22km North of Bunbury), which supply approximately half of Perth's freshwater requirements, also operate in the bioregion.

BIOREGIONAL SPECIFIC ECOSYSTEM MANAGEMENT

Within each Bioregion there are a range of management measures that have been implemented to manage the potential impact of activities (See Chapter 3 for an overview). Management measures specific to the West Coast Bioregion include:

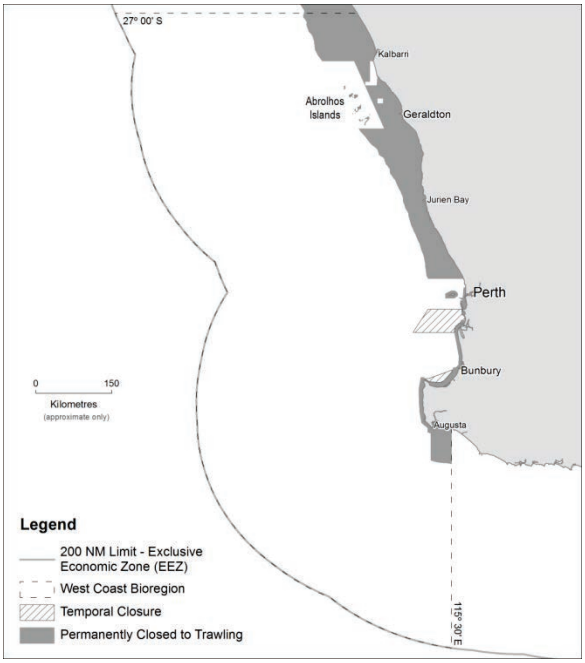
Spatial Closures

The marine benthic habitats and their associated biodiversity along most of the West Coast are largely protected 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 Overview Figure 4). Demersal gillnet and longline fishing was also prohibited from waters inside the 250m isobath between 31º and 33º South in November 2007. The extent of these areas means that most of the West Coast Bioregion inside 200m depth could be classified as one of the marine protected area IUCN categories (Ecosystem Management Table 1).

Protection of fish habitat and biodiversity is also provided by marine protected areas consistent with IUCN categories of I, II and III along the West Coast including: Fish Habitat Protection Areas (FHPAs) at the Abrolhos Islands, Lancelin Island Lagoon, Cottesloe Reef, and Kalbarri Blueholes; Reef Observation Areas within the Abrolhos Islands FHPA and closures to fishing under s.43 of the Fish Resources Management Act 1994 at Yallingup Reef,

Cowaramup Bay, the Busselton Underwater Observatory and around the wrecks of the Saxon Ranger (Shoalwater Bay) and Swan (Geographe Bay). In addition, marine conservation areas proclaimed under the Conservation and Land Management Act 1984 exist 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 Overview Figure 5).

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



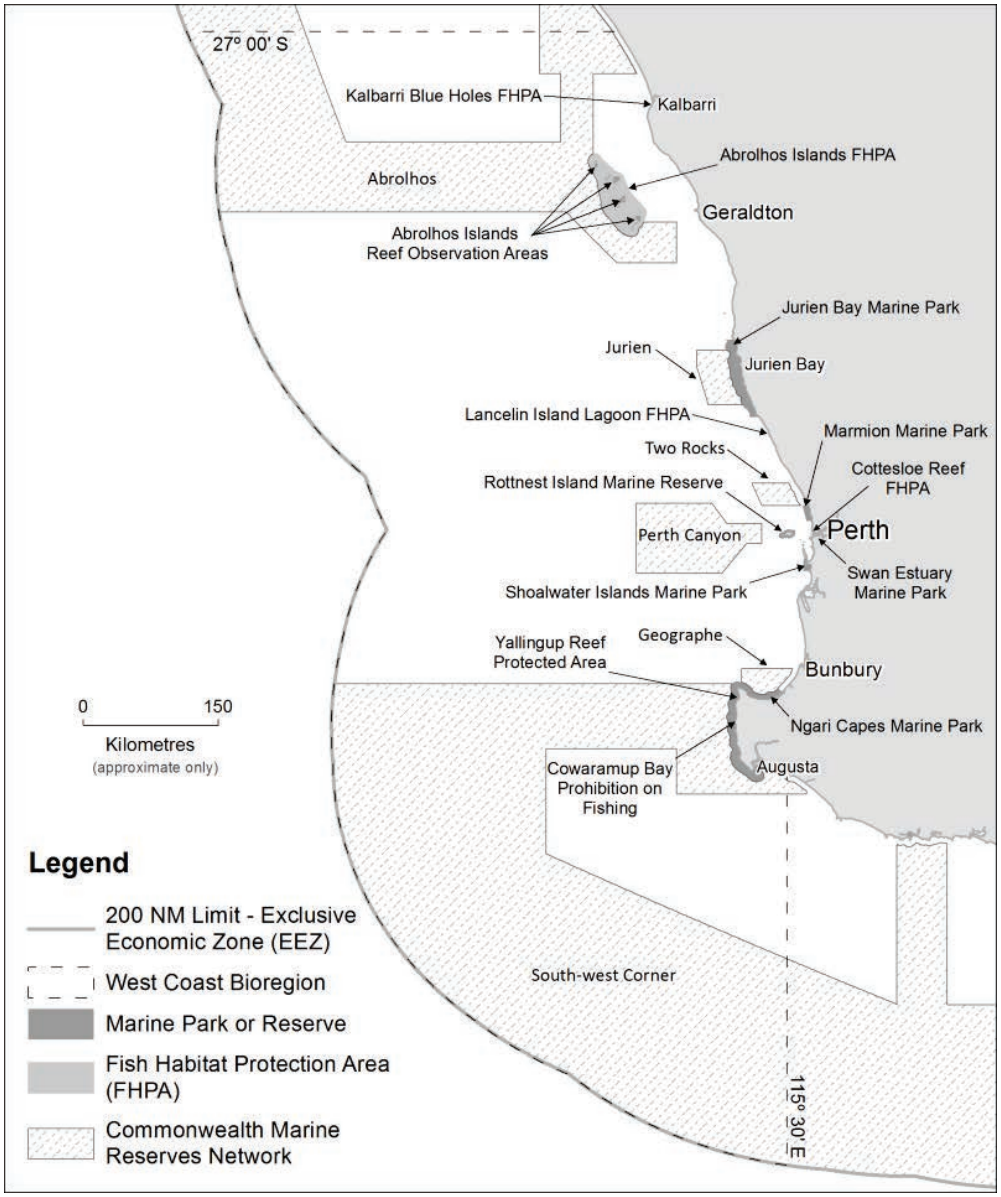
WEST COAST OVERVIEW FIGURE 4

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 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. This table does not yet include the closures that may be implemented by the Commonwealth as part of their marine planning zones.

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



WEST COAST OVERVIEW FIGURE 5

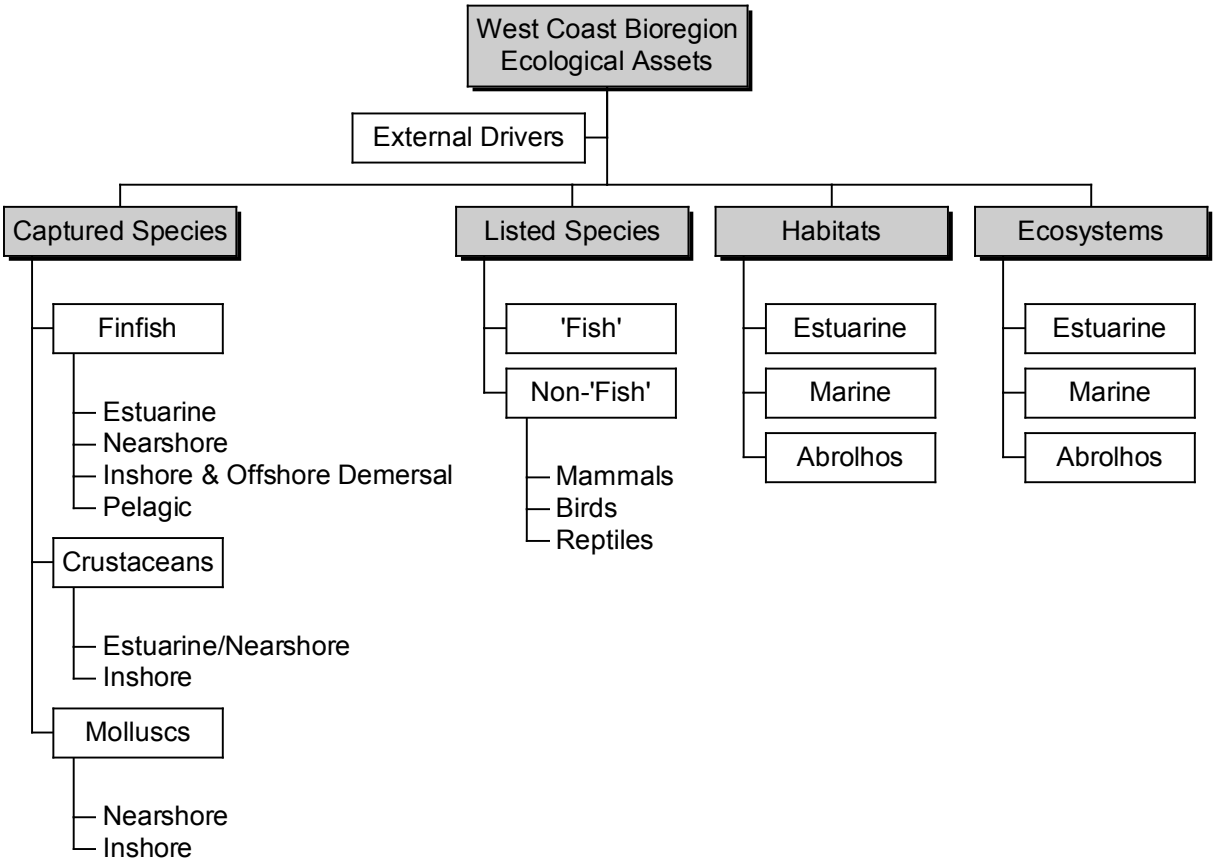
Map showing current and proposed formal marine protected areas in the West Coast Bioregion.

ECOSYSTEM MONITORING AND STATUS

In order to assess the adequacy of management arrangements aimed at ensuring sustainability of the ecological assets within the West Coast Bioregion, the Department must identify and monitor trends in the condition of these resources. This is achieved through application of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher*, et al.,* 2010 see How to use this Volume for more information) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment. (See How to Use section for more details). These key ecological assets identified for the West Bioregion are identified in West Coast Ecosystem Management Figure 6 and their current risk status reported on in the following sections.

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 West Coast Bioregion include climate and introduced pests and diseases.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 6
Component tree showing the ecological assets identified and separately assessed for the West Coast Bioregion.

Climate

External Drivers	Current Risk Status
Climate	HIGH (long term)

Some climate change information has been taken into account in the rock lobster stock assessment process but further information is required to examine potential impacts on this bioregion.

Introduced Pests and Diseases

External Drivers	Current Risk Status
Introduced Pests	LOW
Introduced Diseases	LOW

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 introduced species *Didemnum perlucidum* has recently been detected at the Abrolhos Islands.

Captured Species

Finfish

Estuarine

Captured Species	Aquatic zone	Ecological Risk
Finfish	Estuarine	HIGH (non-fishing)

There is concern for some indicator fish stocks within estuaries in the West Coast Bioregion mainly due to external (non-fishing) factors (e.g. poor water quality and other environmental factors).

Nearshore

Captured Species	Aquatic zone	Ecological Risk
Finfish	Nearshore	SIGNIFICANT

With the increasing concerns for Australian herring, tailor and whiting in the nearshore regions, additional activities are being undertaken to assess these stocks and to develop methods to measure shore-based fishing catch and effort.

Inshore (20-250m depth) and Offshore (>250m depth) Demersal

Captured Species	Aquatic zone	Ecological Risk
Finfish	Inshore and Offshore Demersal	MODERATE

Following assessments of the inshore demersal indicator species (dhufish, pink snapper, baldchin groper), management actions were implemented to reduce both the commercial and recreational catch levels by 50% of their 2005/06 levels. Based on level 3 assessments of indicator stocks in 2013, this resource is now considered to be in a recovery phase.

While the deep-water indicator species are vulnerable to overfishing, current catch levels are low and therefore the stocks are not at risk. However, long term management arrangements for fishing in these depths, particularly for the recreational sector are still being finalised.

Pelagic

Captured species	Aquatic zone	Ecological Risk
Finfish	Pelagic	LOW

There is minimal capture of pelagic fish in this bioregion.

Invertebrates

Crustaceans

Captured species	Aquatic zone	Ecological Risk
Crustaceans (Crabs)	Estuarine/Nearshore	HIGH
Crustaceans (Lobsters)	Inshore	LOW
Crustaceans (Prawns)	Inshore	LOW

The stocks of crabs in Cockburn Sound have now recovered and the fishery has re-opened. Assessment of other crab stocks in this region (e.g. Peel/Harvey) has been completed and all are considered to be in an adequate state and fishing levels are acceptable.

The stock levels of western rock lobster and prawns are both currently at appropriate levels. The strong management that was applied to the rock lobster fishery has ensured that the lobster spawning stock is currently at record high levels despite on-going relatively low puerulus recruitment over the past 6 seasons.

Molluscs

Captured species	Aquatic zone	Ecological Risk
Molluscs (Abalone)	Nearshore	HIGH
Molluscs (Scallops)	Inshore	HIGH

The stocks of abalone are conservatively managed with strong management controls on both commercial and recreational fishers. However, the marine heat wave in 2010/11 caused the almost total loss of Roes abalone in the Kalbarri region and that region has consequently been closed since 2011/12.

The stock of scallops is considered environmentally limited with the Abrolhos Island fishery closed and no fishing occurring in the Mid-West Trawl Fishery.

Listed species

A variety of endangered, threatened and protected[1] (ETP) species can be found within the West Coast Bioregion, including cetaceans, sealions, 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*.

Fish

Listed species	Ecological Risk
Fish	MODERATE

Grey nurse shark (*Carcharias taurus*) is protected under State and Commonwealth legislation throughout this and all bioregions. Blue groper (Rottnest Island), cobbler (Swan Canning)and baldchin groper (Abrolhos Islands FHPA between 1 Nov and 31 Jan) cannot be landed by commercial or recreational fishers in the particular areas and periods given parentheses.

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.

Non-Fish

Listed species	Ecological Risk
Mammals	MODERATE
Birds and Reptiles	LOW

The only identified risk to bird species was to little penguins from boat strikes and non-fishing activities.

The West Coast Bioregion lies to the south of most marine turtles' distributions and, thus, there are minimal risks to turtles from fishing activities within this bioregion. The leatherback turtle, which is relatively more common in temperate latitudes, is rarely encountered in continental shelf waters, where the majority of fishing activities occur. Therefore, fishing is also considered to pose a low risk to this species. In addition, the small trawl fishery that operates around the Abrolhos Islands uses bycatch reduction devices, which are effective at minimising the capture of turtles.

Sea lion exclusion devices have now been implemented for rock lobster pots near Australian sea lion breeding colonies. Demersal gillnet fishing effort, which has historically been responsible for a very small number sea lion captures, has been reduced to less than 10% of its peak level in the late 1980s. Regulated modifications rock lobster fishing gear configuration during humpback and southern right whales' northerly winter migration, have successfully reduced entanglement rates by more than 65% in recent years. Thus, risks to mammals from fishing activities in the West Coast Bioregion have decreased in recent years (but are not yet considered to be low).

Habitats and Ecosystems

Due to the counter-acting Leeuwin and Capes currents, the West Coast Bioregion has the unique characteristic of containing tropical, sub-tropical and temperate ecosystems.

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:

Algae: Along the WCB, algae attach to intertidal and subtidal rocky substrata and in turn, are habitat to a variety of organisms. Algal assemblages contribute to marine nutrient and carbon cycling are also an important as a food source, nursery grounds and shelter for a variety of organisms. Along the WCB, there is a gradual transition from a subtropical flora of the Abrolhos Islands and north of Geraldton to a cold-temperate flora found along the southwest corner and south coast of WA. Macroalgae along the southwestern and southern coasts of Australia are very diverse, with a high level of endemism.

Sand: The majority of seabed of the WCB is composed of soft, unconsolidated sediments. These sediments provide an important habitat for microalgae and benthic infauna.

Seagrasses: In temperate WA, seagrasses occupy approx. 20 000 km2 of shallow coastal and grow predominantly on sand from 1 – 35 m depth, but also on deep rock to over 50 m deep. Seagrasses provide of habitat for many fish and crustacean species, stabilise of coastal sediments and prevent of coastal erosion. In addition seagrasses are also important for primary production, CO2 uptake and nutrient cycling. The diversity of seagrasses in temperate south-western Australia is the highest for any temperate region, with 17 species within WCB and SCB combined.

Corals: Due to the cool temperate waters corals are not common in the WCB with the exception of the Abrolhos Islands, which are located offshore and are more exposed to the warm Leeuwin Current. The Abrolhos Islands are well-known for their high species diversity, coral reefs and unique mixture of temperate and tropical species. Currently there are 184 known coral species at the Abrolhos. Elsewhere in the WCB corals occur in patches around offshore islands, usually comprised of only a few species.

Sponges: In southwestern Australia, sponges are found in areas where algae are less dominant, which includes areas deeper than 30 m and caves. As they are sessile filter-feeders, sponges flourish in areas of high current, although large sponges are also found in calmer deeper waters. In areas with an absence of reef-building corals, sponges function as large epibenthos that form the three-dimensional structure of subtidal reefs providing shelter for other organisms, such as worms, crustaceans, echinoderms, molluscs and fish.

Habitats

Habitats	Aquatic zone	Current Risk Status
West Coast Habitat	Estuarine	SIGNIFICANT (non-fishing)
West Coast Habitat	Marine	LOW
Abrolhos Islands	Marine	MODERATE

The West Coast is a microtidal, relatively high-energy area, with clear water and few rivers. The coastline is characterised by long beaches with occasional limestone cliffs and headlands, with offshore limestone islands and reef complexes. There are numerous protected marine areas in the West Coast (West Coast Overview Figure 5). Spatial zoning restricts activities within these areas including preventing trawling.

The Peel Harvey Estuary habitats are under pressure due to poor water quality as a result of farming, canal development and urbanisation in the surrounding catchment. A benthic habitat monitoring program is planned to quantify impacts of recreational crabbing as a part of the MSC assessment process. Cockburn Sound which contains large areas of seagrass has been mined for shell sand since 1972. The permitted areas for mining have been increasingly restricted and regulated since the commencement of mining operations.

The main fisheries in the Central West Coast involve fishing gear which has minimal impacts to the benthic habitats. These include: western rock lobster which uses traps, Roes abalone which are hand collected and several fin fisheries that mainly use lines.

Due to the unique diversity of tropical and temperate habitats, the Abrolhos Islands were gazetted as WA's first Fish Habitat Protection Area (FHPA) and have been placed on the National Estate Register. Due to this, the risks to Abrolhos Islands habitats are assessed separately to the bioregion as a whole.

The main activities at the Abrolhos are commercial rock lobster potting and line fishing and recreational fishing and diving. The Department has a long term coral reef monitoring program at the Abrolhos to detect potential impacts from human use and natural influences. A significant coral bleaching event was observed during the marine heat wave event in 2011 (Abdo *et al*. 2012)[1].

There are 45 public moorings installed at the Abrolhos Islands, distributed around the different island groups, to minimise impacts of anchoring to the benthic habitats. The commercial scallop fishery (which is currently closed) also operates away from coral reef habitats, predominately in areas of sand.

Ecosystems

Ecosystem	Aquatic zone	Current Risk Status
West Coast	Estuarine	SIGNIFICANT (non-fishing)
West Coast	Marine	MODERATE
Abrolhos Islands	Marine	MODERATE

The estuarine ecosystems within this bioregion 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 mass mortality events in Cockburn Sound are of particular concern.

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 allow evaluation of potential ecosystem impacts of lobster fishing in deeper water ecosystems.

The Abrolhos Islands is noted for its high species diversity, which is attributed to the relatively equal mix of temperate and tropical species. Due to the uniqueness of the AIE in the West Coast Bioregion, it is assessed separately to the bioregion as a whole.

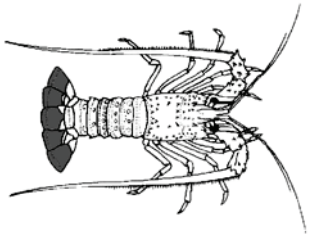
The Abrolhos Islands are protected within a 'Fish Habitat Protection Area', and are not considered to be at unacceptable risk from fisheries related activities. The first significant bleaching of corals was observed during the marine heat wave event along the Western Australian coast in 2011 (Abdo *et 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.

1Abdo DA, Bellchambers LM, Evans SN. 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 NG, and Wise BS. 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.

WEST COAST ROCK LOBSTER RESOURCE STATUS REPORT 2016

S. de Lestang and M. Rossbach



OVERVIEW

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 by both the commercial and recreational sector for which formal IFM allocations have been determined.

The commercial fishery was one of the first limited entry fisheries in the world and for over 20 years utilised a sophisticated Individual Transferrable Effort system based on the number of allowable baited pots. In 2010/11 the fishery began the transition to an Individually Transferable Quota (ITQ) fishery and now has a harvest strategy that uses maximum economic yield as its management target (DoF, 2014). This fishery has historically been Australia's most valuable single species wild capture fishery and, in 2000, became the first fishery in the world to achieve Marine Stewardship Council (MSC) Certification. In 2012 it was the first to be certified by MSC for the third time. The commercial fishing season now begins on the 15 January each year and runs 12 months.

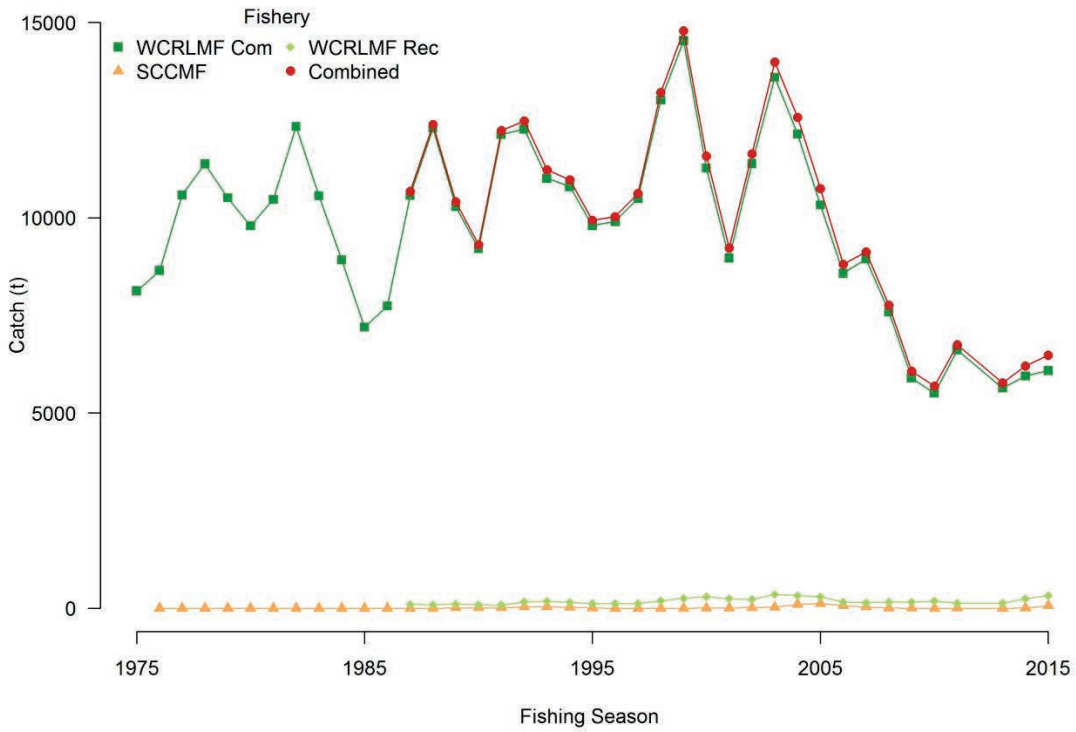
The recreational fishery extends from 15 October each year until the following 30 June. Licenced recreational fishers are allowed to each use two baited pots or hand collection by diving to collect legal sized and reproductive condition lobsters up to the bag or boat based limit.

SUMMARY FEATURES 2016

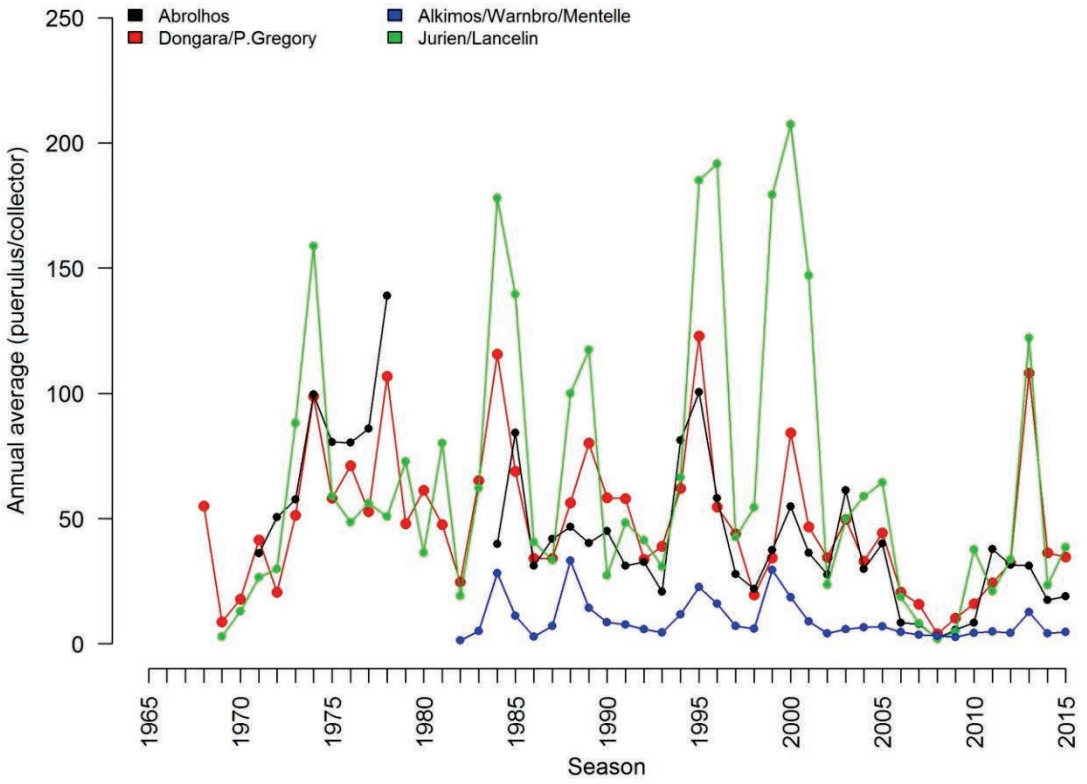
Fishery Performance	Commercial	Recreational	
Total Catch 2015	6086 t	267-394 t	
Fishing Level	Acceptable	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Western Rock Lobster	Sustainable - Adequate	Annual: Integrated Model, Egg Production	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low Risk	**Listed Species**	Negligible Risk
Habitat	Low Risk	**Ecosystem**	Low Risk
Social	High Amenity Low Risk	**Economic**	GVP ($423 million)-Moderate Risk
Governance	Review of Harvest Strategy	**External Drivers**	Moderate Risk

CATCH AND LANDINGS

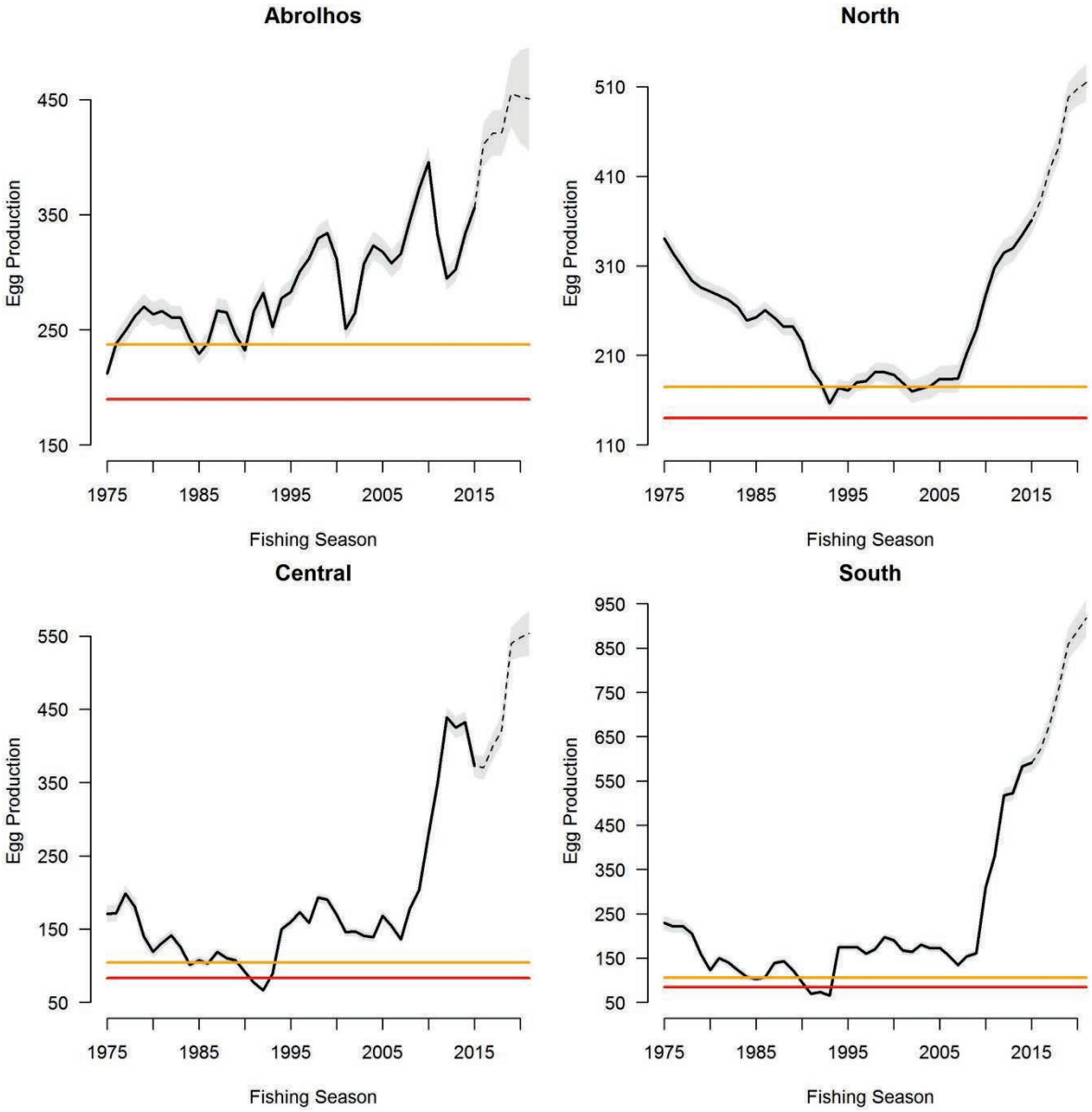
The total landings of western rock lobster in 2015 from the WCRLMF were 6416 t. The commercial catch was 6086 t compared to an allowable catch of 6090 t (TACC of 6000 plus drip loss). The recreational catch was estimated to be between 274-394 t compared to the TARC of 404 t (Western Rock Lobster Figure 1).



WESTERN ROCK LOBSTER FIGURE 1. *Total landings by fishery (and combined) for western rock lobster.*



WESTERN ROCK LOBSTER FIGURE 2. *Levels of puerulus settlement in four regions of the fishery from 1968 until 2015.*



WESTERN ROCK LOBSTER FIGURE 3. *Modelled estimates (black) and projections (dotted line) of egg production for the four breeding stock management areas based on a TACC of 6300 t. 75% CI is denoted in grey. Horizontal lines represent the threshold (orange) and limit (red) reference points for breeding stock levels in each breeding stock management area.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Western rock lobster - (Sustainable-Adequate)

Western rock lobster (WRL) is considered a single management unit in the West Coast Bioregion and the same genetic stock extends into the South Coast Bioregion (see de Lestang *et al.*, 2016 - WRL RAR 2016 for further details). http://www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_9.pdf

Fishery-independent egg production indices at all sites are well above long-term levels and above threshold reference levels indicating that the biomass and egg production in all locations of the fishery is at record high levels since the mid-1970s. The breeding stock is therefore considered adequate.

Fishery-independent recruitment (puerulus) monitoring indicates that the current puerulus settlement is continuing its recent pattern of being just below its historic average (Western Rock Lobster Figure 2).

The integrated population model indicates that a continuation of fishing at similar or slightly higher TACCs (e.g. 6300 t) over the coming five year

period will continue to result in increasing biomass and catch rates (see WRL RAR section 9.3.14 and Western Rock Lobster Figure 3).

BYCATCH AND PROTECTED SPECIES INTERACTIONS

The main by-catch species landed in the WCRLMF are octopus, champagne crabs (CC) and baldchin grouper (BG). Octopus contribute most to total by-catch landings with 10.2 t in 2015 and only incidental landings of the other species being recorded (1.1 and 1.5 t for CC and BG, respectively).

The WCMRLF may interact with a number of protected species with substantial improvements having been achieved during the past decade (see WRL EAR section 4).

To mitigate the risk to juvenile Australian sea lions (ASL) all pots fished within designated sea lion areas are now fitted with devices to stop the accidental drowning of ASL. Since their implementation there have been no records of drowned ASL.

During the whale migration season (May – October inclusive) all pots must comply with mitigation measures aimed at reducing the entanglement of migrating whales (see WRL EAR section 4). This has resulted in a significant (80%) reduction in reported whale entanglements. There were two entanglements reported in 2015.

Turtles can also get caught in the float rigs of lobster pots. In 2015 no turtles were reported to have been entangled in lobster fishing gear.

HABITAT AND ECOSYSTEM INTERACTIONS

While WRL may use a range of habitats throughout their life-cycle, including shallow water reefs and adjacent seagrass beds as juveniles, or un-vegetated areas during their migratory phase ('whites'), the algal covered limestone reefs form the habitat for the majority of the population.

WRL are an omnivorous generalist feeder, with a diet that consists on a variety of invertebrate, algae, carrion and bait. Results from monitoring in areas closed and open to WRL fishing, established to examine the potential ecosystem effects of WRL removal, suggest that lobsters do not play a keystone role in ecosystem functioning (see WRL EAR section 6.2).

SOCIAL AND ECONOMIC OUTCOMES

Social

The commercial rock lobster fishery is important for regional employment with over 230 commercial vessels operating in 2015 with catch handled by four main processing establishments. The rock lobster fishery is also a major recreational activity and provides a significant social benefit to the Western Australian community with over 50,000 recreational fishers obtained rock lobster licences in 2015. At current high stock levels there is **low risk** to the social amenity.

Economic

The estimated average price across all processors and all zones of the fishery received by commercial fishers for the western rock lobster in 2015 was $69.52/kg. This was an increase on the $60.40/kg paid in 2014, and may be due to better fishing practices and a stronger export market and relatively lower Australian dollar. The increased beach price with a slightly higher TACC resulted in the overall value of the fishery increasing to $420 million. As the majority of landed lobsters are exported to a single market (China) this represents a **moderate risk**.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

The landed commercial catch of 6086 was very close to the Total Allowable Commercial Catch (TACC) of 6000 t plus 1.5% for water loss (= 6090 t) and therefore the catch level was acceptable. The upper end of the estimate of recreational catch (274-394 t) was also close to the TARC of 404 t and was therefore also considered acceptable.

Harvest Strategy

A common Harvest Strategy and Decision Rules (DoF, 2014) are used to set catch limits for both commercial and recreational sectors on an annual basis. The HSDR have a primary sustainability objective to maintain egg production at sustainable levels and a secondary economic objective to target maximising the profitability of the fishery i.e. at Maximum Economic Yield (MEY) levels. The upper limit of the MEY assessment is currently used to determine the upper limit of the annual Total Allowable Catch (TAC) as this is the

basis of setting the Total Allowable Recreational Catch (TARC).

Modelled future projections of the fishery and MEY analysis indicates that a small (5 – 10%) increase in TAC will move the commercial fishery towards MEY and maintain healthy levels of egg production. As such the commercial fishery has requested an increase in the TACC from 6000 t in 2016 to 6300 t in 2017.

Compliance

The majority of enforcement effort is applied to ensure that fishers' catches are within their quota entitlement.

Consultation

Consultation occurs between the Department and the commercial sector either through the Western Rock Lobster Council or the Annual Management Meetings convened by the Western Australian Fishing Industry Council. Consultation with Recfishwest and other interested stakeholders is conducted through specific meetings and the Department's website.

Management Initiatives

Consultation with the commercial industry and Recfishwest on the review of the HSDR will begin in 2017. This process will aim to incorporate some of the outcomes from a recent FRDC project which examined the current TAC setting methodology.

EXTERNAL DRIVERS (*Moderate Risk*)

The variations in western rock lobster recruitment to the fishery are largely a result of variable levels of puerulus settlement 3-4 year previously. Catches are also dependent upon the environmental conditions at the time of fishing. Investigation into the puerulus downturn in 2007-2009 have identified that when the spawning started early (temperature driven) and was coupled with low numbers of winter storms during the larval phase, the puerulus settlement was significantly lower.

At a longer time scale, western rock lobsters have been rated a **high risk** to the effects of climate change as many aspects of its life history are highly sensitive to environmental conditions (Caputi *et al*., 2010).

The economic performance of the fishery is strongly affected by the value of the Australian dollar (affecting the price of lobsters), fuel and labour costs and status of the Chinese economy as China imports nearly all of the western rock lobsters.

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de Lestang S, Caputi N, and How J. 2016. *Western Australian Marine Stewardship Council Report Series No. 9: Resource Assessment Report: Western Rock Lobster Resource of Western Australia*. Department of Fisheries, Western Australia.

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Thompson AP, Hanley JR, and Johnson MS. 1996. *Genetic structure of the western rock lobster, Panulirus cygnus, with the benefit of hindsight*. *Marine and Freshwater Research,* 47: 889–896.

WEST COAST ROE'S ABALONE RESOURCE STATUS REPORT 2016

L. Strain, J. Brown and S. Walters

OVERVIEW

The Roe's abalone (*Haliotis roei*) fishery is a dive and wade fishery, operating in shallow coastal waters along WA's western and southern coasts. The commercial Roe's abalone fishery is managed primarily through Total Allowable Commercial Catches (TACCs), which are set annually for each of the six management areas and allocated as Individually Transferable Quotas (ITQs).

The recreational fishery is divided into three zones: Zone 1 (Western Zone - including Perth metropolitan area), Zone 2 (Northern Zone) and Zone 3 (Southern Zone), with management arrangements that include a specific abalone recreational fishing licence, size limits, daily bag and possession limits, temporal and spatial closures, and a Total Allowable Recreational Catch (TARC) in the Western Zone. Further details on the fishery can be sourced from Hart *et al*. (2017).

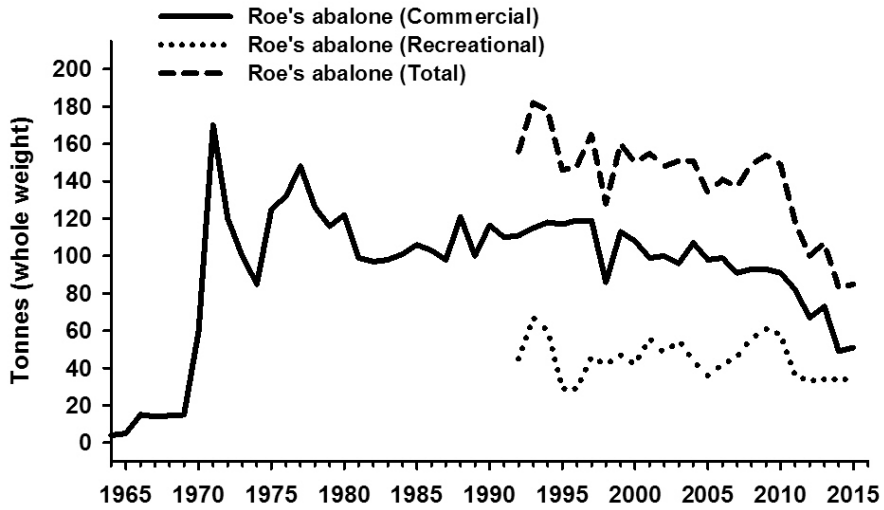
SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	51 t	15 - 25 t Perth Metro Area; 14 t Other	
Fishing Level	Acceptable	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Roe's abalone	Sustainable - Adequate (some areas)	Annual: Catch, Catch Rates, Surveys	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Negligible Risk	**Listed Species**	Negligible Risk
Habitat	Negligible Risk	**Ecosystem**	Negligible Risk
Social	High Amenity High Risk	**Economic**	GVP - $1.2 million High Risk
Governance	TAC review (Area 7 / Zone 1) MSC full assessment underway	**External Drivers**	High - Extreme Risk

CATCH AND LANDINGS

In 2015 the total commercial catch was 51 t whole weight, a 4% increase from 2014 (49 t) and only 59% of the 87 t whole weight TACC (Roe's Abalone Figure 1). The commercial catch was less than the TACC in Area 1 (0% caught), Area 2 (61% caught), Area 5 (28% caught) and Area 6 (22% caught), which was primarily driven by economic reasons (low value of catch and few viable markets), high cost of accessing these areas and prevailing weather conditions (Area 6). Area 7 (Perth metropolitan fishery) was the only management area that fishers caught the entire TACC, while Area 8 is still closed.

The total recreational catch of Roe's abalone in 2015 was 34.4 t whole weight, which represents about 40% of the total Roe's abalone catch (Roe's Abalone Figure 1). The recreational catch includes 15 – 25 t (20.4 t) from the Perth metropolitan stocks, and an estimate of 14 t for the rest of the state (Western Zone excluding the Perth metropolitan stocks and Southern Zone) derived from a 2007 phone diary survey. The Perth metropolitan fishery catch level was similar to that taken in the last 4 years.



ROE'S ABALONE FIGURE 1. *Roe's abalone commercial and recreational catch (t, whole weight) by season as recorded against the nearest calendar year.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Roe's abalone (Sustainable-Adequate for some areas)

Roe's abalone are found in commercial quantities from the WA/SA border to Shark Bay. Evidence suggests the existence of one single Roe's abalone population across this entire range but with three adaptive populations (Sandoval-Castillo *et al*. 2015). The size at sexual maturity is approximately 40 mm shell length and the legal minimum length for Roe's abalone is 60 mm in most parts of the fishery, which based on growth rates, protects 1 to 2 breeding year classes (see Hart *et al*. 2017).

The stock status is assessed using commercial and recreational catch and effort, and fishery-independent sampling. Trends in stock indicators were used to determine the 2016 TACC for each management area, and the TARC for Zone 1 of the recreational fishery.

Area 1 (near WA/SA border): There was no fishing in 2015. This area is a marginal part of the fishery in a remote location making it uneconomical for fishers given current market conditions.

Area 2 (Esperance): The catch in 2015 was 11 t whole weight of the 18 t TACC. The standardised catch per unit effort (SCPUE) has been gradually declining since 2010 but it is above the threshold reference level.

Area 5 (Albany): The catch in 2015 was 5.6 t whole weight of the 20 t TACC. The SCPUE has reduced slightly in the last three years but it is still above the threshold reference level.

Area 6 (Capes): The catch in 2015 was 2.6 t whole weight of the 12 t TACC. The SCPUE in 2015 was above the threshold reference level and within the historical range, but due to the prevailing weather conditions resulting in low catch there is a degree of uncertainty around the SCPUE estimate.

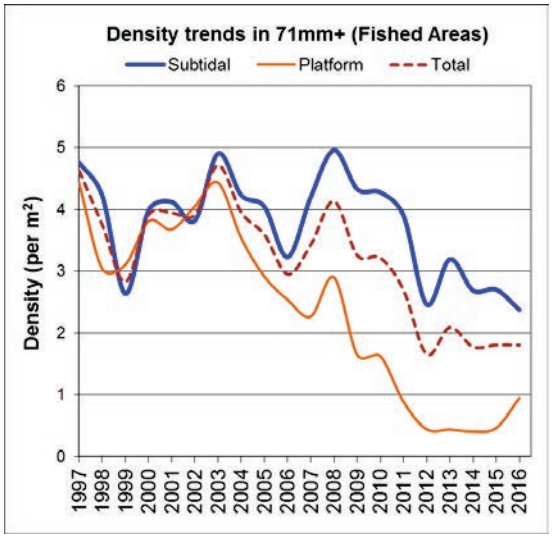
Area 8 (Kalbarri): Closed since the 2011/12 season due to catastrophic mortality following the 2011 marine heat wave. With no evidence of natural recovery, a restocking project has been initiated.

Perth Metropolitan Roe's Abalone Fishery (Area 7/Zone 1): The commercial catch in 2015 was 31.7 t of the 32 t TACC, which was 4 t less than the average historical catch/TACC (1999-2013). The SCPUE in Area 7 has declined since 2005 but it is still above the threshold reference level and the TACC was set using the stock prediction model (DoF 2017). The recreational catch estimate was 15 – 25 t (20.4 t) whole weight and has been managed to the 20 t (± 2 t) TARC for the last 5 years. Despite the reduced recreational catch through this period, the catch rates and mean Roe's abalone whole weight caught are still within historical ranges.

Fishery-independent surveys indicate that the density of harvest-sized (commercial) Roe's

abalone has declined in both subtidal and platform habitats, and across both fished and unfished areas over the last decade (Roe's Abalone Figure 2a and b). The density of harvest-sized animals on the reef platform declined by more than 80% from 2003 to 2012 but has since remained stable, whereas in the reef subtidal habitat the density is currently at the lowest recorded level (Roe's Abalone Figure 2a). Significantly, the levels of decline have been even greater in areas where no fishing occurs suggesting these declines are not being generated by fishing (Roe's Abalone Figure 2b). The trend in declining density is also present in Age 1+ (17 – 32 mm) animals post marine heat wave, when the recruitment density declined by 80% between 2010 and 2013, with 2012 – 2016 being the five lowest years on record (Roe's Abalone Figure 2c).

a)



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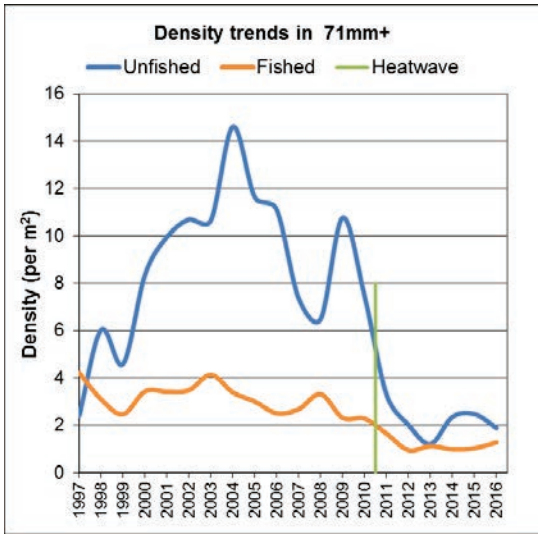

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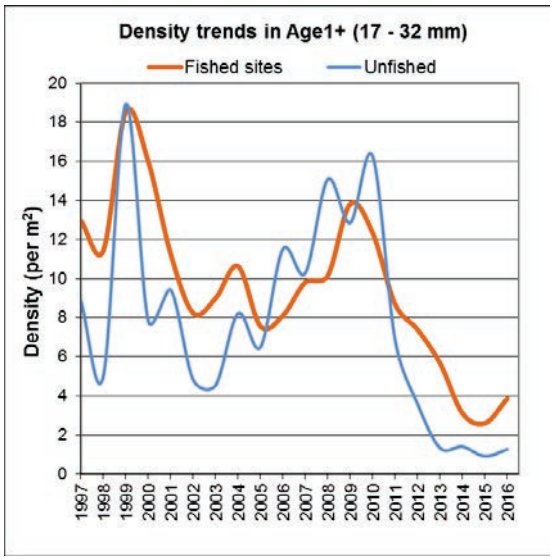

ROE'S ABALONE FIGURE 2. *Density of Roe's abalone in the Perth metropolitan fishery (Area 7/Zone 1) from fishery-independent surveys. a) Density of Roe's abalone (71 mm+) in the subtidal and platform fished areas, b) Density of Roe's abalone (71 mm+) in the fished and unfished areas, c) Density of Roe's 1+ abalone (17 – 32 mm) in the fished and unfished areas.*

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Negligible Risk*)

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. The only potential listed species interaction is with the white shark (*Carcharodon carcharias*), with some divers adopting the 'shark shield' technology.

HABITAT AND ECOSYSTEM INTERACTIONS (*Negligible Risk*)

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 fished areas, and hence it is considered unlikely that the fishery has any significant effect on the food chain in the region.

SOCIAL AND ECONOMIC OUTCOMES

Social (High Risk)

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 Perth 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 16,965 licenses were issued that would have allowed fishers to participate in the recreational abalone fishery.

Economic (High Risk)

Estimated annual value (to fishers) for 2015 was $1.2 million, based on the estimated average price for Roe's abalone of $23.69/kg whole weight. The price of Roe's abalone has dropped by over 50% since 2000, when it was $55/kg whole weight. This is due to the value of the Australian dollar and wild caught Roe's abalone being in direct market competition with abalone produced by aquaculture.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels (Commercial – Acceptable)

Commercial: 87 t (TACC) (530 - 640 fishing days)

(Recreational – Acceptable)

Recreational: 20 t (TARC) Perth metropolitan fishery only (Zone 1)

Commercial catch was less than the quota in Area 1 (0% caught), Area 2 (61% caught), Area 5 (28% caught) and Area 6 (22% caught), due to economic reasons (low value of catch) and high cost of accessing these areas. Area 8 is still closed due to the catastrophic mortality following a marine heat wave. Area 7 (Perth metropolitan fishery) survey abundance of recruitment and spawning stock at low levels, which require additional management actions implemented including the TARC being reduced to 20 t.

Harvest Strategy (Formal)

The harvest strategy (DoF 2017) uses SCPUE as a proxy for biomass as the key performance indicator, which are assessed against specified biological reference levels for each management area. The Perth metropolitan fishery (Area 7 / Zone 1) is managed using a stock prediction model along with a temperature factor (DoF 2017). The predicted recruitment is used to set the TAC, with the habitat biomass and sectorial patterns of usage separating the TAC into TACC and TARC.

Compliance

The Department conducts regular inspections of commercial catch at both the point of landing and processing facilities to ensure the commercial industry is adhering to governing legislation. The recreational fishery, particularly the Perth metropolitan fishery, has a high level of enforcement given its high participation rate combined with restrictive season length and bag limit.

Consultation

The Department undertakes consultation directly with the Abalone Industry Association of Western Australia (AIAWA), the West Coast Abalone Divers Association and 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 facilitated by Recfishwest under a Service Level Agreement, although the Department undertakes direct consultation with the community on specific issues.

Management Initiatives (MSC Assessment)

The fifth year of the trial of a summer season for the Western Zone of the recreational fishery was undertaken for the 2015/16 summer. The season began on the first Sunday of November 2015 and extended till the first Sunday of March 2016, with fishing taking place between 7 and 8 am on the first Sunday of each month. Evidence from the first four seasons indicates a considerable drop in

effort due primarily to poor weather conditions, despite a relatively constant number of licenses. For the 2015/16 season, the same number of fishing days and the reduced daily bag limit of 15 (from 20) abalone per person was maintained from the previous season. The objective of continuing the reduced bag limit is to maintain low catches so as to promote an increase in density on the platform habitats, which have experienced significant declines in the last decade (Roe's Abalone Figure 2a). The commercial Roe's abalone fishery is currently undergoing full MSC assessment (https://www.msc.org/track-a-fishery/fisheries-in-the-program/in-assessment/Indian-ocean/Western-Australia-abalone-fishery/Western-Australia-abalone-fishery).

EXTERNAL DRIVERS (*High-Extreme Risk*)

During the summer of 2010/11, the West Coast experienced a marine heat wave such that in the area north of Kalbarri mortalities on Roe's abalone were estimated at 99.9%, and a complete closure of the commercial and recreational fisheries was implemented. The heat wave also affected the Perth metropolitan stock but to a lesser extent. Annual weather conditions have a significant effect on catch rates and total catch of recreational fishers. The small size of Roe's abalone mean it is in direct competition with hatchery-produced abalone and therefore, there has been a decline in beach price and overall economic value during the last decade.

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WEST COAST BLUE SWIMMER CRAB RESOURCE STATUS REPORT 2016

D. Johnston, R. Marks and J. O'Malley

OVERVIEW

Blue swimmer crabs (*Portunus armatus*) are found along the entire Western Australian coast (<50 m). The commercial crab fisheries within the West Coast Bioregion are the Cockburn Sound Crab Managed Fishery, the Warnbro Sound Crab Managed Fishery, Area 1 (Swan-Canning Estuary) and Area 2 (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. Commercial crab fishers currently use purpose-designed crab traps. For more detailed descriptions of the crab fisheries see Johnston *et al*., 2015a.

Blue swimmer crabs represent the most important recreationally fished inshore species in the southwest of WA in terms of participation rate centred largely on the estuaries and coastal embayments from Geographe Bay to the Swan River and Cockburn Sound using either drop nets, scoop nets or diving. Management arrangements for the commercial and recreational fisheries include minimum size, protection of breeding females, seasonal closures with effort controls for the commercial fishery.

Both the commercial and recreational Peel-Harvey crab fisheries attained MSC Certification in 2016 (see Johnston *et al*., 2015b for full details).

SUMMARY FEATURES 2016

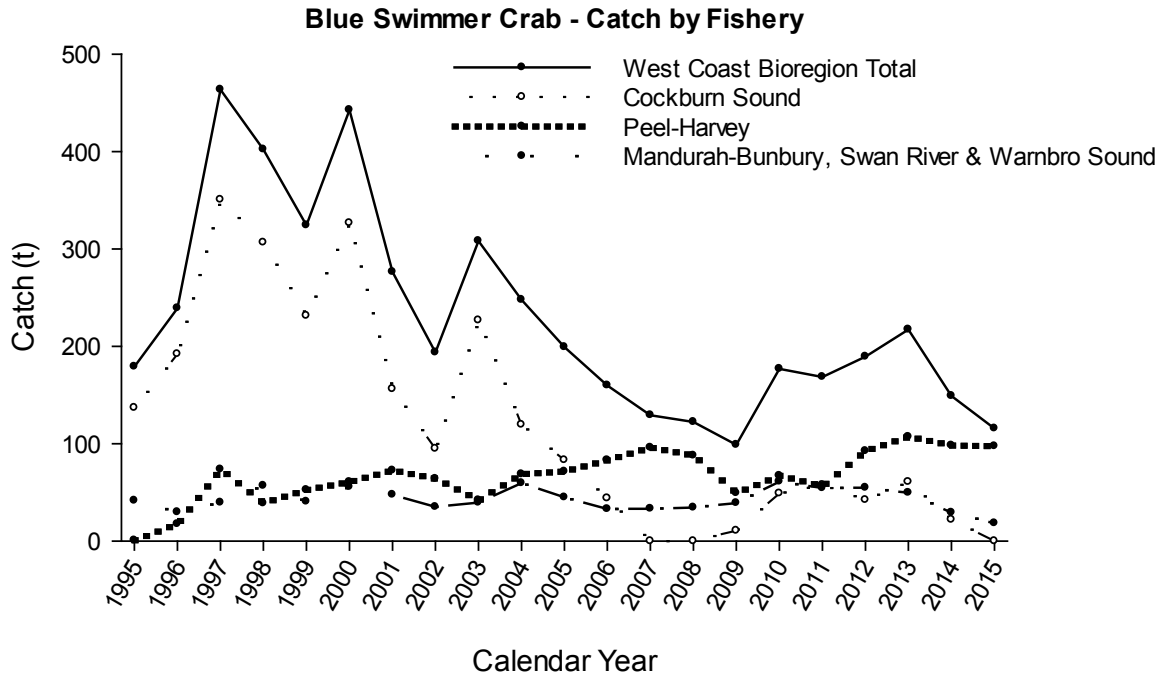
Fishery Performance	Commercial	Recreational
Total Catch 2015	116 t	64 t (Boat survey May 13-Apr 14)
Fishing Level	Cockburn Sound: Closed Peel-Harvey: Acceptable Other fisheries: Acceptable	Cockburn Sound: Closed Peel-Harvey: Acceptable Other fisheries: Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Cockburn Sound	Environmentally Limited	Level 4 Direct Survey
Peel-Harvey	Sustainable – Adequate	Level 2 Catch Rates
Other SW	Sustainable - Adequate	Level 2 Catch Rates

EBFM Performance Asset	Level	Asset	Level
Bycatch	Negligible Risk	**Listed Species**	Negligible Risk
Habitat	Low Risk	**Ecosystem**	Low Risk
Social	High Amenity Moderate-High Risk	**Economic**	GVP Level 2 ($1-5 million) Moderate-High Risk
Governance	Management Review Underway	**External Drivers**	Moderate- High Risk

CATCH AND LANDINGS

Commercial Sector

The total commercial catch from the West Coast Bioregion in 2015 was 116 t. This represents a 22% decrease on the 149 t taken in 2014, primarily due to the closures of Cockburn Sound and Warnbro Sound and cessation of fishing in Area 2 of the Mandurah to Bunbury Developing Crab Fishery (Blue Swimmer Crab Figure 1).



BLUE SWIMMER CRAB FIGURE 1. *West Coast bioregion commercial catch history for the blue swimmer crab in Western Australia since 2000.*

Recreational Sector

Most (88%) of the recreational blue swimmer crab fishing in Western Australia occurs in the West Coast Bioregion (Ryan *et al*. 2015). The survey provided a statewide estimate of the boat-based recreational retained catch of 72 t (S.E.±4.8 t), of which 64 t (S.E.±4.7 t) was from the West Coast bioregion.

A previous (2008), more comprehensive survey of recreational fishing in Peel-Harvey covering fishing from boats, shore, canals, and houseboats estimated the recreational catch to be between 107-193 t. This was lower compared to the recreational catch estimate of 251-377 t in 1998/99 (Johnston *et al*., 2014). Additional recreational surveys have been conducted in Cockburn Sound, Warnbro Sound, Swan-Canning Estuary, Leschenault Inlet and Geographe Bay (see Johnston *et al*., 2015a,b).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Crab assemblages in the southwest are genetically separate to more northern stocks in Shark Bay and Exmouth Gulf, but there is genetic overlap between some stocks in the south-west that are spatially adjacent to each other. South-west stocks are however managed separately at the present time but with recognition that recruitment and breeding stock may be fluid between some areas.

Spawning in the south-west peaks between September and January. Juvenile growth is rapid with crabs maturing (at approx. 90mm carapace width) within 12 months and attaining commercial size (130 mm CW) within 15 months.

Cockburn Sound (Environmentally Limited)

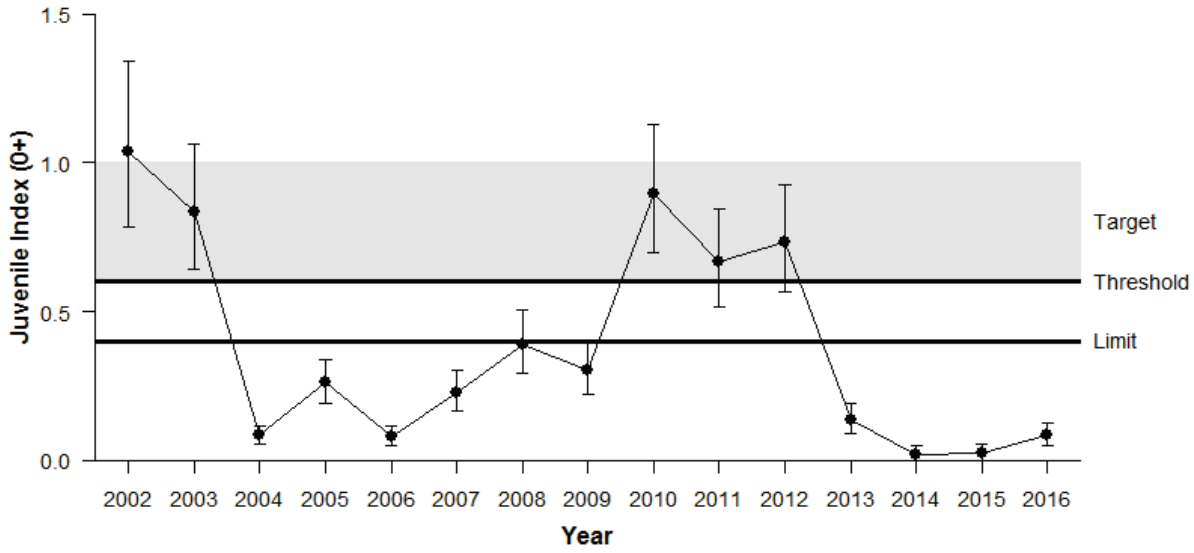
Since the fishery was closed in 2014, a preliminary harvest strategy has been determined for the Cockburn Sound Crab Fishery where the primary performance indicators are the juvenile index and egg production index (Johnston *et al*., 2015a,b). A weight of evidence approach is used for the stock assessment 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: The juvenile index for 2015 of 0.02 juveniles/100m^2 trawled was still below the limit. The juvenile index for 2016 was a slight improvement but continues to be below the limit at 0.08 juveniles/100m^2 trawled (Blue Swimmer Crab Figure 2).

Egg Production index: The revised egg production index in 2014 (4.0) and 2015 (2.8) remains well

below the proposed threshold level of 12, (based on the stock-recruitment relationship) outlined within the draft harvest strategy and the fishery remains closed.

Reasons for the stock decline being investigated include combined effects of reduced levels of primary productivity within Cockburn Sound, changes in water temperature, increased predation and the negative effects of density dependent growth which appears to have had an effect on the proportion of berried females. The declines in abundance are therefore substantially attributable to environmental changes, rather than fishing, consequently the stock is classified as **Environmentally Limited**.



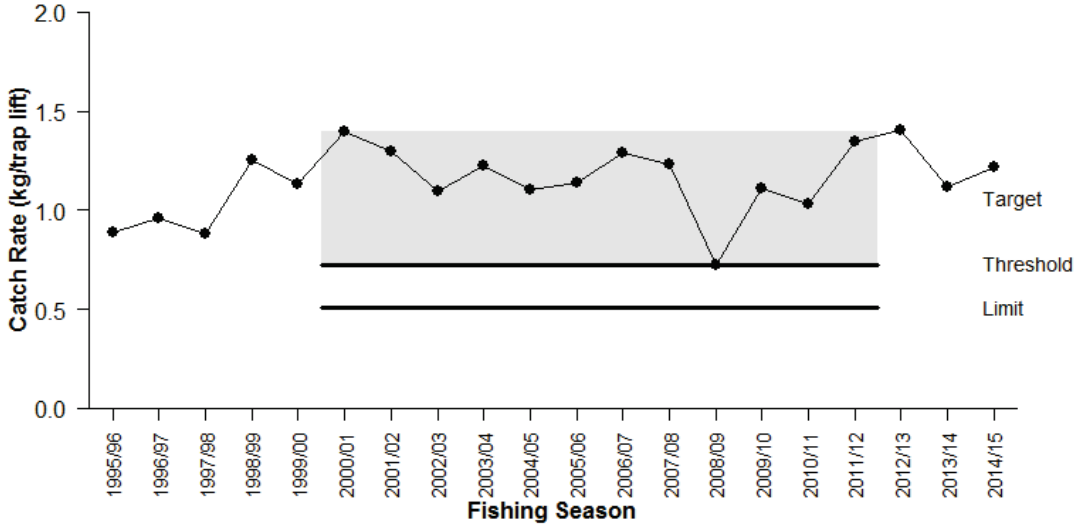
BLUE SWIMMER CRAB FIGURE 2. *Annual standardised index of juvenile (0+) blue swimmer crabs in Cockburn Sound calculated using data from juvenile research trawl conducted in April, May and June of each year. The index units are numbers of juveniles/100m^2 trawled. The associated reference points (target, threshold and limit) for the preliminary harvest strategy and the 95% confidence intervals are shown.*

Peel-Harvey Estuary (Sustainable Adequate)

The commercial catch and effort from the Peel-Harvey Estuary for the 2014/15 fishing season was 97 t from 69,888 trap lifts which are both very similar to 2013/14 (Blue Swimmer Crab Figure 3).

Since the complete gear conversion from nets to traps in 2000/01, annual commercial catch rates have fluctuated between 0.8 and 1.7 kg/trap lift, but have generally remained above 1 kg/trap lift.

The nominal annual catch rate for 2014/15 in the Peel-Harvey Estuary was 1.4 kg/trap lift (West Coast Blue Swimmer Crab Figure 3). The standardised catch rate of 1.3 kg/traplift for the 2014/15 fishing season was well above the harvest strategy threshold of 0.7 kg/traplift, indicating the stock is currently being fished at sustainable levels. On the basis of this evidence, the crab stock in the Peel Harvey is classified as **Sustainable**.

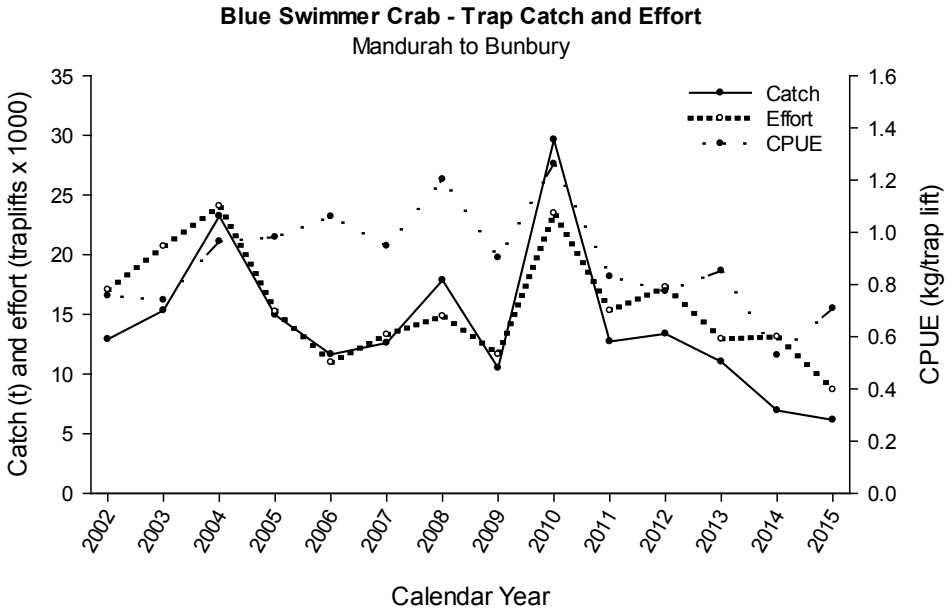


BLUE SWIMMER CRAB FIGURE 3. *Annual standardised commercial catch rate (kg/traplift) of blue swimmer crabs in the Peel-Harvey crab fishery relative to the associated reference points (target, threshold and limit) for the harvest strategy. The reference period is from 2000/01 to 2011/12; defined as the 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.*

Mandurah to Bunbury Developing Crab Fishery (Sustainable – Adequate)

The Mandurah to Bunbury Developing Crab Fishery (Area 1 and Area 2) reported a total annual catch and effort for 2015 of 6 t from 8,684 trap lifts, representing 11% and 34% decreases compared to 2014 (Blue Swimmer Crab Figure 4).

The mean catch rate for 2015 of 0.7 kg/trap lift was a 34% increase on the 2014 catch rate of 0.5 kg/trap lift (Blue Swimmer Crab Figure 4). On the basis of this evidence, the crab stock in this region is classified as **Sustainable**.



BLUE SWIMMER CRAB FIGURE 4. *Blue swimmer crab trap catch per unit effort (kg/traplift) in Area 1 and Area 2 of the Mandurah to Bunbury Developing Crab Fishery since 2002.*

BYCATCH

Crab pots are purpose-designed to minimise the capture of non-target species and are therefore an inefficient way to capture fish. The low number of fish caught and returned poses a **negligible risk** to these stocks.

PROTECTED SPECIES INTERACTIONS

The crab trap longline system 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 and are therefore considered a **low risk**.

HABITAT

Retrieval of traps may result in minor dragging across the mostly sandy substrate. The small amount of living seagrass removed, results in minimal habitat damage and hence trapping poses a **low risk** to benthic habitats. The potential impacts of wading on near shore habitats by the recreational fishers who scoop net in the Peel-Harvey Estuary is currently being assessed.

ECOSYSTEM INTERACTIONS

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 and are a **low risk** to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

West Coast blue swimmer crab fisheries provide a high social amenity to recreational fishing and diving and to consumers via commercial crab supply to markets and restaurants. During 2015, approximately 20 people were employed as skippers and crew on vessels targeting blue swimmer crabs in the West Coast Bioregion. Blue swimmer crabs provide a highly popular recreational fishery, particularly in the Swan River, Cockburn Sound, Warnbro Sound, the Peel-Harvey Estuary and the Geographe Bay region, where they dominate the inshore recreational catch. They are the highest captured recreational species.

Economic

The commercial blue swimmer crab catch in the West Coast Bioregion for 2015 had an estimated gross value of product (GVP) of approximately $0.62 million, an increase on the $0.78 million in 2014 (level 2 $1-5 million). 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 and for 2015 were set at $5.36 per kg.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

Cockburn Sound: Under review

Peel Harvey: 45 - 107 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.

Harvest Strategy

Cockburn Sound: Closed

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.

As these indicators are below the limit levels, the fishery will remain closed.

Peel Harvey:

A harvest strategy has been determined for the Peel-Harvey Crab Fishery (Johnston *et al.*, 2015 b) where the primary performance indicator is standardised annual catch rate with the reference period between 2000/01 and 2011/12.

As the indicator was above the threshold, no changes to the management will occur for the 2017 season.

Other West Coast Fisheries:

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 using the reference period for Area 1 Comet Bay is between 2005/06 and 2011/12, and for Area 2 Mandurah-Bunbury between 2004/05 and 2011/12.

As the indicator was above the threshold, no changes to the management will occur for the 2017 season.

Compliance

Current risks to enforcement are low for West Coast crab fisheries. However, the Peel-Harvey Estuary has a high level of enforcement risk as it has the highest level of non-compliance in the State, particularly for undersize crabs being taken and during night-time periods.

Consultation

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.

Management Initiatives

A southwest crab fishery management review is being undertaken during 2016/17 with the aim of increasing protection to female breeding stock. Potential options include extending or introducing season closures and increasing minimum size to provide a greater buffer to female breeding stock.

EXTERNAL DRIVERS

Levels of recruitment to many of the crab fisheries fluctuate considerably, mainly due to environmental influences (e.g. water temperature), both on spawning success and larval survival through to recruitment. 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 is being 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. Temperature appears to be an important factor contributing to the decline of the Cockburn Sound Crab Fishery.

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WEST COAST OCTOPUS RESOURCE STATUS REPORT 2016

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

OVERVIEW

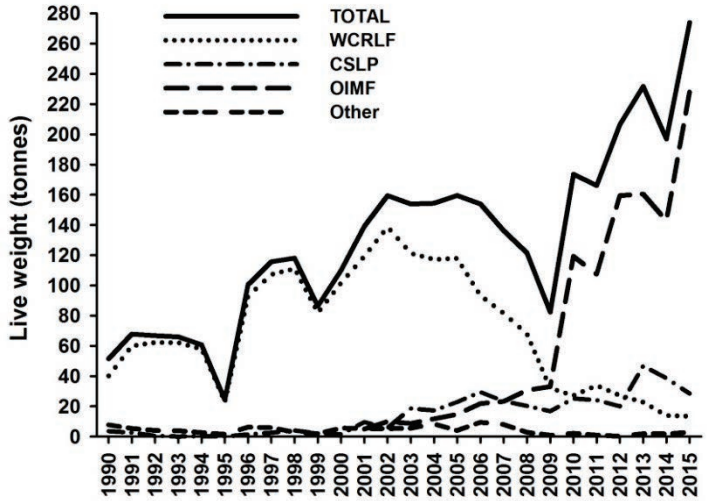
The octopus fishery in Western Australia targets the gloomy octopus (*Octopus tetricus*). Commercial octopus catch is harvested from three different fisheries with the majority of commercial catch coming from the Octopus Interim Managed Fishery (OIMF). The primary harvest method in the OIMF is a 'trigger trap'. Unbaited or passive (shelter) pots are also used and octopus are also caught as by-product by rock lobster pots. Commercial management arrangements include input controls on the total allowable number of pots/traps permitted in each spatial management zone.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	274 t	2 t	
Fishing Level	Acceptable	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Gloomy Octopus	Sustainable - Adequate	Annual: Catch, CPUE	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low Risk	**Listed Species**	Low Risk
Habitat	Low Risk	**Ecosystem**	Low Risk
Social	Low Amenity	**Economic**	GVP – ($2.2 million)
	Low Risk		Low Risk
Governance	New Management Plan	**External Drivers**	Low Risk

CATCH AND LANDINGS

In 2015 the total commercial octopus catch was 274 t live weight, which was a record-high catch and a 34% increase over last year's catch of 204 t (Octopus Figure 1). The recreational catch by boat-based fishers at both the state-wide and bioregional levels estimated the total number of octopus captured during 2013/14 for all bioregions was 2,800 (92% in the West Coast Bioregion), which equates to a total weight of 2.0 tonnes (Ryan *et al*. 2015).



OCTOPUS FIGURE 1. *Commercial catch (t) of Octopus tetricus in Western Australia since 1990. WCRLF (West Coast Rock Lobster Fishery), CSLPF (Cockburn Sound Line and Pot), OIMF (Octopus Interim Managed Fishery) and Other, which is bycatch from trawl and miscellaneous pot fisheries.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Gloomy octopus (Sustainable-Adequate)

Octopus tetricus was subject to a recent comprehensive stock assessment which looked at biology, fishing efficiency and stock abundance and distribution (Hart *et al*. 2016). The overall conclusion was that the stock is highly productive, with an average maximum age of 1.5 years, as well as abundant and widely distributed along the West and South Coast of Western Australia. The estimated area of fished habitat (507 km^2) was found to be only a minor percentage (~2%) of the total estimated habitat area of >30,000 km^2 (Hart *et al*. 2016). The current catch of 274 t is considerably lower than the estimate of sustainable harvest derived by Hart *et al*. (2016), which was in the range of 800 – 2200 tonnes. Consequently the breeding stock is considered to be **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS *(Low Risk)*

The selective method of fishing used results in a minimal level of bycatch of other species. In 2015 there were no reported entanglements with whales. This compares favourably with 2014 when there were two reported whale entanglements in octopus fishing gear. Fishers have adopted gear changes to mitigate entanglements, which includes setting pots on longlines, and using weighted ropes that hang vertically in the water column.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat effects (Low Risk)

In the CSLPF and OIMF, 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 OIMF and 15-20 days in the CSLP. 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).

Food chain effects (Low Risk)

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**.

SOCIAL AND ECONOMIC OUTCOMES

Social (Low Risk)

Each dedicated octopus fishing vessel employs between 2 and 4 people. In 2015, ~ 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, 4 vessels fished in the CSLP, and 14 vessels in the OIMF. There is also a substantial processing and value-added component to the octopus catch with factories in Fremantle and Geraldton.

Economic (Low Risk)

The estimated annual value for 2015 was $2.2 million based on the total catch of 274 t and an average product price of $8.13 /kg live weight.

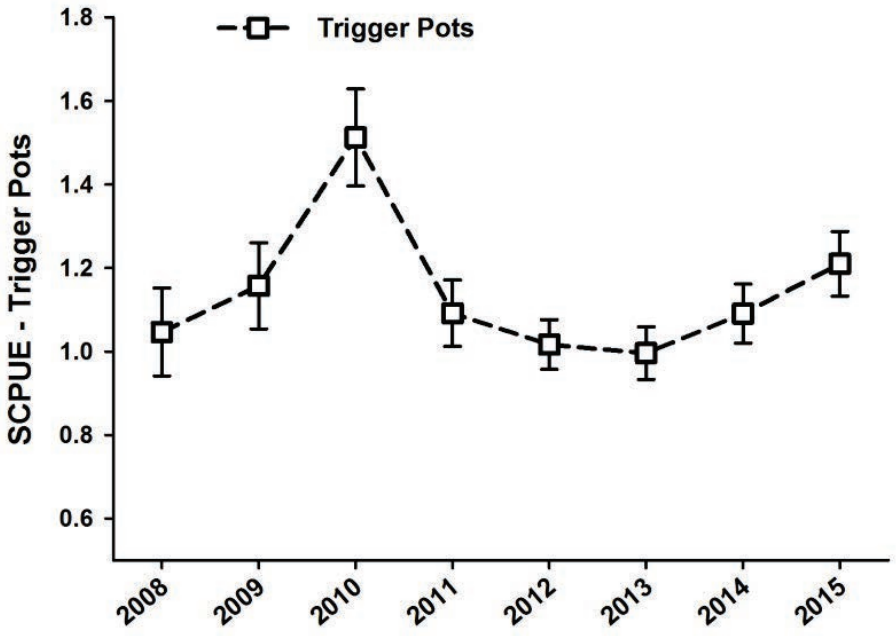
GOVERNANCE SYSTEM

Annual Catch Tolerance Range (Acceptable)

Under previous commercial fishing effort levels, the target catch range for octopus was 50-250 t, this level has been exceeded in 2016 due to expansion of the fishery and additional pot allocations in late 2015. The Fishery is currently in a new development phase and the allowable catch range will be reviewed in 2016 and 2017.

Harvest Strategy

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 OIMF sector. Current catch rate is around 250 kg/day, however both these measures are being reviewed in light of the developing nature of the fishery. The main performance indicator for the proposed new harvest strategy will be a standardised catch per unit effort (SCPUE) in kg/pot lift, which accounts for environmental and efficiency changes in the fishery, and has been increasing since 2013 (Octopus Figure 2).



OCTOPUS FIGURE 2. *Standardised catch per unit effort (SCPUE) (±95% CL) in kg / pot (kg in live weight) of octopus tetricus.*

Compliance

There are no significant issues but it is important to highlight the importance of timely logbook data from fishers to reflect current status of the fishery.

Consultation

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.

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 Initiatives (New Management Plan)

The Department has developed formal management arrangements for the OIMF. Following the conclusion of an independent panel process on access and allocation, an Interim Management Plan for the OIMF was gazetted in 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 DRIVERS *(Low Risk)*

Cephalopods in general, including octopus, are known to be subject to large environmentally-driven fluctuations in abundance. 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 WCRL fishery remains a low % of the overall catch.

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WEST COAST NEARSHORE AND ESTUARINE FINFISH RESOURCE STATUS REPORT 2016

K. Smith and M. Holtz

OVERVIEW

In the West Coast Bioregion (WCB) nearshore and estuarine finfish are targeted by beach-based fishers and boat-based fishers operating in shallow water. The main recreational method is line fishing. The main commercial methods are haul, beach seine and gill netting. Fishery landings of nearshore species include whitebait (*Hyperlophus vittatus*), western Australian salmon (*Arripis truttaceus*), Australian herring (*Arripis georgianus*), southern school whiting (*Sillago bassensis*), yellowfin whiting (*Sillago schombergkii*), yelloweye mullet (*Aldrichetta forsteri*), tailor (*Pomatomus saltatrix*), southern garfish (*Hyporhamphus melanochir*), silver trevally (*Pseudocaranx georgianus*) and King George whiting (*Sillaginodes punctata*). Landings of estuarine finfish are mainly sea mullet (*Mugil cephalus*), estuary cobbler (*Cnidoglanis macrocephalus*) and black bream (*Acanthopagrus butcheri*).

Five commercial fisheries target nearshore and/or estuarine finfish in the WCB. Four estuaries are open to commercial fishing. The Peel-Harvey Estuary commercial fishery (Area 2 of the West Coast Estuarine Managed Fishery) received Marine Stewardship Council (MSC) certification in June 2016 (see Department of Fisheries 2015, Johnston *et al*. 2015 for full details).

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	371 t	78 t (boat-based only)	
Fishing Level	Acceptable	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Nearshore	Inadequate	Annual: Catch, Catch Rate; Periodic: Fishing mortality, SPR	
Estuarine	Sustainable - Adequate	Annual: Catch, Catch Rate	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low Risk	**Listed Species**	Negligible Risk
Habitat	Negligible Risk	**Ecosystem**	Low Risk (from fishing)
Social	High Amenity Moderate Risk	**Economic**	GVP Level 2 ($1-5 million) Moderate Risk
Governance	Harvest strategy for herring under development	**External Drivers**	High Risk (habitat degradation, climate change)

CATCH AND LANDINGS

In 2015, the total commercial catch of nearshore and estuarine finfish in the WCB was 371 t, comprising 217 t from ocean waters and 154 t from estuaries (Nearshore and Estuarine Finfish Table 1). The commercial catch was taken by five fisheries: West Coast Estuarine Managed Fishery, West Coast Beach Bait Managed Fishery, Cockburn Sound (Fish Net) Managed Fishery, South West Coast Salmon Managed Fishery and the South West Beach Seine Fishery.

The total recreational catch was not estimated in 2015 due to lack of information about the shore-based recreational sector, which takes a significant proportion of the catch of these species. The boat-based recreational catch of nearshore and estuarine finfish in the WCB was estimated to be 78 t in the most recent survey in 2013/14 (Ryan *et al.* 2015).

NEARSHORE AND ESTUARINE FINFISH TABLE 1. *Total catches of finfish in commercial fisheries in nearshore and estuarine waters in West Coast Bioregion in previous five years.*

Species	Scientific name	2011	2012	2013	2014	2015
Sea mullet	*Mugil cephalus*	77.7	103.7	100.1	123.4	143.4
Whitebait	*Hyperlophus vittatus*	34.8	65.7	18.6	63.5	61.2
Western Australian salmon	*Arripis truttaceus*	6.3	47.1	92.7	60.1	37.9
Australian herring	*Arripis georgianus*	37.2	28.5	47.1	46.6	49.0
Yellowfin whiting	*Sillago schombergkii*	17.9	18.4	24.1	36.6	46.5
Yelloweye mullet	*Aldrichetta forsteri*	16.2	22.6	18.6	19.8	6.3
Tailor	*Pomatomus saltatrix*	7.2	9.0	14.2	10.5	9.8
Southern garfish	*Hyporamphus melanochir*	19.2	5.8	4.3	4.8	2.4
Estuary cobbler	*Cnidoglanis macrocephalus*	7.4	5.2	1.8	0.2	1.3
King George whiting	*SIllaginodes punctata*	5.1	3.7	2.0	0.9	0.8
Trevallies	*Pseudocaranx* spp.	2.3	2.3	2.8	2.2	1.7
Other finfish		15.1	14.0	24.7	11.7	10.5
Total		**246.5**	**325.4**	**346.4**	**378.4**	**370.8**

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

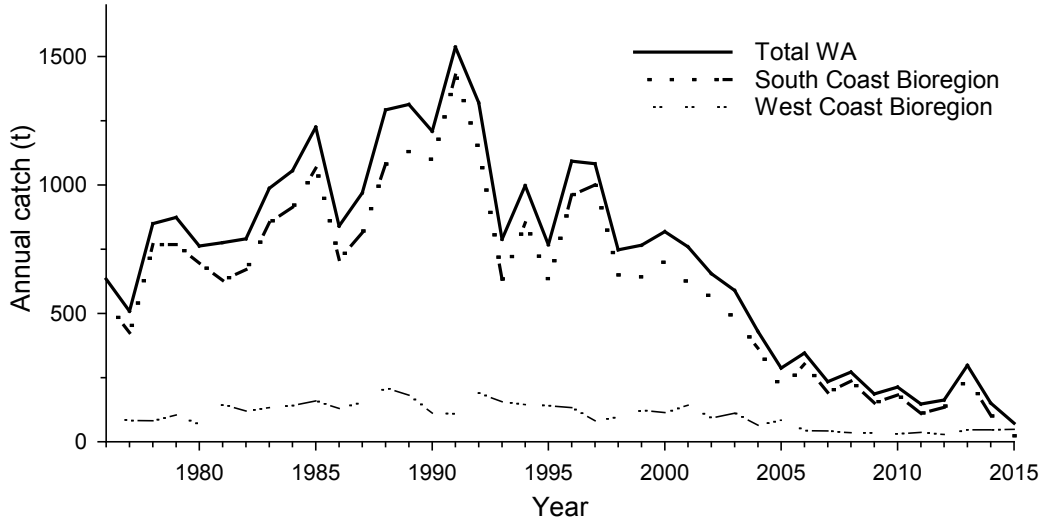
The status of each stock is assessed using a weight-of-evidence approach that considers all available information about the stock. For level 3 assessments, performance indicators now include both spawning potential ratio (SPR) and fishing mortality (F).

Australian herring (Sustainable-Recovering)

Australian herring comprise a single breeding stock across southern Australia, which spawns in Western Australia (WA) (Smith and Brown 2014). The species is caught by commercial and recreational fisheries in WA and South Australia, with negligible quantities also taken in Victoria (Smith *et al.* 2013a).

In 2015, the total WA commercial catch was 72 t, the lowest since the 1940s (Nearshore and Estuarine Finfish Figure 1). The South Coast Estuarine Managed Fishery, Cockburn Sound (Fish Net) Managed Fishery and South West Beach Seine Fishery reported most of the commercial catch in 2015. Estimated boat-based recreational catches of herring declined from 29 t (± 3 t) in 2011/12 to 16 t (±2 t) 2013/14 (Ryan *et al.* 2015). The current shore-based recreational catch is unknown.

SPR is now the key indicator of stock status; with *F* used as one of the lines of evidence in Level 3 assessments. SPR has been below the limit reference level of 20% since 2009/10 (Department of Fisheries in prep). A recovery plan has been implemented for this stock. On this basis, the Australian herring stock is classified as **recovering**.



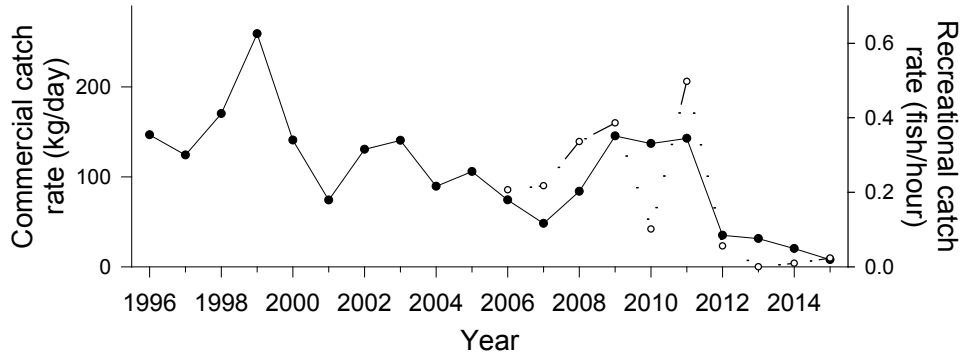
NEARSHORE AND ESTUARINE FINFISH FIGURE 1. *Total commercial catches of Australian herring, 1976 to 2015.*

Southern garfish (Perth metropolitan zone) (Inadequate)

Southern garfish ranges across southern Australia from WA (Lancelin) to New South Wales (Eden). Population structure is complex. Semi-discrete populations can arise over small distances (<60 km) due to the low rates of movement/dispersal by individual fish (Smith *et al.* 2016). In the WCB, the main fishing area is the Perth metropolitan zone, particularly Cockburn Sound. Garfish in this area are likely to have limited connectivity with populations further south (e.g. in Geographe Bay).

Total commercial landings in the WCB peaked at 44 t in 1999 and then steadily declined, reaching an historical low of 2 t in 2015. Partial estimates of shore-based recreational catch are available for the Perth area, April-June only. The April-June catch was estimated to be >5 t in 2010, but <0.5 t in subsequent years (Smallwood *et al.* 2012). In the WCB, the total boat-based recreational catch was estimated to be 2-5 t per year in 2005/06, 2008/09, 2009/10, and 2011/12, but declined to <1 t in the most recent survey in 2013/14 (Ryan *et al.* 2015, Smith *et al.* 2016).

The SPR had declined from 40% in 1998 to be approximately equal to the limit reference level of 20% in 2010/11 (Smith *et al.* 2016). Commercial catch rates have been declining since 1996 (Figure 2), including a sharp decline after the 2011 'heatwave' event, and further declines during 2012-2015. The trends suggest a substantial decline in stock level since the late 1990s. The current spawning biomass is likely to be <20% of the unfished level and therefore the southern garfish stock in this region is classified as **inadequate.**



NEARSHORE AND ESTUARINE FINFISH FIGURE 2. *Standardised commercial and recreational catch rates of southern garfish in Cockburn Sound.*

Sea mullet (Sustainable-Adequate)

Sea mullet occurs in all WA Bioregions. It was formerly regarded as a single species with a global distribution but sea mullet along the west and east coasts of Australia are now regarded as at least two distinct species (Krück *et al.* 2013). Sea mullet within each WA Bioregion are currently regarded as discrete breeding stocks.

In the WCB, the majority (60-70% p.a.) of commercial landings are taken in Peel-Harvey Estuary. Recent commercial landings are low compared to historical levels due to effort reductions. Since 2000, landings have been relatively stable and ranged from 77 t (in 2011) to 143 t (in 2015) (Table 1). The boat-based recreational catch is estimated to be <1 t (Ryan *et al.* 2015) and, whilst the current recreational shore-based catch is not known, it is believed to be low.

The Peel-Harvey standardised commercial catch rate has been stable since the 1970s, suggesting a relatively stable WCB stock level over a long period. On the basis of this evidence, the sea mullet stock in this region is classified as **adequate.**

Yellowfin whiting (Sustainable-Adequate)

Yellowfin whiting occurs in WA from Exmouth to Albany and based on known life history and behaviour traits, the 'southern' (WCB and South Coast Bioregion) and 'northern' (Gascoyne Coast Bioregion) populations of this species are currently regarded as separate stocks.

The majority (>95%) of commercial landings of the southern stock occur in the WCB. The West Coast Estuarine Managed Fishery (WCEMF) takes ≥50% of these landings each year, with the South West Beach Seine Fishery contributing significant amounts in some years. The commercial catch in the Peel-Harvey Estuary (i.e. Area 2 of the WCEMF) has rapidly increased in the past 3 years, from 10 t in 2012 to 30 t in 2015. In 2015, the total commercial catch was 49 t.

The total recreational catch is unknown due to lack of information about the shore-based sector which is believed to take almost all recreational landings of this species (Brown *et al.* 2013). Anecdotal reports suggest a recent increase in the recreational catch also occurred in the Peel Harvey region. The boat-based recreational catch is estimated to be very low (<1 t) (Ryan *et al.* 2015).

Preliminary findings from a level 3 assessment indicate that the higher catches in recent years are due to strong recruitment. Catches in both sectors are expected to decline and return to more typical levels in the next few years as the influence of the recruitment event wanes. On the basis of this evidence, the yellowfin whiting stock in this region is classified as **adequate.**

King George whiting (Sustainable-Adequate)

King George whiting ranges across southern Australia from WA (Jurien Bay) to New South Wales (Jervis Bay). It is believed that that a separate breeding stock occurs in WA (Jenkins *et al.* 2016.

In WA, the majority of landings are taken recreationally. The current shore-based recreational catch is unknown, but likely to be smaller than the boat-based recreational catch (Brown *et al.* 2013). Estimated boat-based recreational catches were 27 t (±4 t) in 2011/12 and 22 t (±4 t) in 2013/14 (Ryan *et al.* 2015). In those years, the total commercial catch was 15 t and 14 t, respectively. In 2015, the total commercial catch was 23 t. The catch level can fluctuate markedly in response to recruitment variations.

A level 3 assessment in 2010-2012 indicated that F was moderate in inshore waters where juveniles occur, but low in offshore waters where adults occur (Fisher *et al.* 2014). SPR was estimated to be around the target level of 40%. The total catch (commercial plus recreational) in 2015 is likely to be higher than in 2010-2012, due to recruitment variations, but still within the historical range. Thus, overfishing is unlikely to be occurring and the current spawning biomass is likely to be at a similar level to that estimated in 2010-2012. On the basis of this evidence, the King George whiting breeding stock is classified as **adequate.**

Whitebait (Sustainable-Adequate)

In WA, whitebait has been reported from Kalbarri southwards, but most commonly between Perth and Cape Naturaliste. The range appears to have contracted over the past 1-2 decades in response to environmental changes, and the stock is now

mainly found in the Bunbury area. Whitebait usually inhabits coastal waters within 10 km of the shore and has traditionally been targeted by commercial beach-based haul netting (Gaughan *et al.* 1996). Recreational landings are negligible.

Since 2003/04, virtually all commercial landings have been reported in the Bunbury area by the SWBSF. Landings followed a relatively stable trend (i.e. non-directional) from the late 1980s until 2009/10. Since then, relatively low catches have been reported that are likely due to low stock abundance. Whitebait has a lifespan of only 3-4 years, and so catches are strongly driven by recruitment variability. The 2011 heatwave event along the west coast appears to have resulted in spawning failure in winter 2011, and led to exceptionally low catches and catch rates in 2012/13 and 2013/14 (Nearshore and Estuarine Finfish Table 1). The increase in total catch to 97 t in 2014/15 suggests that the breeding stock is **adequate**.

Tailor (Adequate)

In WA, tailor occurs from Onslow to Esperance and is believed to constitute a single stock over this range (Smith *et al.* 2013b). In 2015, the total commercial catch of tailor was 20 t (Nearshore and Estuarine Finfish Table 1). Approximately half of this catch was taken in the WCB, with most of the remainder in the Gascoyne Coast Bioregion (see Inner Shark Bay Scalefish Status Report) and a small amount in the South Coast Bioregion. In the WCB, the total commercial catch has typically been less than 20 t per year since records commenced in 1912. The catch was 10 t in 2015, with the majority taken in the Peel-Harvey Estuary.

The current recreational catch is unknown due to lack of information about the shore-based sector, which is believed to take a larger catch share of tailor than the boat-based sector (Smith *et al.* 2013b). Estimated boat-based recreational catches were 14 t (±4 t) in 2011/12 and 6 t (±1 t) in 2013/14 (Ryan *et al.* 2015). Most of the recreational catch of tailor is taken in the WCB.

The catch rate of tailor fluctuates markedly in response to recruitment variations, which are linked to environmental factors. Catch rates and juvenile recruitment are monitored annually in the Perth area. A level 2 assessment in 2012 indicated that stock status was acceptable (Smith *et al.* 2013b). Current catch, catch rate and recruitment levels are within the recent historical range, indicating that overfishing is unlikely to be occurring and the current stock status remains **adequate**.

Estuarine cobbler (Peel-Harvey-Adequate)

In WA, cobbler occurs in ocean and estuarine waters but is mainly caught by commercial fishers in estuaries. Landings by recreational fishers are believed to be negligible. 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 1996, annual landings of cobbler in the WCB have ranged from <1 t to 10 t. Almost all WCB commercial landings occurred in the Peel-Harvey Estuary. In 2015, approximately 1 t of cobbler was reported from this estuary. Commercial landings of cobbler in the Peel-Harvey Estuary are now managed under a Harvest Strategy, which uses catch and catch rate as indicators of fishery performance (DoF 2015). Both catch and catch rate were within the target range in 2015, indicating a low fishing impact on this stock. On the basis of this evidence, the cobbler breeding stock in this estuary is classified as **adequate.**

Black bream (Swan Canning-Adequate)

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 the WCB, this species is mainly taken recreationally. Estimated boat-based recreational catches of black bream were 3.1 t (±0.9 t) in 2011/12 and 1.1 t (±0.3 t) in 2013/14 (Ryan *et al.* 2015). The current shore-based recreational catch is unknown, but is believed to be larger than the boat-based recreational catch.

In the Swan-Canning Estuary, recreational and commercial catch rates suggested an increase in black bream availability between 1990 and 2000, followed by a slight decline from 2000 to 2006 (Smith 2006). Voluntary recreational logbook fisher catch rates suggest stable availability from

2004 to 2015. On the basis of this evidence, the cobbler stock in the Swan-Canning Estuary is classified as **adequate**.

Perth herring (Environmentally Limited)

Perth herring is endemic to the WCB, where a single breeding stock is believed to occur. Stock level was assessed via commercial catch rate trends in the Swan-Canning Estuary until cessation of fishing for this species in 2007 (Smith 2006). Swan-Canning catch rates suggested a major decline in the stock after 1980, which is attributed to historical overfishing and environmental degradation in estuaries (Smith 2006). Limited fishery-independent evidence suggests regional abundance remains low compared to historical levels. The Peel-Harvey Estuary is now the only area where this species is caught commercially, albeit in low quantities. Landings by recreational fishers are negligible.

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 WCB estuaries and low rainfall is believed to be the main cause of ongoing low stock abundance. Commercial landings within the Peel-Harvey Estuary are managed under a Harvest Strategy, which specifies a limited annual catch (<2.7 t) for this vulnerable species (Department of Fisheries 2015). The catch was below this target level in 2015, indicating a low fishing impact on the stock. On the basis of this evidence, the Perth herring stock is classified as **environmentally limited.**

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch: 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 and so bycatch species are at **low risk**.

Protected Species: Interactions with listed species by the fishing gear used in these commercial fisheries are negligible. Estuarine birds have been known to interact with fishing nets, but none have been reported in recent years and the risk to their populations is negligible. Commercial fishers are required to report all interactions with listed species. Recreational fishers using line-fishing methods are unlikely to capture listed species and interactions are expected to be a **negligible risk**.

HABITAT AND ECOSYSTEM INTERACTIONS

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

Ecosystem: Whitebait in Warnbro Sound is a key prey item for little penguins (*Eudyptula minor*) and whitebait availability may affect their breeding success (Cannell *et al.* 2012). Major fluctuations in whitebait abundance are believed to be primarily due to environmental factors. Current levels of commercial effort are historically low, and so whitebait removals by fishing pose a **low risk** to local penguins.

SOCIAL AND ECONOMIC OUTCOMES

Social

The nearshore and estuarine recreational fisheries of the WCB provide a **high social amenity** for the WA community. This Bioregion hosts the main population centres and these resources are very accessible to shore-based and small vessel recreational fishers. There is currently a **moderate risk** to these values.

In the WCB, there were 31 commercial fishers employed (either part or full time) in nearshore and estuarine fisheries in 2015, largely supplying fresh fish to meet demand for locally-caught product.

Economic

Estimated annual value (to fishers) for 2015: Level 2 ($1 to 5 million).

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

West Coast Estuarine Managed Fishery (Peel-Harvey Estuary only):

Finfish caught commercially in the Peel-Harvey Estuary are managed according to a Harvest Strategy which uses catches and catch rates as indicators of fishery performance (Department of Fisheries 2015). In 2015, the catches of sea mullet and yellowfin whiting exceeded their threshold reference levels (70 t and 14t, respectively). The Department reviewed the risks posed by these catch levels and determined that they were **acceptable**.

Cockburn Sound (Fish Net) Managed Fishery:

The catch in 2015 was below the tolerance range of 30 – 112 tonnes (finfish only). The catch has been below this range for 8 of the past 10 years. This range was based on annual landings by a higher number of vessels than are currently operating. A single vessel now operates in this fishery and catch data cannot be reported for confidentiality reasons.

Australian herring fisheries:

The commercial catch tolerance range is 50-179 tonnes. This range represents the minimum and maximum total annual catches by 'minor' herring fisheries (i.e. excluding G-trap net fishery) over the period 2000-2014. The 2015 catch was 72 t, which was **acceptable**. The current catch tolerance range used to assess annual recreational fishery performance is based on boat-based catches remaining below the estimated 2013/14 state-wide catch of herring, i.e. <16 t. The next catch estimate (2015/16) for this sector will be available in 2017.

Whitebait:

The catch tolerance range is 60-275 tonnes. The catch in 2014/15 was 97 t and was therefore **acceptable**.

Harvest Strategy

This resource is harvested using a constant exploitation approach, where the annual catch taken varies in proportion to variations in the stock abundance. Indicator species are used to determine the status of the resource. All indicator species are assessed annually based on catch and/or catch rate trends, where data is available (noting that recreational fishery data is limited for these stocks). Additionally, higher level assessments are periodically undertaken for some stocks. A formal harvest strategy exists for finfish captured commercially within the Peel-Harvey Estuary. A draft Harvest Strategy for Australian herring was released for public comment in 2016. A formal harvest strategy is not currently in place for the remainder of this resource.

Compliance

The Department undertakes regular compliance inspections to ensure fishing is being undertaken in accordance with the governing legislation and runs education programs with various stakeholder groups to increase the levels of voluntary compliance.

Consultation

The Department undertakes consultation directly with licensees on operational issues. Industry 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. Consultation with the recreational sector is undertaken via the peak representative body, Recfishwest, and/or the Department's website when documents are released for public comment.

Management Initiatives

In response to Australian herring stock sustainability concerns, the commercial herring 'G-trap' fishery was closed, and the herring recreational bag limit was reduced from 30 to 12, effective from 1 March 2015. A draft Harvest Strategy for Australian herring was released for public comment in 2016.

Consultation with peak sector bodies is currently being undertaken to determine the management response to address concerns about the sustainability of southern garfish in the Metropolitan zone.

EXTERNAL DRIVERS (*High Risk*)

Annual variations in coastal currents (particularly the Leeuwin and Capes Currents) appear to

influence the spawning and recruitment patterns of species such as whitebait, tailor, Australian herring and western Australian salmon (Lenanton *et al.* 2009).

Changes in environmental variables such as ocean temperature, currents, winds, nutrient supply, rainfall, ocean chemistry and extreme weather conditions are expected to have major impacts on marine ecosystems. These impacts are expected to create both difficulties and opportunities for fisheries.

In 2011, a 'heatwave' event in coastal waters of south-western WA altered the distribution (e.g. tropical species occurring in temperate waters) and behaviour (e.g. spawning activity, migration) of many nearshore finfish species, which appears to have affected the abundance of these species in 2011 and in subsequent years (Caputi *et al.* 2014).

WCB estuaries are highly modified, and often degraded environments and the impacts of environmental factors on estuarine fish are likely to be at least as important as fishing pressure. Impacts in 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).

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

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WEST COAST SMALL PELAGIC SCALEFISH RESOURCE STATUS REPORT 2016

J. Norriss and G. Baudains

OVERVIEW

The five species comprising the west coast small pelagic scalefish resource are tropical sardine (scaly mackerel, *Sardinella lemuru*), pilchard (*Sardinops sagax*), Australian anchovy (*Engraulis australis*), yellowtail scad (*Trachurus novaezelandiae*) and maray (*Etrumeus teres*). They are taken predominantly by the quota based West Coast Purse Seine Fishery (WCPSF) using purse seine gear in waters between Ningaloo and Cape Leeuwin which includes three separate zones - Northern Development (22° 00'S to 31° 00'S), Perth Metropolitan (31° 00'S to 33° 00'S) and Southern Development Zone (33° 00'S to Cape Leeuwin). The WCPSF is also entitled to take Perth herring (*Nematalosa vlaminghi*), which forms part of the West Coast Nearshore and Estuarine Finfish Resource, but has not done so since 1997.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	1,253 t	<1 t (2013/14)	
Fishing Level	Acceptable	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
West Coast Small pelagic	Sustainable - Adequate	Biology and total catch	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Negligible Risk	**Listed Species**	Low Risk
Habitat	Negligible Risk	**Ecosystem**	Low Risk
Social	Low Amenity Low Risk	**Economic**	GVP ($1-5 million) Low Risk
Governance	Stable	**External Drivers**	Low Risk

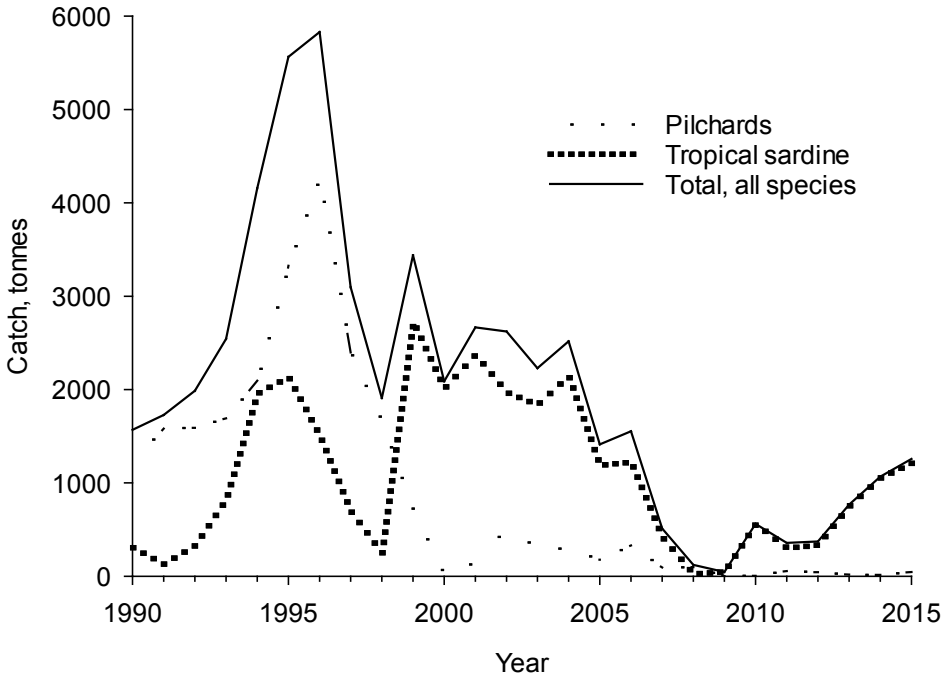
CATCH AND LANDINGS

The total combined catch of the six species that can be taken by the WCPSF in 2015 was 1,253 t, of which 96% was tropical sardine, the remainder being pilchards and yellowtail scad (West Coast Small Pelagic Scalefish Figure 1). Tropical sardines have dominated the catch since pilchards suffered mass mortality events in 1995 and 1998/99 caused by a herpesvirus.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Tropical sardine (Sustainable-Adequate)

Tropical sardines are a small pelagic species that feed by filtering plankton, living for up to seven years and reaching a maximum size of about 21 cm FL on the WA west coast (Gaughan and Mitchell 2000). The WCPSF operates at the southern limit of the species distribution in WA. Analysis of otolith chemistry showed no evidence for the existence of separate stocks between Carnarvon and Fremantle, where they appear to be highly mobile resulting in a patchy but widespread distribution.



WEST COAST SMALL PELAGIC SCALEFISH FIGURE 1. *Time series of total annual catch of tropical sardines, pilchards and the total for all six species combined in the WCPSF since 1990.*

The WCPS catch of tropical sardines in 2015 was 1,209 t, a 15% increase from 2014 and a continuation of an upward trend in recent years, though well below historical high levels (West Coast Small Pelagic Scalefish Figure 1). The limited spatial distribution of fishing effort for what appears to be a highly mobile species suggests that only a small proportion of a widespread stock is being targeted. Catches are therefore considered sustainable and the biological stock **adequate**.

Pilchard (Sustainable-Adequate)

The pilchard is a small, low trophic level pelagic species that feeds by filtering plankton. Longevity is up to 9 years and the maximum size is 200-250 mm SL.

The high pilchard catch in the 1990s, primarily from the Perth Metropolitan Zone, declined precipitously during the mid to late 1990s following two mass mortality events (West Coast Small Pelagic Scalefish Figure 1). While the stock had recovered by the mid-2000s (see below), catches have remained low since then as the WCPSF has transitioned to take mostly tropical sardine.

Population modelling, based on spawning biomass estimates (from egg surveys), catch-at-age and catch data, suggested that by the mid-2000s the stock had recovered from the 1998/99 mass mortality event. The mid-2000s exploitation rate for the WA west coast stock was less than 5 per cent (around 400 t) of the estimated spawning biomass of approximately 25,000 t. Since 2007 the total annual catch has never exceeded 100 t. The current exploitation rate is therefore unlikely to cause the stock to become recruitment overfished. The biological stock is therefore considered **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

The species available for capture in the WCPSF is restricted by the West Coast Purse Seine Limited Entry Fishery Notice 1989. Small quantities of bycatch species are sometimes captured incidentally, but this occurs infrequently and the majority are released from the net unharmed. Interactions with endangered, threated and protected species must be reported to the Department of Fisheries on Catch and Effort Statistics returns that must be lodged monthly. There is no evidence to indicate any significant interactions with these species.

HABITAT AND ECOSYSTEM INTERACTIONS

Purse seine nets are pelagic in nature, with no impact on benthic habitats during normal operations. On rare occasions nets may be deployed in shallow waters and come into contact with sensitive habitats such as seagrass beds. The light structure of the net is expected to cause minimal damage to benthic habits when this occurs, and would be kept to a small, localised area. The WCPSF is therefore considered to be a negligible risk to these habitats.

SOCIAL AND ECONOMIC OUTCOMES

Social

Local employment was provided by 7 active vessels as well as local processing factories. The only small pelagic species detected by recent surveys of boat-based recreational fishing was a small total catch of yellowtail scad.

Economic

A small proportion of the catch is sold for human consumption but the large majority for bait, aquaculture feed or pet food. The estimated gross value of product (GVP) for the WCPSF in 2015 was level 2 ($1-5 million). There is currently a **low level of risk** to this level of return.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

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 2014/15 licensing period (1 April 2014 – 31 March 2015) the notional TAC was 2,328 t for pilchards and a separate TAC of 672 t for other small pelagic species (including *Sardinella*) was in place. Reaching or exceeding the notional TACs will trigger a management response.

Harvest Strategy

No formal harvest strategy has been developed for the WCPSF.

Compliance

Compliance is monitored via aerial patrols and both at-sea and on-land inspections.

Consultation

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

Management Initiatives/Outlook Status

A stable management outlook is envisaged for the WCPSF. Stocks will continue to be monitored principally through Level 1 (catch based) assessments.

EXTERNAL DRIVERS

Climate change is likely to be facilitating a southward shift in the natural distribution of both pilchards and tropical sardine.

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WEST COAST DEMERSAL SCALEFISH RESOURCE STATUS REPORT 2016

D. Fairclough and M. Holtz

OVERVIEW

The West Coast Demersal Scalefish Resource (WCDSR) comprises over 100 species in inshore (20-250 m deep) and offshore (>250 m) demersal habitats of the West Coast Bioregion (WCB), which are exploited by both commercial and recreational (including charter) boat-based line fishers. The indicator species for inshore waters include West Australian dhufish (*Glaucosoma hebraicum*), snapper (*Chrysophrys auratus*), redthroat emperor (*Lethrinus miniatus*), bight redfish (*Centroberyx gerrardi*) and baldchin groper (*Choerodon rubescens*), while the proposed indicators for offshore waters include hapuku (*Polyprion oxygenios*), blue-eye trevalla (*Hyperoglyphe antarctica*) and eightbar grouper (*Hyporthodus octofasciatus*) (see DoF 2011).

Following identification of overfishing of the inshore demersal resource, the current management arrangements designed to recover stocks were progressively introduced between late 2007 and early 2010. These include maintaining the retained catches of all sectors below 50% of their 2005/06 catch benchmarks in order to reduce fishing mortality rates (*F*) of indicator species to below the threshold reference point and to meet a formal IFM sectoral allocation decision.

To achieve these management goals each of the commercial fisheries authorised to land demersal scalefish in the WCB have individual management plans with access, gear, area and entitlement limitations. Similarly, boat-based recreational and charter fishers are licensed and managed by input/output controls including a closed season. For further details see the West Coast Demersal Scalefish Resource Assessment Report (in prep) and SAFS (2016).

SUMMARY FEATURES 2016

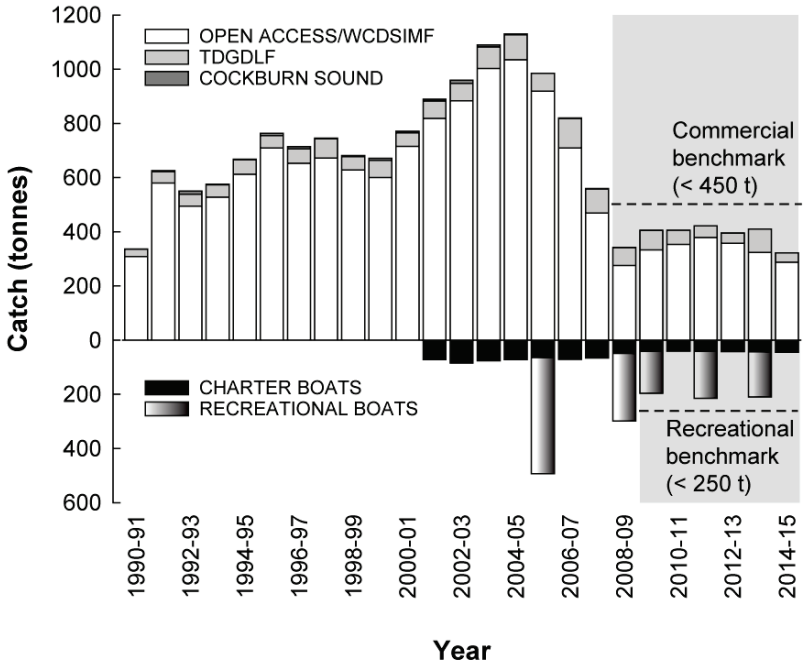
Fishery Performance	Commercial	Recreational	
Total Catch 2015	283 t	184-211 t	
Fishing Level	Acceptable (≤ 450 t)	Acceptable (≤ 250 t)	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Inshore Demersal	Sustainable - Recovering	Annual: Catch Periodic: Fishing mortality, SPR	
Offshore Demersal	Sustainable - Adequate	Annual: Catch	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low Risk	**Listed Species**	Negligible Risk
Habitat	Negligible Risk	**Ecosystem**	Low Risk
Social	High Amenity Moderate Risk	**Economic**	GVP Level 2 ($1-5 million) Moderate Risk
Governance	Stable	**External Drivers**	Moderate Risk

CATCH AND LANDINGS

The total catch of all species in 2015 by the main commercial fishery, the West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF), was 271 t, of which, 246 t comprised demersal species. Other commercial fisheries in the WCB (during 2015 or 2014/15; Temperate Demersal Gillnet and Demersal Longline fisheries; Cockburn Sound Line and Pot Managed Fishery, South-west Trawl Managed Fishery, West Coast Rock Lobster Managed Fishery) landed a total of 36 t of demersal species, taken mostly by the temperate demersal gillnet/longline fisheries.

Catches of demersal species by the WCDSIMF and by all commercial fisheries in the WCB were below stock recovery benchmarks (50% of 2005/06 catch) of 410 t and 450 t, respectively, and much lower than prior to management changes (West Coast Demersal Scalefish Figure 1). Catches by the WCDSIMF in 2015 were lower than in recent years (2009-2014). This follows reductions in effort entitlements (and effort expended) in the Kalbarri and Mid-west Areas in 2015 to limit catches of snapper, an indicator species, which had exceeded its stock recovery retained catch benchmark for over three years.

Total annual recreational sector boat based catches of the top 15 demersal species have remained below the recovery benchmark of 250 t (West Coast Demersal Scalefish Figure 1). Charter fishers landed 45 t of the top 15 demersal species in 2014/15, similar to 2013/14, despite a decrease in effort from 22,700 to 19,680 fisher days. Boat-based recreational fishers landed 139-166 t (≈95% CI) of demersal species in 2013/14, which is similar to 2011/12 (West Coast Demersal Scalefish Figure 1).). However, effort in the WCB decreased from 293,000 to 250,000 boat days (Ryan *et al*., 2015).



WEST COAST DEMERSAL SCALEFISH FIGURE 1. *Estimated retained catches of demersal species in the West Coast Bioregion since 1990-91 and stock recovery catch benchmarks introduced between 2008 and 2010 (grey shading). Estimated recreational sector retained catches combine data for financial year for charter (since logbooks introduced in 2001/02) and survey year for recreational boats. Recreational catches are point estimates of the mean and do not show 95% CIs (see Ryan et al., 2015). 2011/12 and 2013/14 estimates were derived from integrated phone diary surveys, while prior estimates were derived from boat ramp creel surveys.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Inshore (Sustainable-Recovering)

Each of the indicator species for the inshore demersal suite (West Australian dhufish, snapper, baldchin groper) comprises a single genetic stock across the entire WCB (SAFS, 2016). These species reach large sizes and are long-lived, with relatively slow growth and complex reproductive biology, making them inherently vulnerable to the effects of fishing (further detail in West Coast Demersal Scalefish Resource Assessment Report). Annual monitoring is undertaken using catch levels. Periodic Level 3 assessments of stock status for each of the indicator species also evaluate additional key performance indicators including fishing mortality (*F*) and spawning potential ratio (SPR) using a weight-of-evidence approach that considers all available information (Wise *et al*., 2007; Fairclough *et al*., 2014). The next Level 3 assessment will be completed in 2017.

West Australian dhufish (Sustainable-Recovering)

Retained catches of West Australian dhufish in the WCB by all commercial fisheries, the WCDSIMF and the recreational sector (boat-based fishers plus charter fishers) have been at acceptable levels (below stock recovery benchmarks) since inception of the current management regime, i.e. < 82, 72 and 126 t, respectively (West Coast Demersal Scalefish Figure 2a). WCDSIMF catches in the Mid-west and South-west areas have also remained at or below recovery benchmarks of 44 t and 19 t. Discard/release rates of dhufish by boat-based recreational fishers were high in 2013/14 at 66%, mainly as a result of the capture of undersized fish.

The most recent assessment (Fairclough *et al*., 2014) of *F* at the biological stock level, using age composition data collected between 2008/09 and 2010/11 (during management changes) decreased from the previous period 2005/06-2007/08 (West Coast Demersal Scalefish Figure 2a; Fairclough *et al*., 2014). However, *F* was still above the limit reference point of 1.5*M*. Spawning potential ratio lay between the limit (0.2) and threshold (0.3) reference point.

The above evidence indicates that the current level of fishing pressure, if maintained, should allow the stock to recover from overfishing. The biological stock is classified as **recovering**.

Snapper (Sustainable-Recovering)

Retained catches of snapper in the WCB by all commercial fisheries and the WCDSIMF were above recovery benchmarks of 126 and 120 t, respectively between 2010 and 2014. Reductions in effort entitlements to WCDSIMF fishers in the Kalbarri and Mid-west areas in 2015 contributed to reducing the total catch below the benchmarks. This was also the case for both the Kalbarri and Mid-west areas (i.e. ≤ 65 and 43 t). Estimated total retained catches of the recreational sector (recreational boat-based fishers plus charter fishers) during years of the integrated surveys of 2011/12 and 2013/14 were above the recovery benchmark of 37 t, but within proposed 10-20% tolerance limits (Fletcher *et al*. 2016). Seventy three per cent of snapper landed in 2013/14 by boat-based recreational fishers were discarded/released, due mostly to being undersize (Ryan *et al*. 2015).

Estimates of *F* at the biological stock level derived from age composition data collected between 2008/09 and 2010/11 decreased from the previous period 2005/06-2007/08 (West Coast Demersal Scalefish Figure 2b; Fairclough *et al.,* 2014). However, *F* was still above the limit reference point of 1.5*M* and SPR ≤ the limit (0.2).

The above evidence indicates that the current level of exploitation should allow the stock to recover from overfishing. The biological stock is classified as **recovering**.

Baldchin groper (Sustainable-Recovering)

Retained catches of Baldchin groper in the WCB by all commercial fisheries, the WCDSIMF and the recreational sector (boat-based fishers plus charter fishers) have been at or below stock recovery benchmarks since commencement of the current management regime, i.e. < 22, 17 and 33 t, respectively (West Coast Demersal Scalefish Figure 2c). About 35% of baldchin groper landed in 2013/14 by boat-based recreational fishers were discarded/released, with the vast majority being undersize.

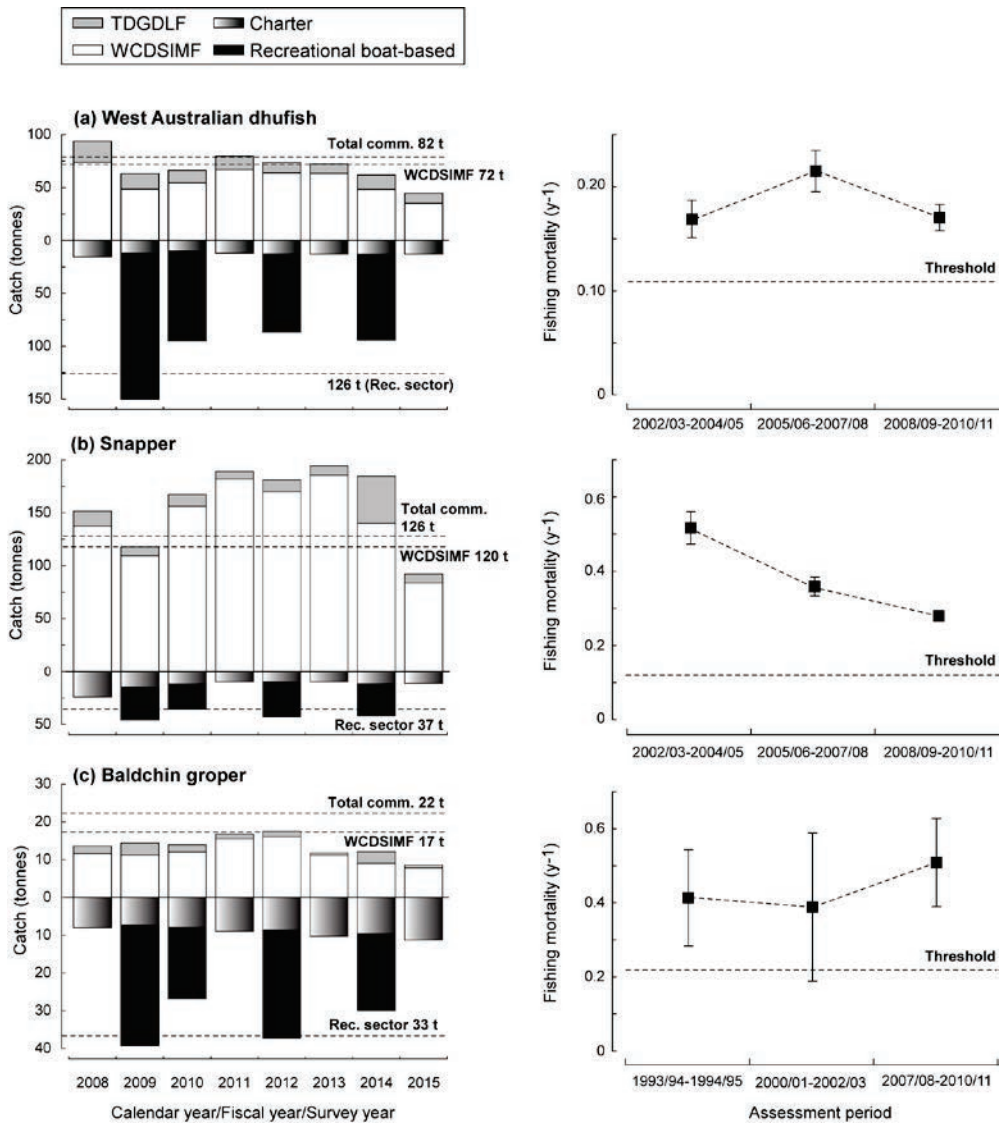
Rates of *F* at the biological stock level, using age composition data collected from 2008/09 to 2010/11 (i.e. during management changes) indicated no change since the previous assessment and were above the limit reference point of 1.5*M* (West Coast Demersal Scalefish Figure 2c; Fairclough *et al*., 2014). Similarly, little change was identified in SPR, with point estimates falling between 0.2 and 0.3.

The current level of fishing pressure should allow the stock to recover from overfishing. The biological stock is classified as **recovering**.

Offshore Demersal (Sustainable-Adequate)

Estimated retained catches of offshore demersal species (6-14 t) by the WCDSIMF have remained below the nominal sustainable catch range for this suite (20-40 t) since this fishery commenced in 2008. Offshore demersal species are rarely caught by other state commercial fisheries, but are sometimes caught by the Western Deepwater Trawl Fishery (Cwth). However, recent effort and estimated catches have remained relatively low (e.g. since 2002: ruby snapper < 25 t, hapuku/bass groper < 1 t, blue-eye trevalla = 0 t). The current

level of fishing pressure is such that the biological stocks of offshore demersal species are considered **adequate**.



WEST COAST DEMERSAL SCALEFISH FIGURE 2. *Estimated commercial and recreational retained catches vs 50% of 2005/06 catch benchmarks (dashed lines) for stock recovery (left column) and fishing mortality estimates vs threshold reference points (right column; Fairclough et al., 2014) for (a) West Australian dhufish, (b) snapper and (c) baldchin groper. Note recreational catches are point estimates and do not show 95% CIs (Ryan et al., 2015). 2011/12 and 203/14 estimates were derived from integrated phone diary surveys, while prior estimates were derived from boat ramp creel surveys.*

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch: Line fishing for demersal species using baited hooks is highly selective for demersal fishes. While other 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 to their stocks and therefore a **low risk**.

Protected Species: Interactions with listed species by commercial, charter and recreational fishers in the WCDSF are minimal. Commercial WCDSIMF and charter fishers are required to record listed species interactions in their statutory returns. During 2015, two grey nurse sharks were caught by the WCDSIMF and both released alive.

In 2014/15, charter fishers caught and released alive three grey nurse sharks, five goldspotted rockcod and one potato rockcod. Risks to protected species are therefore considered **negligible.**

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat: Line fishing is the main fishing method used in the commercial and recreational fishery for demersal species which has little physical impact on the benthic environment and hence **negligible risk** to benthic habitats.

Ecosystem: Hall and Wise (2011) found that while the species composition in catches of commercial wetline, gillnet and longline fisheries in the WCB had changed over a 30 year timeline this may be a function of changes in targeting or differences in reporting methods. There was no evidence of a decline in the trophic level or mean size in catches and the fishery therefore represents a **low risk** to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

The WCDSR provides high social amenity to recreational fishing and diving and to consumers via commercial fish supply to markets and restaurants. There is currently a **moderate level of risk** to these values.

The demersal resource in the WCB is highly accessible to boat fishers with approximately 131,000 Recreational Fishing from Boat Licences held in WA from May 2013 to April 2014. The commercial WCDSIMF vessels operating in 2015 employed zero to four crew, excluding the skipper, with the majority employing two crew per vessel. Fifty three licenced charter operators fished in the WCB in 2014/15, a decrease from 62 in 2013/14. The number of people employed in the charter industry has not been estimated.

Economic

The estimated gross value of product (GVP) for the WCDSIMF in 2015 was level 2 ($1-5 million). There is currently a moderate level of risk to this level of return.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels (Acceptable)

The retained catch levels of both the commercial and recreational sectors indicate that the fishery performance for both sectors is considered **acceptable**. Total retained catches of demersal species by the commercial and recreational sectors were maintained below recovery catch benchmarks of 450 and 250 t, respectively. After retained commercial catches of snapper in the WCB, total WCDSIMF, Kalbarri WCDSIMF and Mid-west WCDSIMF were above their respective recovery catch benchmarks of 126, 120, 65 and 43 t for more than three years, management changes reduced entitlements to the WCDSIMF Kalbarri and Mid-west Areas at the beginning of 2015. Retained catches were reduced to acceptable levels (below recovery benchmarks) in 2015 in each case.

Harvest Strategy (Under Development)

The WCDSR is currently managed using a constant catch strategy. Although a formal harvest strategy is not currently in place for this resource, a stock rebuilding program is underway, whereby retained catches are to remain < 50% of 2005/06 catches until fishing mortality rates fall below the threshold reference point. Proposals to define maximum tolerance levels around the acceptable catches and rates of decrease in *F* during the recovery phase have been identified (Fletcher *et al*., 2016).

Compliance

The Department undertakes regular compliance inspections to ensure fishing is being undertaken in accordance with the governing legislation and runs education programs with various stakeholder groups to increase the levels of voluntary compliance.

Consultation

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. Consultation with the recreational sector is undertaken via the peak representative body,

Recfishwest, and/or the Department's website when documents are released for public comment.

Management Initiatives (Stable)

The trial of filleting on-board commercial vessels presented no compliance issues and will therefore be formalised in the management plan for the fishery. No other reviews of management are anticipated for 2017.

EXTERNAL DRIVERS (*Moderate Risk*)

Recruitment success of demersal species, such as West Australian dhufish and snapper, vary annually and are influenced in part by environmental factors. Climate change may lead to a range of factors (e.g. increased water temperatures, changes in current strength) which may influence the biology of demersal species.

Declines in demersal catch and catch rates in the South-west Area followed an extreme event, a marine heatwave in 2011 (Caputi *et al*., 2014), which may be associated. Ongoing industrial development in Cockburn Sound may affect the spawning aggregation behaviour and survival of juvenile snapper in that area.

There is some overlap of species captured in the WCB by state fisheries and by the Commonwealth Western Deepwater Trawl Fishery and Great Australian Bight Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery (>200 m). These catches are currently very small. The Commonwealth's proposed South-West Marine Bioregional Plan incorporates areas that will restrict access to fishing in parts of the WCB to the commercial and recreational sectors.

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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.

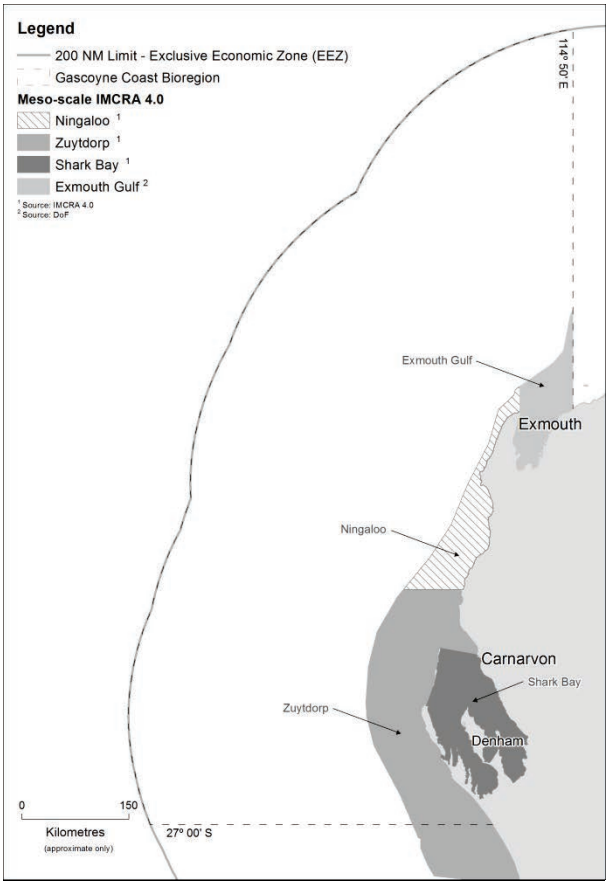
The waters off the Gascoyne Coast are also strongly influenced by the unusual southward-flowing Leeuwin Current, generated by flow from the Pacific through the Indonesian archipelago. This tropical current becomes evident in the North West Cape area and flows along the edge of the narrow continental 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.

The ecosystem boundaries as defined by IMCRA (V 4.0) in the bioregion are depicted in Gascoyne Overview Figure 1. The potential threats and risks to these ecosystems are often similar. For simplicity risk ratings were allocated by grouping the ecosystems into two broad groups, estuarine or marine. However, if a particular ecosystem is unique and/or is exposed to different or significant threats, risk was allocated to these ecosystems separately.



GASCOYNE OVERVIEW FIGURE 1

Map showing the Gascoyne Coast Bioregion and IMCRA (V 4.0) meso-scale regions: Zuytdorp, Shark Bay, Ningaloo and Exmouth Gulf.

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.

GASCOYNE COAST OVERVIEW FIGURE 2

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

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

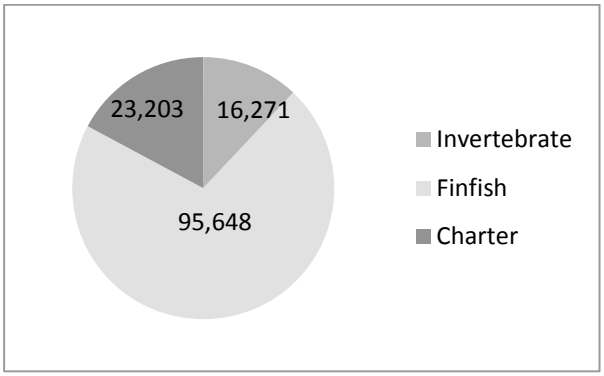
invertebrates operating in the bioregion include collecting silver lipped pearl oyster which is used in pearl culture, though most effort is focused in the North Coast Bioregion.

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 2013/14, and the charter boat catch numbers for the same period.

Aquaculture

Aquaculture in the Gascoyne focuses on the blacklip oyster *Pinctada margitifera*. The local aquaculture sector is also focusing on the production of aquarium species, including coral and live rock.

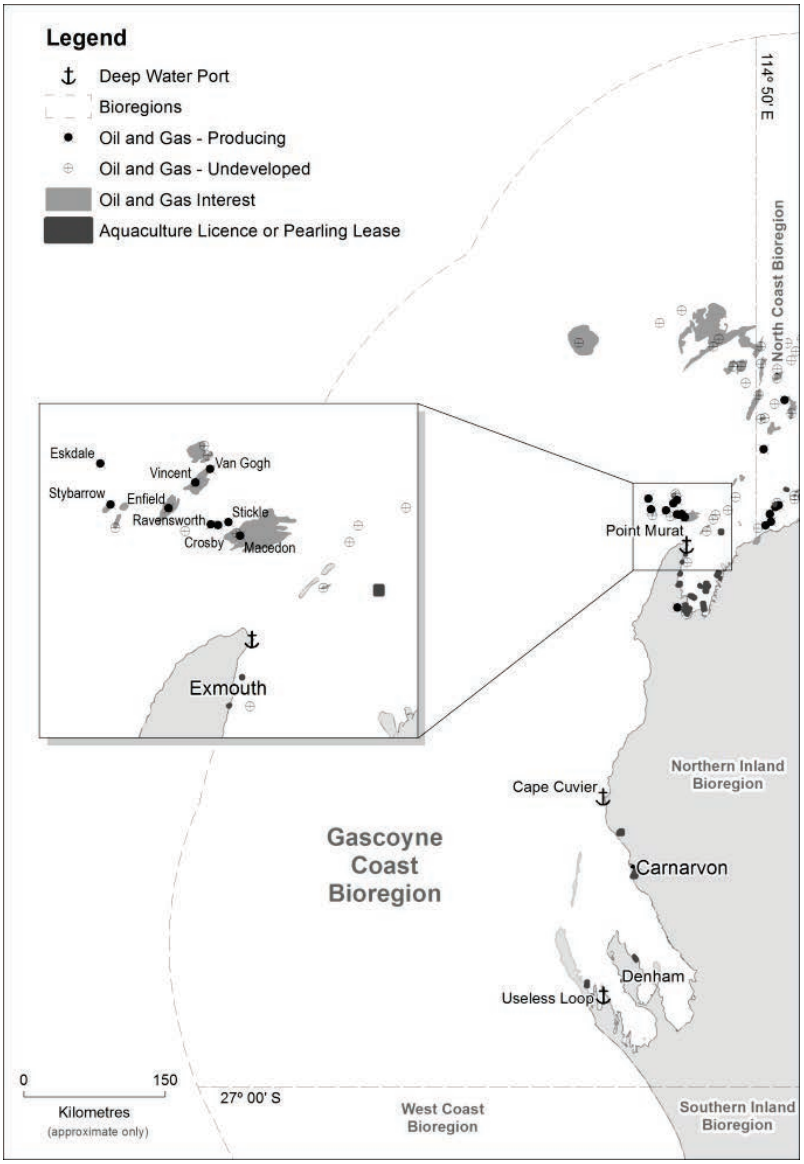
Tourism

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 Murat, a naval port facility at Exmouth. The majority of shipping movements involve coastal cargo vessels, shipping associated with the two salt fields in the region, large passenger cruise vessels and fishing vessels operating out of the numerous small ports along the coast.

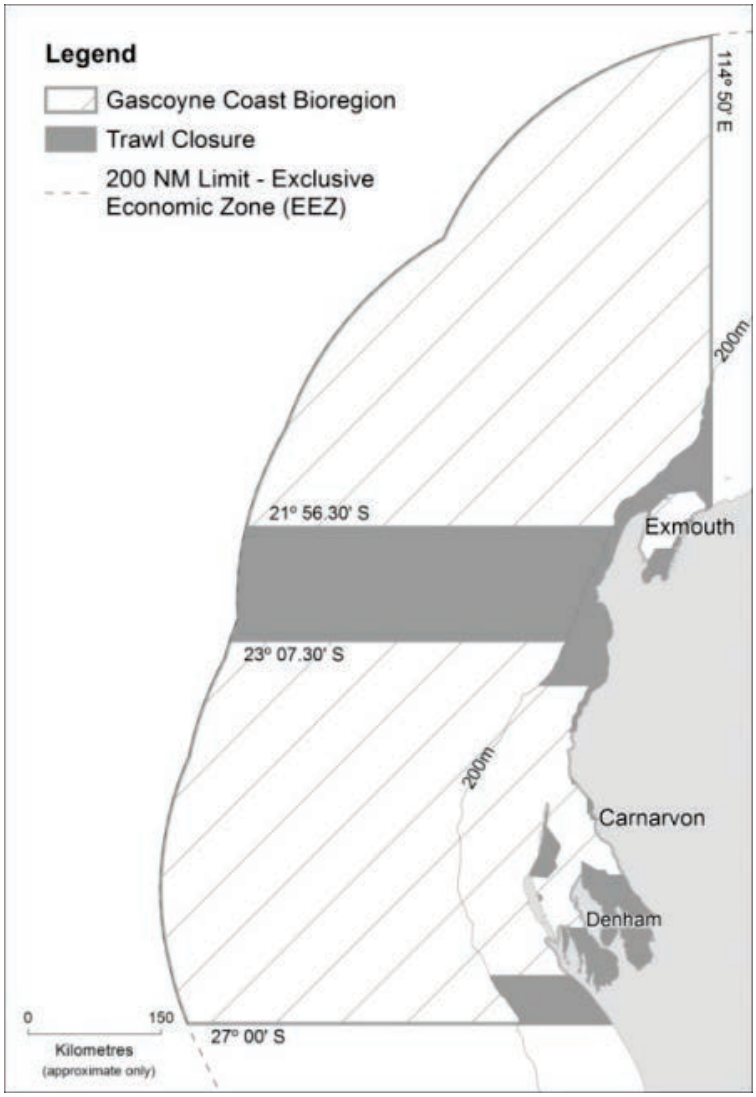
Other harbours and maritime facilities of the Gascoyne Coast Bioregion include Denham, Carnarvon, Coral Bay and Exmouth, all of which largely service local fishing and charter vessels, as well as the private vessels of local residents and tourists. The expansion of oil and gas, along with increased recreational, 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.

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.[1]

IUCN category or equivalent	State Waters only (24,100 km^2)				All Waters (416,300 km^2 (including State Waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km^2	%	km^2	%	km^2	%	km^2	%
I	0	0	0	0	0	0	0	0
II	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 I.

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.

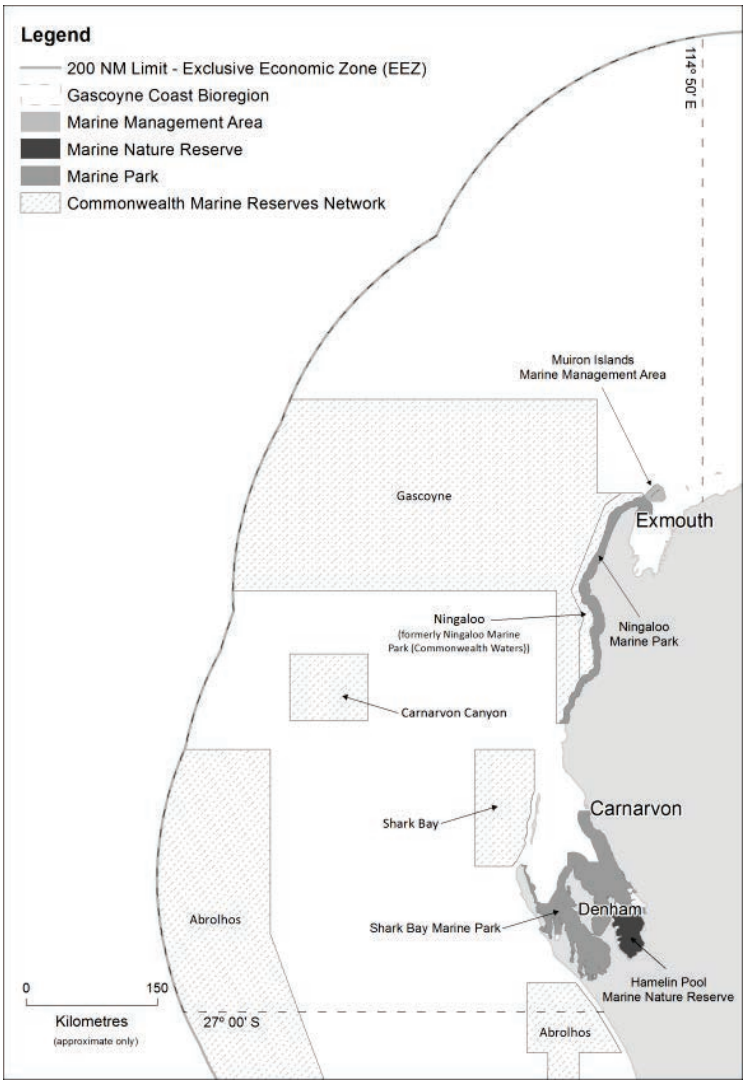
BIOREGIONAL SPECIFIC ECOSYSTEM MANAGEMENT

Within each Bioregion there are a range of management measures that have been implemented to manage the potential impact of activities (See Ecosystem Management Section for an overview). Management measures specific to the Gascoyne Coast Bioregion include:

Spatial Closures

The Department of Fisheries has established a comprehensive set of spatial management closures within the Gascoyne region that are equivalent to a number of IUCN categories for marine protected areas. Extensive trawl closures inside the 200 m depth zone in the Shark Bay and Exmouth region provide protection to sensitive benthic habitat, including coral reef, sand flats and seagrass beds of the continental shelf. These areas provide significant fish nursery, breeding and feeding habitat (Gascoyne 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 2012*[1]). There are also a number of other 'formal' marine protected areas in this Bioregion that have been established under both the Conservation and Land Management Act 1984 and the Fish Resources Management Act 1994 (see Gascoyne Overview Figure 6). These include the Ningaloo and Shark Bay marine parks, the Murion Islands Marine Management Area, and the Quobba and Miaboolya Beach Fish Habitat Protection Areas. Commercial and recreational fishing activities are restricted in these regions.

The Commonwealth Government has identified a number of potential protected areas for Commonwealth waters between Shark Bay and the Northern Territory border.



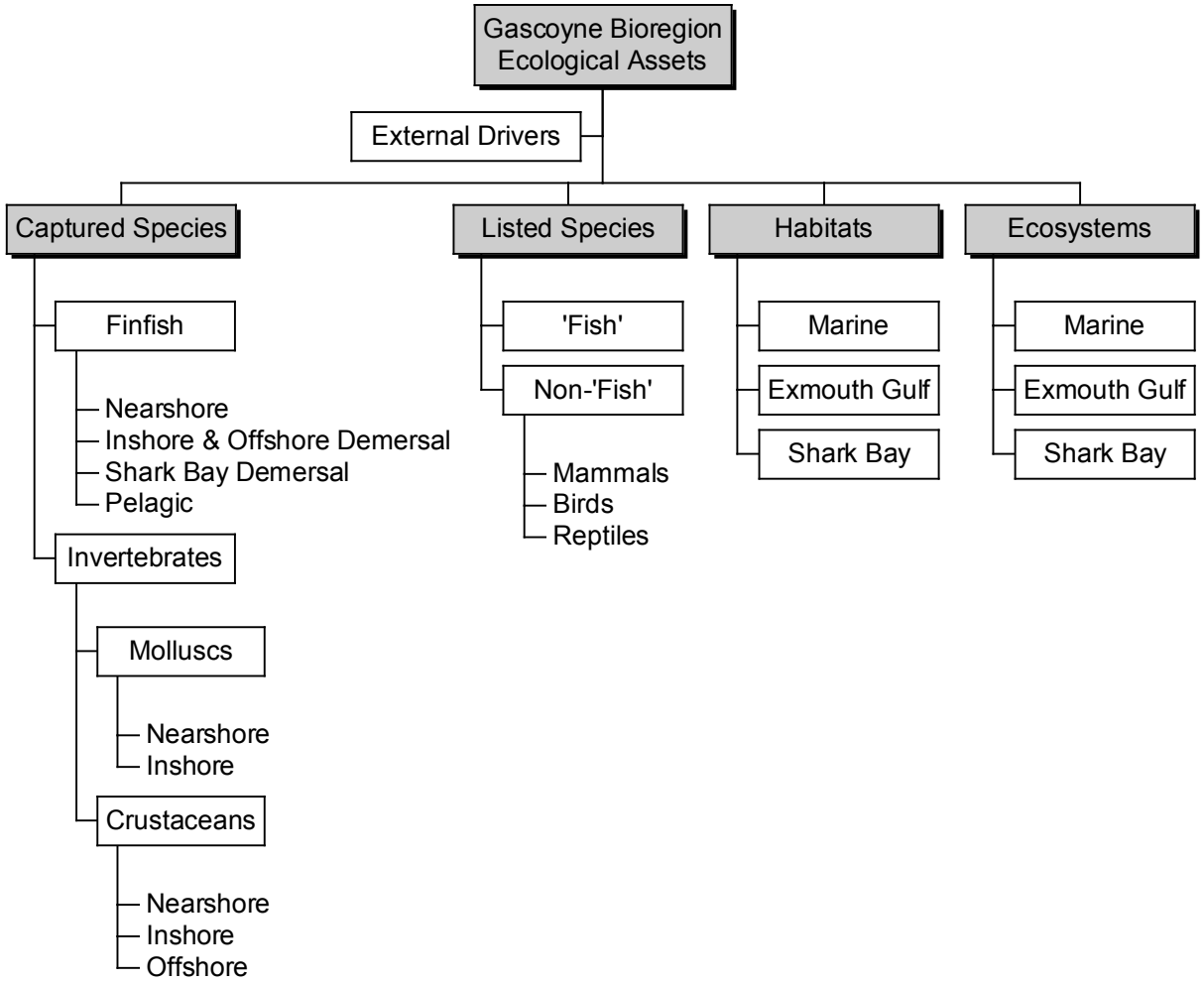
GASCOYNE OVERVIEW FIGURE 6

Map showing the Gascoyne Coast Bioregion and current and proposed state and Commonwealth marine parks and reserves in the Gascoyne Region.

ECOSYSTEM MONITORING AND STATUS

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

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



GASCOYNE OVERVIEW FIGURE 7

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

External Drivers

External factors include those 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 Drivers	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] 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 °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 Drivers	Current Risk Status
Introduced Pests	LOW
Introduced 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 Appendix section entitled "Activities of the Marine Biosecurity Research Group during 2015/16". A summary of pest detections resulting from surveillance at major ports is provided in the Overview section of this report (Table 3).

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.

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 recognized aquatic zones. Indicator species which reflect the characteristics of the broader exploited stocks are monitored in order to assess ecological

risk to the suite of species targeted. The major fishery operating at the bioregional level is the Gascoyne Demersal Scalefish Fishery. This line fishery originally targeted pink snapper but 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 and Offshore demersal

Captured Species	Aquatic zone	Ecological Risk
Finfish	Inshore and Offshore Demersal	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 indicator species for fishery are pink snapper spangled emperor, and goldband snapper.

Shark Bay Demersal

Captured Species	Aquatic zone	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.

Pelagic

Captured Species	Aquatic zone	Ecological Risk
Finfish	Pelagic	MODERATE

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

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.

Molluscs

Captured Species	Aquatic zone	Ecological Risk
Molluscs (Pearl Oysters)	Nearshore	MODERATE
Molluscs (Scallops)	Inshore	HIGH

The recent levels of pearl oysters in the bioregion have been low. Recovery management arrangements have been implemented and minimal catches have been taken in recent years.

The Shark Bay Scallop Managed Fishery is currently in a recovery phase. The stock has fully recovered in Denham Sound but is recovering more slowly in northern Shark Bay. The current status is the result of a series of poor recruitment events associated with sustained unfavourable environmental conditions resulting from the marine heat wave in 2010/11.

Crustaceans

Captured Species	Aquatic zone	Ecological Risk
Crustaceans (Crabs)	Nearshore	MODERATE
Crustaceans (Prawns)	Inshore	MODERATE
Crustaceans (Deep Sea Crabs)	Offshore	MODERATE

Blue swimmer crab stocks in Shark Bay are currently considered to be recovering following declines in 2011/2012 that were attributed to the impacts of anomalous environmental conditions.

Stocks in both the Exmouth and Shark Bay Prawn Managed Fisheries are considered adequate with both fisheries gaining Marine Stewardship Certification in 2015.

However, 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.

Stocks in the West Coast Deep Sea Crustacean Managed Fishery, that operates primarily in the Gascoyne bioregion, are considered adequate with the fishery gaining Marine Stewardship Certification in 2016.

Listed species

A variety of endangered, threatened and protected[1] (ETP) species can be found within the Gascoyne Coast Bioregion, including cetaceans, dugongs, marine turtles, sea snakes, elasmobranchs, seahorses and pipefish and sea/shore birds. These species are protected by various international agreements and national and state legislation. Primary pieces of legislation include the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*, the *Western Australian Wildlife Conservation Act 1950*, and the *Fish Resources Management Act 1994*.

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

Fish

Listed species	Risk
Fish	MODERATE

Statutory reporting indicates there are a low number of interactions with sawfish. However, increasing the understanding of the number and nature of the interaction of trawl fisheries in the bioregion with sawfish was raised as an issue through the MSC process.

Non-Fish

Listed species	Risk
Birds and Reptiles	MODERATE
Mammals	LOW

While there are a number of listed species in the Gascoyne bioregion, only sea snakes and occasionally turtles are encountered in the trawl catches. The number of turtles captured now is very low and most of these are returned alive Both groups are typically returned to the sea alive.

Captures of both turtles and sea snakes are recorded and their status at release are monitored and reported.

However, increasing the understanding of the number and nature of the interaction of trawl fisheries in the bioregion with sea snakes was raised as an issue through the MSC process.

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

Habitats and Ecosystems

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

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.

including coral reef, seagrass and sand flats. These areas also provide significant nursery, breeding and feeding habitats for many retained and listed species. There is also a large area from Point Maud to Tantabiddi Well off the Ningaloo Coast (23° 07.30' S to 21° 56.30' S) that is closed to all commercial fishing activities (Gascoyne Overview Figure 5).

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

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

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

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

Gascoyne Marine

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

Habitats

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. The main risk is to coral habitat results from tourism and other boating related activities. There are no major pressures on seagrass communities, which are general small and patchily distributed in this region.

The remainder of the bioregion is dominated by mud/sand bottoms. 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. The Gascoyne Demersal Scalefish Fishery operates in this ecosystem and is based on using hook and lines, resulting in 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 also operates in this area in depths from 150-1200m. Crab traps are mainly set over mud bottom 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.

Ecosystems

Ningaloo is protected via establishment of the Ningaloo Marine Park (NMP) which covers a total area of 4,566 km^2 from the shoreline to continental slope. No commercial fisheries operate in the waters of the NMP and 34% of the park is zoned as no-take sanctuary areas. A significant level of research and monitoring is being undertaken in the Ningaloo marine park region by DPaW, CSIRO, AIMS

and universities. This reflects the main pressures on the ecosystem which are largely not fishing-related.

The remainder of the ecosystem is largely protected due to the lack of trawling that occurs in this area.

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].

Exmouth Gulf

Ecosystem/Habitat	Aquatic zone/category	Current Risk Status
Exmouth Gulf benthic habitat	Sand, Mud, Sponge, Seagrass	HIGH
Exmouth Gulf ecosystem	Marine	MODERATE

Habitats

There is significant protection in place for all sensitive habitats and restrictions on the level of impacts that can occur in less sensitive habitats. Trawling is focused in the deeper central and north-western sections of the Gulf which is primarily mud. The total area trawled each year is monitored and has to remain below 40%.

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. However, there are concerns over seagrass habitats after substantial die backs were associated with the marine heatwave in 2010/11. A better understanding of benthic habitats is also a key component of maintaining Marine Stewardship Council certification for the Exmouth Gulf Prawn Managed Fishery.

Ecosystems

Approximately 29 % (335 nm^2) of Exmouth Gulf is trawled. Trawling is prohibited in a designated nursery area in the southern and eastern section of the Gulf. The nursery area covers 344 nm^2 and represents 28 % of Exmouth Gulf. A major project surveying biodiversity on and off the trawl grounds in Exmouth indicated that trawled areas have similar diversity to the larger adjacent untrawled areas, indicating that the current level of trawling activity does not affect overall biodiversity and cannot be distinguished from other sources of variation in community structure.

The ecosystem in this region could be at increased risk if a number of proposed developments are implemented.

Shark Bay

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

Habitats

Benthic habitats and communities of Shark Bay have been described and mapped (CALM 1996). There is extensive seagrass throughout the eastern and western gulfs, while 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. In addition, permanent trawl closures protect the majority of seagrass and coral habitats in the eastern and western gulfs. 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.

A better understanding of benthic habitats is also a key component of maintaining Marine Stewardship Council certification for the Shark Bay Prawn Managed Fishery.

Ecosystems

The current level of fishing by all methods has not noticeably affected the trophic/community structure in Shark Bay. A study of biodiversity in Shark Bay found 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).

1 Hall NG, and Wise BS. 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.

2 Kangas MI, 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.

GASCOYNE SHARK BAY PRAWN RESOURCE STATUS REPORT 2016

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

OVERVIEW

The Shark Bay Prawn Managed Fishery uses low opening, otter prawn trawl systems within inner Shark Bay (Kangas *et al*. 2015) to target western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*) and lesser quantities of endeavour (*Metapenaeus endeavouri*) and coral prawns (*Metapenaeopsis sp*). This is a managed fishery (SBMF Management Plan, 1993) which is based on input controls, including limited entry, gear controls (maximum headrope units), seasonal and area openings and closures and moon closures designed to keep fishing effort at levels that will maintain a sufficient spawning biomass of prawns. Bycatch reduction devices (BRDs) are mandatory in this fishery, with all boats required to fish with a 'grid' and a secondary fish escape device (FED) fitted in each net.

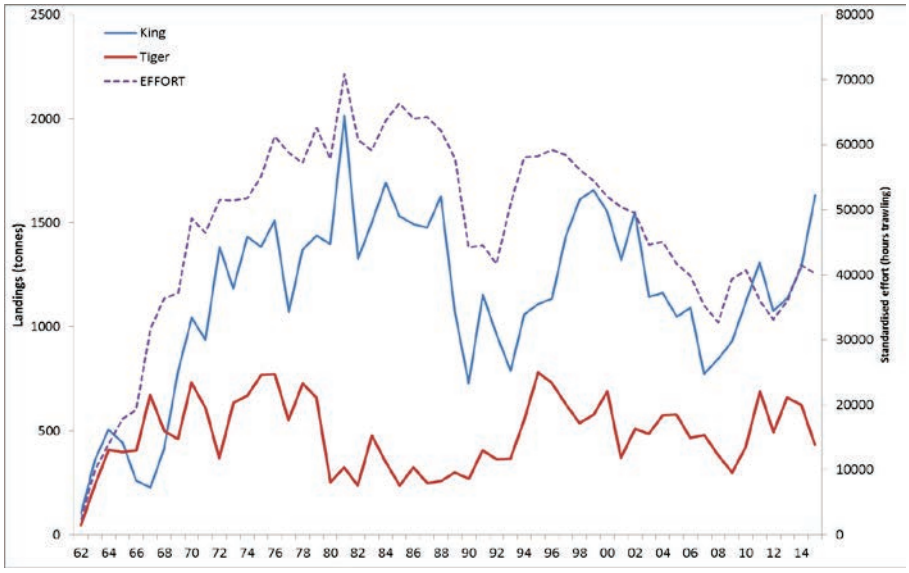
In October 2015 this fishery received Marine Stewardship Council (MSC) certification and it was also accredited for export under the provisions of the EPBC Act (1999) in 2015 for ten years.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	2089 t	Not applicable	
Fishing Level	Acceptable		
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Brown Tiger Prawn	Adequate	Level 4 - Direct Survey/Catch Rate	
Western King Prawn	Adequate	Level 4 - Direct Survey/Catch Rate	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low Risk	**Listed Species**	Low Risk
Habitat	Moderate Risk	**Ecosystem**	Low Risk
Social	Amenity Score 1 Risk Level 1	**Economic**	GVP Risk Level 4 - ($28.7 million)
Governance	Stable	**External Drivers**	Risk Level 4 (Western king prawn) for climate

CATCH AND LANDINGS

The total landings of target prawns in Shark Bay in 2015 were 2,089 t (Shark Bay Prawn Figure 1). The recorded landings of byproduct were 188 t of blue swimmer crab (*Portunus armatus*), 125 t of coral prawns, 58 t of mixed finfish, 23 t of cuttlefish, 6 t of squid, 5 t of bugs (*Thenus orientalis*) and 0.8 t of octopus. Scallop landings are reported in see Saucer Scallop Resource Status Report.



SHARK BAY PRAWN FIGURE 1. *Annual prawn landings (t) and fishing effort (total adjusted hours to twin gear units) for the Shark Bay Prawn Managed Fishery 1962-2015.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS (*Sustainable-Adequate*)

Western king prawns

The western king prawn is distributed throughout the Indo-West Pacific region and within Australian waters, from South Australia, WA, Northern Territory, Queensland and northern New South Wales (Grey *et al*. 1983). In Western Australia, two major fisheries for western king prawns occur in Shark Bay and Exmouth Gulf, with smaller quantities landed off Onslow and Broome.

Western king prawns live between 2-3 years with sexual maturity being reached around 6-8 months. This species can spawn all year round with peaks during spring and autumn. Post-larval and juveniles can be found inshore on shallow tidal flats with salinities higher than seawater (i.e. hypersaline). The juveniles prefer this habitat, unlike most other prawn species, which prefer estuarine conditions.

The status of the stock is assessed annually using a weight-of-evidence approach primarily based on fishery-independent indices of recruitment and spawning stock levels relative to specified reference points (DoF 2014). Although these abundance indices represent key indicators for the stocks, other information collected throughout the season (e.g. commercial catches, effort, grade categories and environmental data) is also evaluated to provide insight on, for example, environmental factors affecting prawn recruitment.

Western king prawns are comparatively more resilient to fishing than the brown tiger prawn (the other key target species) because they are less catchable (strongly nocturnal and they readily bury) and they have a protracted spawning period (Penn 1980, 1984, Kangas *et al*. 2015). The two species overlap in their spatial distribution within Shark Bay, therefore the rates of fishing that maintain the spawning biomass of the brown tiger prawn is well below that which could result in western king prawn becoming recruitment overfished (Kangas *et al*. 2015).

There are more than 40 years of catch and effort data supporting the assessment that this stock has never been reduced to levels considered to be recruitment overfished (Caputi *et al*. 1998) and current effort levels are below the level of effort previously applied (Shark Bay Prawn Figure 1). Analysis of a stock-recruitment relationship for western king prawns showed that the spawning stock was never reduced to levels where it had a significant effect on recruitment. This is supported by there being no significant correlation between spawning stock and recruitment indices derived from fishery independent surveys since 2000 (Kangas *et al*. 2015).

The fishery-independent recruitment surveys assess prawn abundance and size structure, and are used for catch predictions (Caputi *et al*. 2014a,

Kangas *et al*. 2015) and management decisions such as spatial-temporal opening of fishing areas.

There is no evidence of a declining trend in recruitment in fishery independent survey indices since 2000 (Kangas *et al*. 2015) with the annual recruitment indices being well above the target reference level each year (25 kg/hr), indicating most of recruitment variability is driven by environmental factors (e.g. water temperature, Caputi *et al*. 2014b, 2016). Furthermore, the introduction of seasonal, moon and area-closures since the early 1990's provides even more restrictions on the overall fishing effort, which increases protection for the breeding stock (Kangas *et al*. 2015). The fishery-independent recruitment survey in 2015 indicated a mean catch rate which was the fourth highest since surveys commenced in 2000 with a catch prediction between 940 and 1,410 t. The spawning stock surveys target key brown tiger prawn areas but they also cover some of the western king prawn spawning areas and are considered to be indicative of overall spawning stock abundance for this species (Kangas *et al*. 2015). In 2015 the mean spawning stock survey catch rate (mean of 54.1 kg/hr) was the highest since surveys commenced.

Historical catch and catch rates from 1989 to 1998, when it was known that recruitment was not affected by fishing effort, were used as the basis for calculating target catch ranges for this stock (950 to 1,350 t) and mean catch rate (21 kg/hr; range 16 to 29 kg/hr). Total commercial catch for 2,015 of 1,633 t was above the target catch range and an overall mean catch rate of 40.7 kg/hr was well above the target and the highest on record.

Brown tiger prawns

Brown tiger prawns are endemic to tropical and subtropical waters of Australia and are distributed around the northern coast, from central New South Wales in the east to Shark Bay in Western Australia. They are relatively short-lived, 2-3 years, become sexually mature around 6-8 months and primarily spawn in spring and early summer. The eggs hatch within 24 hours and the larvae go through a series of moults and remain in the water column for 2-3 weeks after which they settle into inshore nursery areas with a preference for structured habitats (seagrass and algae). Juvenile prawns remain in the nursery areas until around 4-6 months of age when they migrate into deeper water and become available for capture (Kangas *et al*. 2015).

The status of brown tiger prawns is assessed annually using a weight-of-evidence approach similar to that of western king prawns. A spawning stock–recruitment relationship exists for brown tiger prawns (Penn *et al*. 1995, Caputi *et al*. 1998), and the maintenance of adequate spawning stock (using a target catch rate) is the key management objective (Kangas *et al*. 2015). Brown tiger prawns are managed to reference levels (catch rates) and accompanying control rules (DoF 2014, 2015). A mandatory closure of the brown tiger prawn northern spawning area is enforced on a set date (around June to July), to protect the spawning stock. As fishing ceases, fishery-independent surveys are then conducted to verify catch rates in the northern (as well as the southern) spawning areas.

The June 2015 spawning stock survey showed a mean standardised catch rate of 7.0 kg/hr in the northern spawning area. This was well below the target level of 25 kg/hr. A survey in August indicated a catch rate of 13 kg/hr just above the limit level (10 kg/hr), so it is still considered that the biomass of this management unit is unlikely to be recruitment overfished and it appears that overall there was an adequate spawning stock during the key spawning period in 2015. This conclusion was supported by very high catch rates of brown tiger prawns in the southern spawning area (148 kg/hr in June and 56 kg/hr in August) which were also protected during the spawning period.

The harvest strategy has an annual target catch range of 400 to 700 t. The brown tiger prawn catch prediction (based on fishery independent recruitment surveys) was 410 to 615 t. The total catch (434 t) was within the target catch range and the catch prediction. The level of fishing effort since 2007, when all boats adopted quad gear (4 standardised nets), has remained between 33 and 41 thousand trawl hours (standardised to twin nets) with fishing effort in 2015 being 40 thousand trawl hours. This evidence indicates that the current level of fishing mortality is unlikely to cause the management unit to become recruitment overfished.

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Low Risk*)

Bycatch composition 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 (under commercial size) and other crustacean species are taken in significant quantities but are generally returned alive. Overall bycatch taken in Shark Bay trawl nets is moderate relative to other subtropical trawl fisheries; with quantities ranging from 4–8 times the prawn catch. A study on the bycatch of trawled and untrawled areas of Shark Bay indicated highly diverse fish and invertebrate fauna (Kangas and Morrison 2013, Kangas *et al*. 2007) with no significant differences between trawled and untrawled areas for species richness, diversity or evenness for the major faunal assemblages within Shark Bay. Grid and secondary bycatch reduction devices (square mesh panels in cod-ends) have been fully implemented since 2003 and reduce the quantity of small fish and invertebrates retained in trawls.

Protected species including whales, dolphins, dugongs, turtles and sea snakes are particularly abundant in Shark Bay. However, only sea snakes are seen in the trawl catches in any numbers. Most are returned to the sea alive. The full implementation of bycatch reduction devices (grids) in the fishery has generally reduced the occasional capture of turtles in trawl nets (Shark Bay Prawn Table 1).

Shark Bay Prawn Table 1. *Protected species interactions recorded in the daily logbooks during 2015*

Species	Alive	Dead
Turtles	35	
Syngnathids	20	
Sea Snakes	1133	143
Saw Fish	3	2

HABITAT (*Moderate Risk*) AND ECOSYSTEM INTERACTIONS (*Low Risk*)

As a result of the extensive permanent and temporary closures first introduced in the 1960s, the fleet operates in approximately 5-7% of the overall licensed area of the fishery. Inside Shark Bay, trawl fishing is focused in the deeper areas (predominantly sand/shell habitats) of the central bay; north 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 (Kangas *et al*. 2015).

Due to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little physical impact. Overall, the nature of this trawl fishery and the controls on effort indicate that its environmental effect is likely to be moderate. Performance measures for habitat impact relate to the spatial extent of trawling within the Shark Bay Prawn Managed Fishery. In 2015 the total area trawled, at approximately 798 square nautical miles was 17% of inner Shark Bay, and 7% of the total fishery.

Although the prawn species are managed at 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. Because of this natural variation in prawn populations most prawn predators are opportunistic, and it is unlikely that the commercial take of prawns impacts significantly on the upper trophic levels of the Shark Bay ecosystem. The reduced levels of effort within the fishery now, combined with the gear modifications to reduce unwanted catch, have further lessened the impact the fishery has on the wider Shark Bay food chain.

SOCIAL AND ECONOMIC OUTCOMES

Social

This industry is a major contributor to regional employment. During 2015, approximately 100 skippers and crew were employed in the fishery. There are also approximately 55 processing and support staff employed at Carnarvon. One of the key operators with 10 licences is based in Carnarvon with administration, wharf and engineering staff based at the small boat harbour and a processing factory at Babbage Island. The prawn sector also utilises, wherever possible, Western Australian service companies providing engineering supplies, packaging, transport logistics, ship stores and fuel.

Economic

The value of the fishery including coral prawns, cuttlefish, squid and bugs is $28.7 million. This value excludes scallops and blue swimmer crabs which are separate Managed Fisheries. (see Saucer Scallop Resource and Blue Swimmer Crab Resource Status Reports). Ex-vessel (beach) prices for prawns vary, depending on the type of product and the market forces operating at any one time. Average prices per kg for 2015 were: western king prawns $11.42, brown tiger prawns $14.25, blue endeavour prawns $9.48, coral prawns $3.53.

GOVERNANCE SYSTEM

The total landings, plus the western king prawn and brown tiger prawn annual landings in 2015 were all within their respective tolerance ranges. The annual fishing level is considered **acceptable**.

Shark Bay Prawn Table 2. *Annual catch tolerance levels (acceptable)*

Total Prawn Catch	1,350-2,150 t
Western King Prawns	950-1,450 t
Brown Tiger Prawns	400-700 t
Blue Endeavour Prawns	1-30 t
Coral Prawns	80-280 t

Harvest Strategy (Formal)

The fishery is managed in accordance with the Shark Bay Prawn Managed Fishery Harvest Strategy, 2014-2019 (DoF 2014). The primary management objective is to maintain the spawning biomass above the historically determined biological reference points.

The key stock indicator for each primary species was above their respective target levels hence no changes to management arrangements will occur for 2016/17.

Compliance

It is a requirement that all vessels in the fishery are fitted with an Automatic Location Communicator (ALC). The implementation of an ALC enables the Department of Fisheries (Department) to monitor the fleet using a Vessel Monitoring System (VMS) and manage compliance with temporal and spatial closures. The Department also undertakes regular vessel inspections to ensure fishing is being undertaken in accordance with the governing legislation (e.g. gear requirements, catch reporting).

Consultation

Annual Management Meetings are held between the Department and licensees, in conjunction with the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC). These meetings provide an opportunity for the Department, WAFIC and industry to discuss research outcomes and initiatives, management of the fishery and industry issues.

Season arrangements are developed each year in consultation between the Department and licensees. During the season, the Department and licensees undertake collaborative in-season management to ensure the protection of smaller prawns and to maintain the spawning stock biomass.

Management Initiatives (Stable)

Management initiatives for 2015/16 include undertaking work to address conditions of certification.

EXTERNAL DRIVERS

External drivers for this fishery include increasing costs of fishing, lower returns due to the current global economic climate, and competition from imported and locally aquaculture produced small prawns. This has shifted harvesting practices to focus on targeting larger prawns during high catch rate periods to maximise efficiency. The drop in the value of the Australian dollar has shifted the emphasis from solely domestic markets to include international markets. Industry has been seeking the opportunity to maximise the return from all species taken (including byproduct) in the fishery where possible, particularly saucer scallops and blue swimmer crabs.

The major environmental factor influencing these stocks appears to be the flow of the Leeuwin Current along the outside of the embayment such that increases in water temperature associated with the Leeuwin Current has shown an increase in growth and catchability of prawns.

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SAUCER SCALLOP RESOURCE STATUS REPORT 2016

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

OVERVIEW

Saucer scallops, *Ylistrum balloti* (formerly *Amusium balloti*), are fished using otter trawls in four separate fisheries in Western Australia. The Shark Bay Scallop Managed Fishery (SBSMF) is usually Western Australia's most valuable scallop fishery with boats licensed to take only scallops (11 Class A licenses) and boats that also fish for prawns (18 Class B licenses). The second largest scallop fishery is the Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWTMF). The South West Trawl Managed Fishery (SWTMF) and the South Coast Trawl fishery (SCTF) are multi-species fisheries that primarily target scallops.

Management is generally based on limited entry, gear controls and seasonal closures however Shark Bay has been undertaking a catch quota trial with an allocation between the Class A and B sectors.

Catches in these fisheries vary widely depending on the strength of recruitment, which is thought to be influenced by the strength of the Leeuwin Current and water temperature. Extreme environmental events, as was observed with a marine heat wave in the summer of 2010/11 had a significant impact on scallop stocks, particularly in Shark Bay and the Abrolhos Islands.

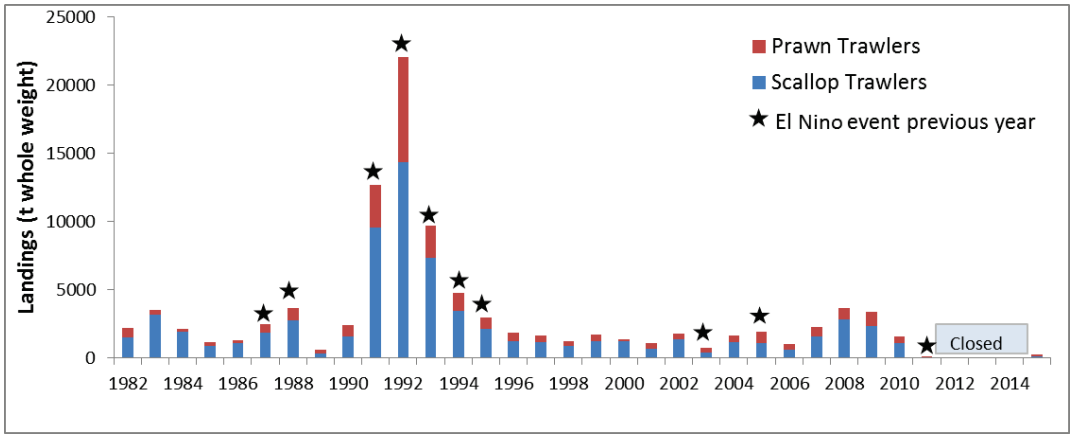
SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2015	121 t meat weight (603 t whole weight)	Not applicable
Fishing Level	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Saucer Scallop	Recovering	Direct survey/catch rate
Shark Bay Abrolhos:	Environmentally limited	Recruitment survey, catch and effort
South-west	Adequate	Catch and effort
South coast	Adequate	Catch and effort

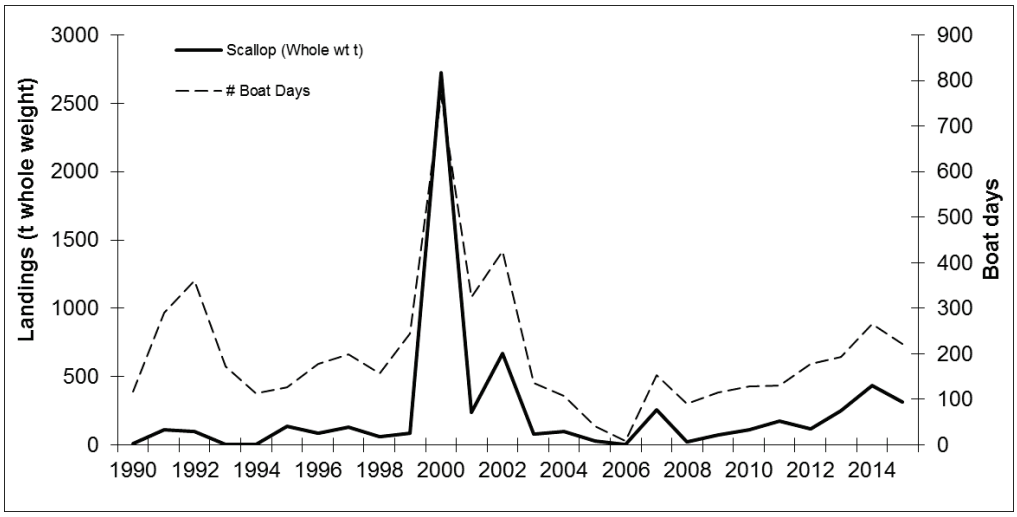
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low Risk	**Listed Species**	Low Risk
Habitat	Low Risk	**Ecosystem**	Low Risk
Social	Amenity Score 1	**Economic**	GVP ($4.2 million)
	Risk Level 1		Risk Level 4
Governance	Plan review	**External Drivers**	Risk Level 5 (climate)

CATCH AND LANDINGS

The total scallop landing was 121 t meat weight (603 t whole weight) in WA in 2015. There was 57.6 t meat weight (287.8 t whole weight) taken in Denham Sound out of a quota with 100 t meat weight. The A Class boats landed 24.8 t (43.2 %) and the B Class boats landed 32.8 t (Saucer Scallop Figure 1). Minimal by-product was retained by A Class boats. The landings in the South Coast Fishery were 57.6 t meat weight (287.8 t whole weight, Saucer Scallop Figure 2). The Abrolhos Island fishery was closed and no fishing took place in the South-West Fishery.



SAUCER SCALLOP FIGURE 1: *Annual scallop catch (t whole weight) for the Shark Bay scallop fishery, 1982 to 2015. The fishery was closed between 2012 and 2014.*



SAUCER SCALLOP FIGURE 2: *Annual scallop catch (t whole weight) and number of boat days fished for the South Coast fishery, 1990 to 2015.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Saucer scallops are distributed from Esperance in Western Australia, across the tropics, to the southern coast of New South Wales. The genus was recently revised (Mynhardt *et al*. 2014). The Western Australian stock spans most of the coast of Western Australia but, given the vast length of this coastline and the potential for regional differences in recruitment, these four fisheries are considered independent management units.

Shark Bay Scallop Managed Fishery *(Recovering)*

The status of the stock in Shark Bay is determined from the annual pre-season fishery independent survey of recruitment and residual stock (Caputi *et al*. 2014a) carried out in November–December. This survey enables the management arrangements of the fishery to maintain adequate level of breeding stocks.

The fishery is currently in a recovery phase because the stock biomass had fallen to a level where there was a significant risk of recruitment failure. This low stock biomass was not due to overfishing or lack of appropriate fisheries management but from a series of poor recruitment events associated with sustained unfavourable environmental conditions dating back to in the marine heat wave that begun in late 2010 (Caputi *et al*. 2014a,b, 2016).

The stock has now fully recovered in Denham Sound but is recovering more slowly in northern

Shark Bay. The estimated spawning biomass in northern Shark Bay remains at record low levels but recruitment of 0+ scallops has increased in November 2015. Continued favourable environmental conditions for recruitment during 2015-16 is expected to further improve spawning biomass levels.

Abrolhos Islands and Mid-West Trawl Managed Fishery *(Environmentally Limited)*

The scallop numbers during the 2015 survey were low, however showed slight improvement on recent years (2012-2014). The numbers indicated that the landings would be less than the limit reference level and target range (95-1830 t whole weight) at which no fishing will occur. The stock continues to be considered as **environmentally limited**.

South West Trawl Managed Fishery (*Adequate*)

Effort has been related to either the abundance of western king prawn or saucer scallop in any given year, which can be highly variable due to sporadic scallop recruitment. Only 2-4 vessels have operated in the fishery since 2005 and have only covered approximately 1-3 per cent of the allowable fishery area. Since 2005 an average of 168 boat days have been recorded annually with a catch range between 1 and 217 t whole weight compared to 490 boat days on average the previous ten years (1995 to 2004) for a catch range between 3 and 23 t whole weight. The level of fishing pressure is unlikely to adversely impact the spawning biomass of saucer scallop. The scallop numbers during limited sampling in the key 'Rottnest' fishing grounds were low and industry chose not to fish this season.

South Coast Trawl Fishery *(Adequate)*

Effort is related to the abundance of scallops in any given year, which can be highly variable due to sporadic recruitment. The few vessels (up to four) that operate in the fishery only fish over 1-3 per cent of the allowable fishery area. In 2015 a total of 315 t whole weight was landed for 222 boat days. The mean catch rate in 2015 was 1419 kg whole weight per boat day compared to a mean of 1168 kg per boat day (range 669 to 1643 kg per boat day) for the previous five years. The above evidence indicates that the biomass of this stock is unlikely to be recruitment overfished. It also indicates that the current level of fishing pressure is unlikely to cause the stock to become recruitment overfished.

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Low Risk*)

Limited and restricted fishing occurred in Shark Bay in 2015. Owing to the legislated 100 mm mesh mesh size of the nets and the relatively short duration of this fishery, the total bycatch landed is minimal. Grids have been fully implemented in this fishery since 2003. Protected species are occasionally captured but generally are released alive due to the relatively short duration of trawls and there were no reported interactions with protected species in 2015.

Protected species that are susceptible to capture by trawling do not occur regularly in the fishing areas of the SWTMF and the SCTF and while turtles occur in the Abrolhos Islands, these are towards the southern extent of their range, and do not breed in the area because water temperatures are too low. Consequently, interactions with turtles were always minimal, and now that grids are compulsory in the fishery their capture should be eliminated. No fishing took place in the AIMWTMF and SWTMF in 2015.

HABITAT AND ECOSYSTEM INTERACTIONS (*Low Risk)*

Habitat effects are considered **low risk**, with trawl boats generally sweeping a small proportion of the designated trawl area. Because these areas are sandy habitats, and trawling activity has low impact on the substrate (Laurenson *et al*. 1993); the overall habitat effects are **low**. In Shark Bay only 4.4% of the allowable trawl area was fished in 2015 (noting northern Shark Bay was closed to scallop fishing). Only 1.9% of the legislated boundary of the fishery was trawled on the South Coast with no fishing in the other two fisheries.

The ecosystem impacts of scallop fisheries are considered to be **low risk**, with the total biomass taken by these operations being small. The high natural recruitment variability and therefore scallop stock abundance and short life span (up to 3 years) also means that few predators will have become highly dependent on the species.

SOCIAL AND ECONOMIC OUTCOMES

Approximately 20 skippers and crew were employed in scallop fishing the Shark Bay and

South Coast fisheries, with support staff in Geraldton and Fremantle. In Shark Bay, an additional 70-80 crew are employed in the prawn fishery (B Class) that can also retain scallops. The overall GVP for the two fisheries that operated in 2015 (including B Class boats in Shark Bay) was $4.2 million.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels (Not Applicable)

Shark Bay: Not applicable for season 2015 (trial quota).

Abrolhos Islands: No fishing in 2015.

South West: Catch range not developed.

Harvest Strategy

The harvest strategy for Shark Bay and the Abrolhos Islands fisheries is based on the abundance of scallop found during annual recruitment/spawning stock surveys. Catch predictions for 2015, derived from surveys in November 2014 were very low for northern Shark Bay but moderate recovery was evident in Denham Sound. Consequently, to provide protection to the breeding stocks and aid recovery, management measures used in 2015 included a ban on scallop harvest from northern Shark Bay and a trial quota of 100 t meat weight for Denham Sound.

Compliance

It is a requirement that all vessels in the fishery are fitted with an Automatic Location Communicator (ALC). The implementation of an ALC enables the Department of Fisheries (Department) to monitor the fleet using a Vessel Monitoring System (VMS) and manage compliance with temporal and spatial closures. The Department also undertakes regular vessel inspections to ensure fishing is being undertaken in accordance with the governing legislation (e.g. gear requirements, catch reporting).

Consultation

Annual Management Meetings are held between the Department and licensees, in conjunction with the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC). These meetings provide an opportunity for the Department, WAFIC and industry to discuss research outcomes and initiatives, management of the fishery and industry issues. Season arrangements are developed each year in consultation between the Department and licensees.

Management Initiatives

Catch quota trial will be continued in 2016 for both A and B Class boats in Shark Bay.

EXTERNAL DRIVERS *(Major Risk)*

Strong La Niña events that are typically associated with strong Leeuwin Currents and warm sea-surface temperatures, often result in below-average scallop recruitment and may necessitate the closure of the Shark Bay Scallop Managed Fishery and/or the Abrolhos Island and Mid-West Trawl Managed Fishery. Between 2012 and 2015 fishery closures in these two fisheries also occurred due to a marine heat wave event in 2010/11 (associated with a strong La Niña) which resulted in mortality of breeding stock and subsequent very poor recruitment for a number of years (Caputi *et al*. 2014 b, 2016). Further research continues into understanding recruitment variation (including the collapse) of scallop stocks.

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SHARK BAY BLUE SWIMMER CRAB RESOURCE STATUS REPORT 2016

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OVERVIEW

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 regionally important recreational fishery. The management moved from an effort-controlled system to a notional quota management system in 2013/14. The Individual Transferable Quota management system was formally implemented for the fishery in the 2015/16 season. The Shark Bay crab resource was allocated across the various sectors based upon proportional catch histories: trap – 66.0%; prawn trawl – 33.8%; and scallop trawl – 0.2%.

Recreational fishing for blue swimmer crabs mainly use drop nets or scoop nets. This sector is managed through a combination of input and output controls including a minimum size limit that is well above the size at sexual maturity along with a bag and boat limits.

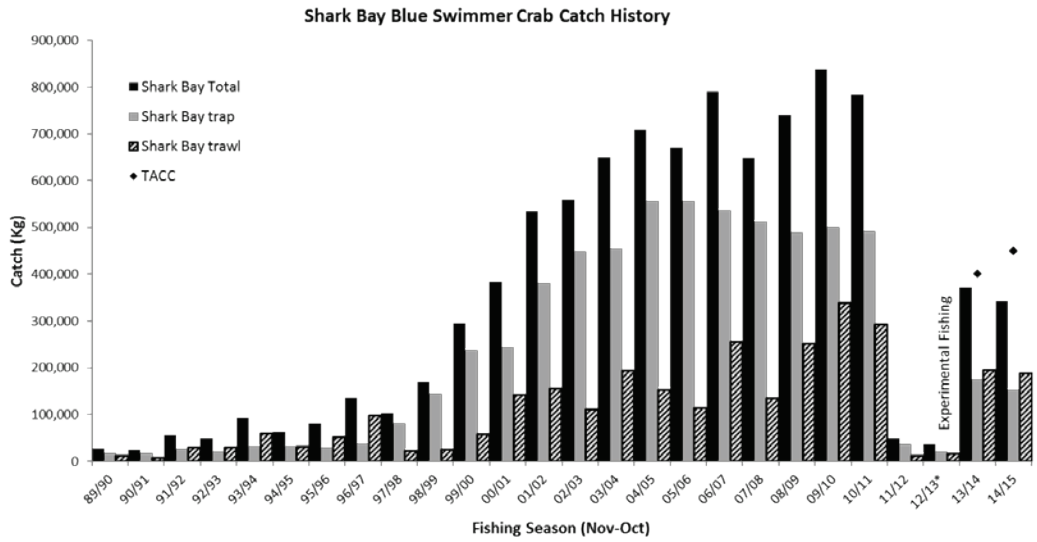
The fishery was assessed under the provisions of the Commonwealth's EPBC Act in 2015 and has been accredited for export for a period of ten years (re-assessment in 2025).

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	341 t (2014/15)	~2.2 t (Gascoyne bioregion boat estimate 2013/14)	
Fishing Level	Acceptable	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Shark Bay Blue Swimmer Crab	Recovering	Direct survey/catch rate	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Negligible Risk (trap) Low Risk (trawl)	**Listed Species**	Low Risk
Habitat	Low Risk	**Ecosystem**	Low Risk
Social	Amenity Score 2 Risk Level 3	**Economic**	GVP Risk Level 5 ($1.83 million)
Governance	New Management plan (Nov 2015)	**External Drivers**	Risk Level 5 (climate)

CATCH AND LANDINGS

A TACC of 450 tonnes was set for 2014/15 fishing season (1 November 2014 to 19 November 2015) and in accordance with the catch share arrangement between the trap and trawl sectors outlined above and some quota was transferred between the trap and trawl sectors. The total catch achieved for the 2014/15 season was 341 t (~76% of the TACC) with a total of 109 tonnes of unfished quota allocation (Shark Bay Blue Swimmer Crab Figure 1). The trap sector's total catch was 153 t over a total of 353 fishing days (all taken in the northern fishing grounds). This represented 45% of the total landings for this season. The prawn trawl sector's total catch was 188 t which represented 55% of the total landings, while the scallop trawl sector's total catch was 143 kg.



SHARK BAY BLUE SWIMMER CRAB FIGURE 1. *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 and 450 tonnes was set for the 2013/14 and 2014/15 fishing seasons respectively.*

SPECIES ASSESSMENTS AND STOCK STATUS

Blue swimmer crabs in Shark Bay have an approximate 18-month life cycle from spawning to becoming commercial sized crabs. The peak spawning period occurs during the cooler autumn/winter months and is captured in the Department's June research survey which provides an index of peak spawning levels. The peak recruitment from this spawning period is during the warmer summer months and is captured during the February survey, approximately 9 months after spawning. Crabs attain sexual maturity within 12 months (between 100 - 110 mm CW) and reach commercial sizes (voluntary minimum size limit of 135 mm CW) between 12 and 18 months of age.

The Shark Bay crab stock experienced a significant stock decline in late 2011, following a series of adverse environmental conditions between 2010 and 2011 (coldest winter on record in 2010 followed by an extreme marine heat wave event and flooding events during the summer of 2010/11). These environmental conditions are believed to have caused a major recruitment decline for the following season. The fishery was closed for a period of 18 months in 2012 to promote stock recovery and is currently in a stock rebuilding phase. Limited commercial fishing resumed under a notional quota management system for the 2013/14 (400 t) season, and continued for the 2014/15 season with a Total Allowable Commercial Catch (TACC) of 450 t.

Indices of spawning biomass levels (survey data and modelling data), while partially recovering, have not increased from the level in 2013 which appears partly due to relatively stable recruitment levels (survey data) since fishing had resumed. If the current level of catch and environmental conditions continue, further spawning stock recovery is not likely to be achieved. Moreover, if landed catches are close to 450 t (the current TACC), it is likely that the spawning biomass will further decline and it is possible that recruitment may be even further affected.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Hourglass traps are purpose-designed to minimise the capture of undersized blue swimmer crabs and non-target species, the majority of which are able to escape through the entrance gaps when the pot is soaking or being hauled. The number of bycatch species recorded in the fishery (mainly finfish and other invertebrates) is low and considered to pose a negligible risk to these stocks. The trap 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. Bycatch from

the prawn and scallop trawl fleets are described in the relevant status reports specific to the trawl fisheries (see Gascoyne Shark Bay Prawn Resource and Saucer Scallop Resource Reports).

HABITAT AND ECOSYSTEM INTERACTIONS

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.

Fishing with traps results in limited habitat disturbance, as only minor dragging of traps on the sea bottom occurs 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. The impact on habitat and ecosystem interactions are described in the relevant status reports specific to the trawl fisheries (see Gascoyne Shark Bay Prawn Resource and Saucer Scallop Resource Reports).

SOCIAL AND ECONOMIC OUTCOMES

Social

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

The average beach price for uncooked crabs across WA was $5.36/kg. The estimated value of the commercial blue swimmer crab resource from Shark Bay was $1.83 million which was a combination of $1.01 million from the trawl sector and $0.82 million from the trap sector for 2014/15.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

TACC of 450 t: The total catch for 2014/15 was 341 t (~76% of TACC). Non achievement of this TACC was largely due to unused quota in trap sector.

Harvest Strategy

The formal harvest strategy is currently under development. The TACC setting process currently takes into account information from fishery-independent surveys, commercial catch and effort, environmental conditions and also results from a biomass dynamic model.

Compliance

The Department undertakes regular vessel and landing inspections to ensure fishing is being undertaken in accordance with the governing legislation (e.g. gear requirements, catch reporting and size and bag limits). It is also a statutory requirement that commercial fishers submit Catch and Disposal Records outlining the weight of crabs landed after each fishing trip. This information enables the Department to monitor the TACC and investigate any breaches of entitlement.

Consultation

The Department undertakes consultation directly with commercial licensees on operational issues. Annual Management Meetings between the Department and licensees are convened by the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC) under a Service Level Agreement (SLA) with the Department. These meetings provide an opportunity for the Department, WAFIC and industry to discuss research outcomes and initiatives, management of the fishery and industry issues.

Recreational consultation processes are facilitated by Recfishwest under a SLA.

Management Initiatives/Outlook Status

On 20 November 2015, the Shark Bay Crab Managed Fishery Management Plan 2015 (new Plan) commenced providing the management framework for the take of blue swimmer crab by all three commercial sectors (i.e. by the prawn

trawl, scallop trawl and crab trap). Concurrently, the Shark Bay Crab Fishery (Interim) Management Plan 2005 was revoked and the Fishing Boat Licence condition which permitted operators to fish in the inner gulfs of Shark Bay was removed, given these arrangements are encompassed under the new Plan. The new Plan is based on an Individual Transferable Quota (ITQ) system of entitlement and includes two zones to maintain the previous access arrangements.

The Department will also be developing a harvest strategy for the fishery in consultation with the relevant stakeholders during 2016/17 outlining the long and short term management objectives for the fishery and the performance indicators, reference levels and harvest control rules required to achieve these objectives.

EXTERNAL DRIVERS

Warmer sea surface temperatures (SSTs) during the winter spawning period and cooler SSTs during the summer months have been identified to be favourable for recruitment of blue swimmer crabs in Shark Bay. Shark Bay experienced the coldest winter SSTs on record prior to the hottest summer SSTs on record between 2010 and 2011, which led to a significant recruitment decline in 2012. Environmental conditions in Shark Bay have since improved but cooler than average winter and warmer than average summer temperatures have been identified as a unique phenomenon that persists within Shark Bay. There is now an ongoing risk associated with the current environmental conditions in Shark Bay on the full recovery of the crab stock and thus it is being closely monitored.

Furthermore, blue swimmer crabs are ranked “high risk” under the current climate change scenario impacting the WA coastline.

GASCOYNE EXMOUTH GULF PRAWN RESOURCE STATUS REPORT 2016

M. Kangas, E. Sporer, S. Wilkin, I. Koefoed, P. Cavalli and L. Pickles

OVERVIEW

The Exmouth Gulf Prawn Managed Fishery uses low opening, otter prawn trawl systems within the sheltered waters of Exmouth Gulf (Kangas *et al*. 2015) to target western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and banana prawns (*Penaeus merguiensis*). Management of this fishery is based on input controls, including limited entry, gear controls (maximum headrope units) seasonal and area openings and closures and moon closures. Management arrangements are designed to keep fishing effort at levels that will maintain a sufficient spawning biomass of prawns (particularly brown tiger prawns). Bycatch reduction devices (BRDs) and a secondary fish escape device (FED) are mandatory.

This fishery received Marine Stewardship Council (MSC) certification in October 2015. The Commonwealth Government's Department of the Environment and Energy (DEE), 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 (https://www.environment.gov.au/marine/fisheries/wa/exmouth-gulf-prawn).

Industry, in association with the Department, successfully gained certification from the US Department of State in 2008 and was re-certified in 2012 which will be reviewed in 2016. This certification allows licensees to export product to the US market.

SUMMARY FEATURES 2016

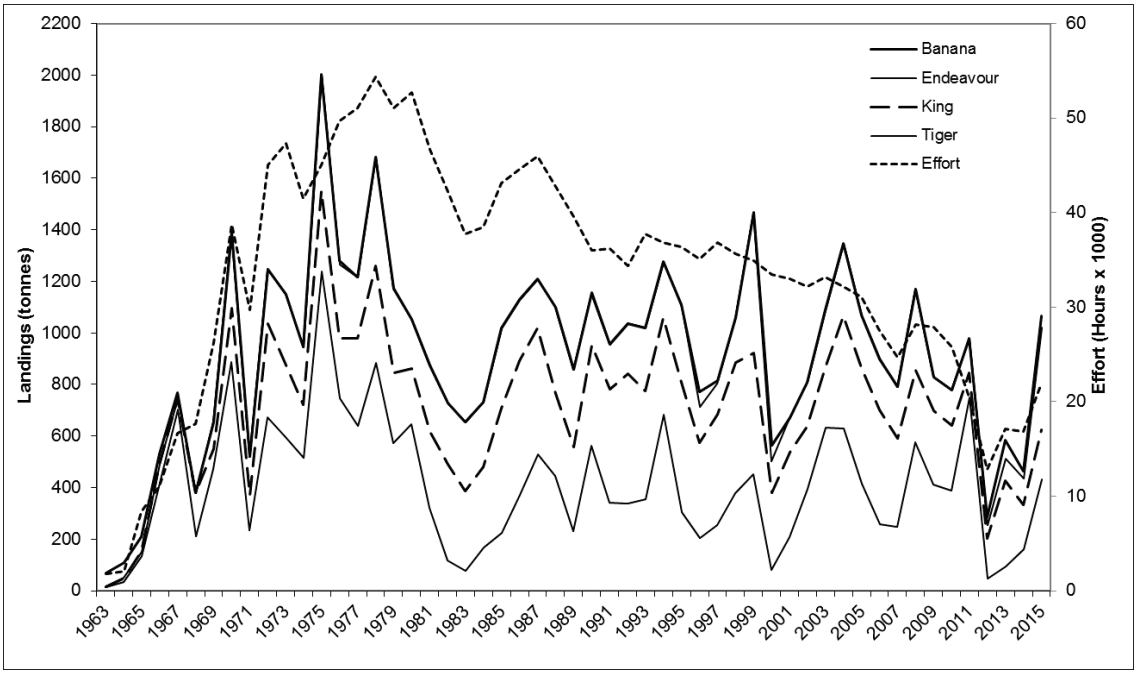
Fishery Performance	Commercial	Recreational
Total Catch 2015	Commercial: 1,067 t	Not applicable
Fishing Level	Acceptable	

Stock/Resource Performance	Stock Status	Assessment Indicators
Brown Tiger Prawn	Adequate	Level 4 - Direct Survey/Catch Rate
Western King Prawn	Adequate	Level 4 - Direct Survey/Catch Rate
Blue Endeavour Prawn	Adequate	Level 2 - Catch and Survey/Catch Rate

EBFM Performance Asset	Level	Asset	Level
Bycatch	Low Risk	**Listed Species**	Low Risk
Habitat	Low Risk	**Ecosystem**	Low Risk
Social	Amenity Score 1 Risk Level 1	**Economic**	GVP Risk Level 4 ($13.9 million)
Governance	Stable	**External Drivers**	Risk Level 5 (climate)

CATCH AND LANDINGS

The total landings of prawns in 2015 were 1,067 t (Exmouth Gulf Prawn Figure 1) and recorded landings of by-product were; 6.6 t of blue swimmer crab (*Portunus armatus*), 1.8 t of squid, 3.0 t of bugs (*Thenus australiensis*), 0.3 t of coral prawns, 0.2 t of cuttlefish and 0.2 t of octopus. Historical landings are provided in Kangas *et al.*2015.



EXMOUTH GULF PRAWN FIGURE 1. *Annual prawn landings (t) and fishing effort (total adjusted hours) for the Exmouth Gulf Prawn Managed Fishery 1963-2015.*

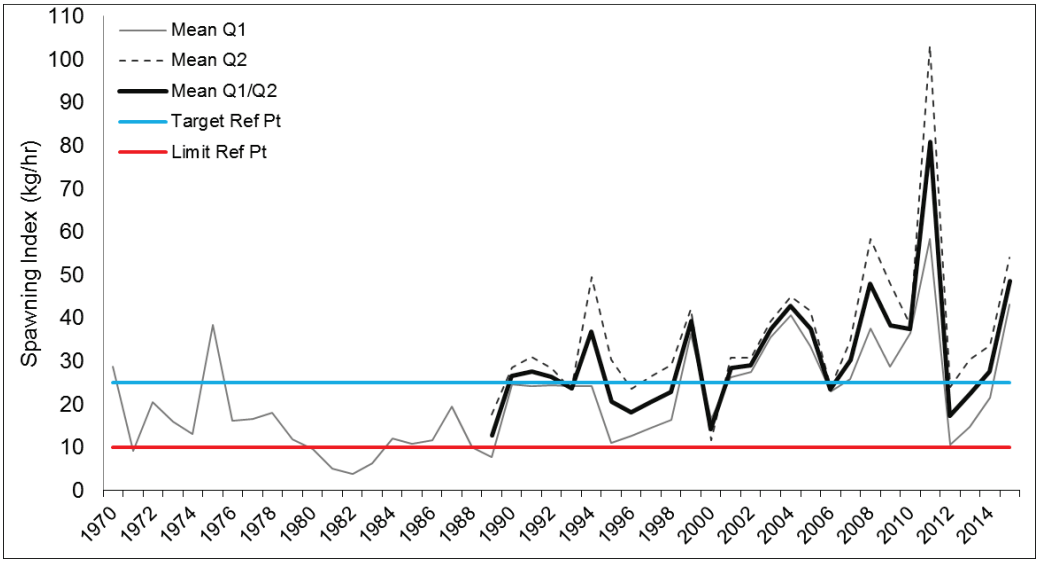
INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS *(Sustainable-Adequate)*

Brown tiger prawns

Brown tiger prawns are endemic to tropical and subtropical waters of Australia and are distributed around the northern coast, from central New South Wales in the east to Shark Bay in Western Australia (Grey *et al.* 1983). They are relatively short-lived (2-3 years), become sexually mature around 6-8 months and primarily spawn in spring and early summer.

The status of the stocks is assessed annually using a weight-of-evidence approach primarily based on monitoring of fishery-independent indices of recruitment and spawning stock levels relative to specified reference points. Recruitment surveys provide the basis of an annual catch prediction (Caputi *et al*. 2014a). Other information collected throughout the season (e.g. commercial catches, effort and environmental data) is also evaluated to provide insight on, for example, any environmental factors affecting prawn recruitment.

The management objective is to maintain the spawning biomass above the historically determined biological reference points, with the present target of 25 kg/hr and a limit of 10 kg/hr in the spawning stock surveys (DOF 2014). Daily monitoring of commercial catch rates ensures cessation of fishing at the target catch rate within the key spawning area. Fishing ceases in early August even if catch rates are above the target level. The standardised spawning stock surveys carried out from August to October 2015 had an average catch rate of 48.5 kg/hr, well above the target level (Exmouth Gulf Prawn Figure 2). The fishery has fully recovered from the effects of the marine heat wave (Caputi *et al*. 2015) that may have affected the structured inshore nursery habitat indicating that the this stock is highly unlikely to be recruitment overfished.



EXMOUTH GULF PRAWN FIGURE 2. *Brown tiger prawn spawning stock mean catch rate (kg/hr) for August, September and October combined and target and limit reference levels.*

With respect to fishing mortality, temporal and spatial closures (based on fishery independent and industry surveys) ensure that brown tiger prawns are not harvested at sub-optimal sizes. The annual catch tolerance range for brown tiger prawns is 250 to 550 t (DOF 2014) with the catch prediction of 220 to 330 t for 2015. The total catch (433 t) was within the target catch range but above the catch prediction. The standardised fishing effort in 2015 was 22 thousand trawl hours which is reduced from historical levels (35 to 50 thousand hours standardised to twin gear) with all boats adopting quad gear (4 nets) and total boat number being reduced from 12 to six (Kangas *et al*. 2015). The current level of fishing mortality is unlikely to cause the stock to become recruitment overfished.

Western king prawns

The western king prawn is widely distributed throughout the Indo-West Pacific region (Grey *et al*. 1983). Two major fisheries occur in Shark Bay and Exmouth Gulf, with smaller quantities landed off Onslow and Broome.

Western king prawns live between 2-3 years with sexual maturity being reached around 6-8 months. This species can spawn all year round with peaks of spawning during the spring and autumn. Post-larval and juvenile western king prawns can be found inshore on shallow tidal flats with sand or mud sediments, such inshore areas can have salinities higher than seawater (i.e. hypersaline waters) and juveniles prefer this habitat, unlike most other prawn species, which prefer estuarine conditions western king prawns are nocturnal and highly sensitive to light, with their activity and catchability influenced by lunar cycles as well as temperature (Penn 1984).

Fishery-independent recruitment surveys are undertaken each year to assess their abundance and size structure and are used for catch predictions (Caputi *et al*. 2014a, 2016) and management decisions such as spatial-temporal opening of fishing areas. In 2015 the recruitment index was 25.4 kg/hr which was below the target (30 kg/hr) and therefore fishing was delayed in key western king prawn grounds until August when catch rates were above the target. The spawning stock index for 2015 (commercial catch rates in key western king prawn fishing ground in August and September) was 35.0 kg/hr which was above the target (25 kg/hr).

With respect to fishing mortality, catch and catch rate levels from 1989 to 1998 have been used as the basis for calculating target catch ranges of 350 to 500 t and a catch rate of 12 kg/hr (range 8 to 14 kg/hr). This target catch range is being reviewed due to the apparent negative impacts of increased water temperature on recruitment and with the level of effort having declined for the fishery as a result of fleet restructures and targeting larger prawns. The commercial catch for 2015 of 192 t was well below the target range with a mean catch rate (8.7 kg/hr) at the lower end of the target range. The above evidence indicates that the biomass of the stock is unlikely to be recruitment overfished and

that the current level of fishing mortality is unlikely to cause the stock to become recruitment overfished.

Blue endeavour prawn

Endeavour prawn fisheries are located in Shark Bay, Exmouth Gulf, on the north coast of Western Australia, the Gulf of Carpentaria, the Torres Strait and on the east coast of Queensland. This species is generally found in coastal waters down to approximately 50 m and is commonly trawled over muddy or sand/mud sediment substrates. They are generally found inshore of the main fishing grounds for the brown tiger and western king prawns.

Blue endeavour prawn catches have ranged between 120 and 300 t in most years, mainly related to the effort applied to brown tiger prawns in areas where endeavour prawns also occur. The breeding stocks of endeavour prawns are considered to be at a lower level of vulnerability to the fishery compared to brown tiger prawns. Therefore, the current strong management controls designed to ensure the sustainability of brown tiger prawns should ensure the maintenance of adequate levels of endeavour prawns. The main part of their distribution is inshore and overlaps with the extensive brown tiger prawn permanent nursery and temporal spawning closures. This protects a significant portion of the blue endeavour prawn breeding stock. In addition, blue endeavour prawns are considered to be more resilient to fishing pressure due to their smaller size and lower catchability. It is therefore unlikely that they are being fished to levels associated with maximum acceptable fishing levels, which represents a **low risk**.

Fishery-independent recruitment surveys of brown tiger and western king prawns also record the abundance of blue endeavour prawns providing an annual recruitment abundance index for this species. In 2015 the mean abundance index (catch rate) for the blue endeavour prawn on the brown tiger prawn grounds of 17 kg/hr was above the 15 year mean (1997-2011) of 15 kg/hr and within the range observed during these years (6 to 35 kg/hr). On the western king prawn grounds the mean abundance index of 22 kg/hr, was well above the 6-year mean (2007-2012) of 14 kg/hr and within the range observed (2 to 38 kg/hr) during those years. There has been no declining trend in the fishery independent survey catch rates over the periods sampled in either of these fishing grounds. As a result, the biomass of the stock is not considered to be recruitment overfished.

With respect to fishing mortality, a target catch range is set at 120 to 300 t, based on historical catches between 1989 and 1998. The total catch in 2015 (397 t) was above the target catch range and the average catch over the past 15 years (201 t) reflecting the higher recruitment observed. The current level of effort is unlikely to cause the stock to become recruitment overfished.

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Low Risk*)

Bycatch levels for Exmouth Gulf are relatively low by tropical trawl fisheries standards, with few species of significance to other fishing sectors being taken. In addition to grids, secondary bycatch reduction devices (square mesh panels) were implemented in all nets in 2005. All boats also use hoppers (in-water catch sorting systems), which adds another level of improvement for bycatch survival and product quality.

While protected species including dugongs, turtles and sea snakes occur in the general area, only sea snakes and occasionally turtles are encountered in the trawl catches (Exmouth Gulf Prawn Table 1). Both species are typically returned alive (Kangas *et al*. 2015). Grids have largely eliminated turtles and other large animal captures.

EXMOUTH GULF PRAWN TABLE 1. *Protected species interactions recorded in the daily logbooks during 2015.*

Species	Alive	Dead	Unknown
Turtles	14	1	NA
Sea Snakes	496	74	NA
Seahorses	4	0	NA
Pipefish	2	0	NA
Saw Fish	4	1	1

HABITAT AND ECOSYSTEM INTERACTIONS *(Low Risk)*

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 fishery and controls on effort indicate that its environmental effect is likely to be low (Kangas *et al* 2015). Performance measures for habitat impact

relate to the spatial extent of trawling within the licensed area of the Exmouth Gulf fishery. In 2015 the performance measure was met as the total area trawled, at approximately 353 square nautical miles (31.0%) per cent of trawlable grounds in Exmouth Gulf was below the 40% level.

Although the prawn species are managed at relatively high levels of annual harvest, the impact of the catch on local food chains is unlikely to be significant given the high natural mortality, extent of the non-trawled areas and variable biomass levels of prawns resulting from changing environmental conditions such as cyclone events.

SOCIAL AND ECONOMIC OUTCOMES

The estimated employment in the fishery for the year in 2015 was 18 people including skippers and other crew. Twenty three additional support staff were based in Exmouth Gulf with additional support staff based in Fremantle for refitting of boats. Within the Exmouth area, the fishery is an important regional employer contributing to the economic viability of the Exmouth township.

Ex-vessel (beach) 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 licensee undertaking direct marketing of the product into domestic and overseas markets. For this reason, the prices quoted for prawns and byproduct are provided by the licensee on an overall average price taking into account each grade landed. The total estimated value of the fishery, including byproduct is $13.9 million.

GOVERNANCE SYSTEM

Total landings of 1,067 t were within the tolerance range as were the landings of brown tiger prawns with blue endeavour prawns above their acceptable range. The catch range for western king prawns is under review. The annual fishing level is considered **acceptable**.

EXMOUTH GULF PRAWN TABLE 2. *Annual catch tolerance levels (acceptable)*

Total Prawn Catch	721–1,410 t
Western King Prawns	(under review)
Brown Tiger Prawns	250–550 t
Blue Endeavour Prawns	120–300 t
Banana Prawns	1–60 t

Harvest Strategy (Formal)

The fishery is managed in accordance with the Exmouth Gulf Prawn Managed Fishery Harvest Strategy, 2014-2019 (DoF 2014). The primary management objective is to maintain the spawning biomass above the historically determined biological reference points.

The key stock indicator for each primary species was above their respective target levels hence no changes to management arrangements will occur for 2016/17.

Compliance

It is a requirement that all vessels in the fishery are fitted with an Automatic Location Communicator (ALC). The implementation of an ALC enables the Department of Fisheries (Department) to monitor the fleet using a Vessel Monitoring System (VMS) and manage compliance with temporal and spatial closures. The Department also undertakes regular vessel inspections to ensure fishing is being undertaken in accordance with the governing legislation (e.g. gear requirements, catch reporting).

Consultation

The Department, in conjunction with the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC) have established an Annual Management Meeting (AMM) for this fishery. The AMM is an opportunity for the Department, WAFIC and Industry to discuss research outcomes, initiatives and management of the fishery and industry issues. Season arrangements are develop each year in consultation between the Department and the license holder. During the season, the Department and the license holder undertake collaborative in-season management to ensure the protection of smaller prawns and to maintain the spawning stock biomass.

Management Initiatives (Stable)

No specific management initiatives are planned for this resource. Stakeholder engagement arrangements will be amended.

EXTERNAL DRIVERS (*High Risk*)

External drivers for this fishery include; increasing costs of fishing, lower returns due to the global economic climate and competition from imported and Australian aquacultured small prawns. This has shifted fishing strategies to focus on targeting larger prawns during high catch rate periods to maximise efficiency. The main emphasis for this fishery is on

domestic markets. Export of product to international export markets is maintained but at lower profit margins.

Cyclones also appear to have a significant effect on the productivity of Exmouth Gulf. Cyclones can either have a positive or negative impact on prawns depending on the timing and severity of the cyclone, the species of prawn and their location in the fishery.

Brown tiger prawns were ranked as a high risk to climate change effects and western king prawns as medium-high so both these species need to be monitored closely (Caputi *et al*. 2014b, 2015). The heat wave event of 2010/11 may have contributed to the recent extremes in abundance of brown tiger prawns in Exmouth Gulf. The cause of the low recruitment is being investigated in regard to nursery habitats and environmental factors (including temperature).

Higher than average water temperatures in the last five years are also having a negative effect on western king prawn catches (Caputi *et al.* 2014b, 2015) and will be further investigated.

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WEST COAST DEEP SEA CRAB RESOURCE STATUS REPORT 2016

J. How and M. Yerman

OVERVIEW

The West Coast Deep Sea Crustacean Managed Fishery (WCDSCF) 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 (>150 m) of the West Coast and Gascoyne Bioregions (see How *et al*. 2015). The fishery is primarily managed using a total allowable catch. In 2016 the WCDSCF achieved MSC certification, confirming the stock assessment, ecosystem impact and governance credentials of the fishery. For more details on the fishery and assessment methodology see How *et al*. 2015.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	154 t	Nil	
Fishing Level	Acceptable	NA	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
	Sustainable - Adequate	Annual: Catch, Catch Rates	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low Risk	**Listed Species**	Low Risk
Habitat	Low Risk	**Ecosystem**	Low Risk
Social	Low Amenity Low Risk	**Economic**	GVP Level 2 ($3.8 million) Moderate Risk
Governance	Minor Adjustments	**External Drivers**	Low Risk

CATCH AND LANDINGS

The total landings from this west coast offshore resource in 2015 as targeted by the WCDSCF was 154.1 t. Catches are dominated by crystal crabs, where 153.7 t (99% of the TAC) was landed. No champagne crabs and only 0.3 t of giant crabs were landed in 2015. Landings of giant crabs predominantly occur off the south coast, as accessed by the South Coast Crustacean Managed Fishery (SCCF). In the 2014-15 season, the SCCF landed 10.2 t of giant crabs and 2.1 t of champagne crabs. For more information on SCCF landings see South Coast Crustacean Resource Status Report.

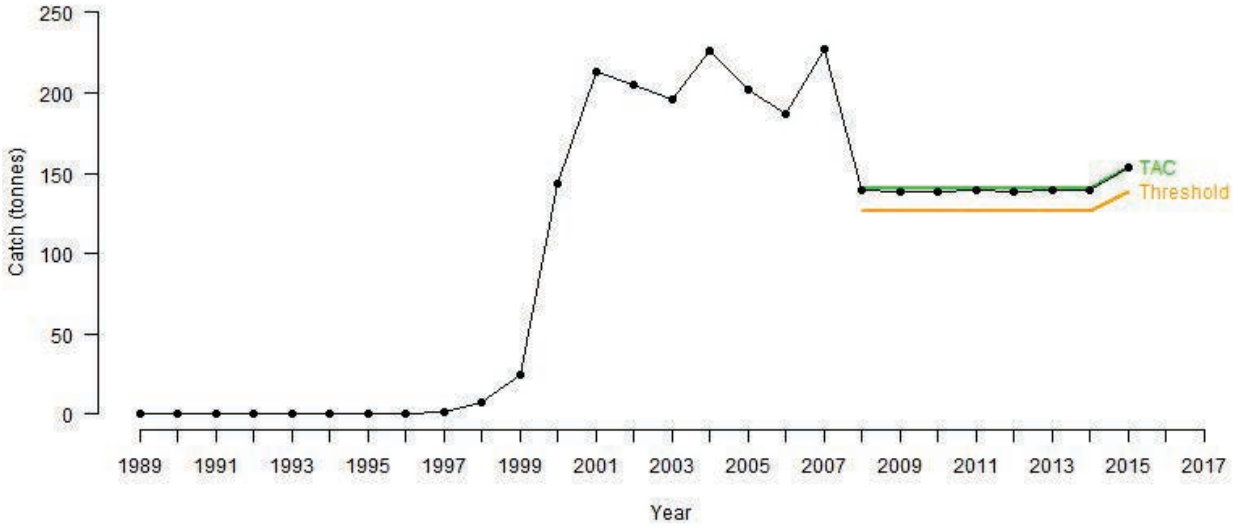
INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Crystal crab

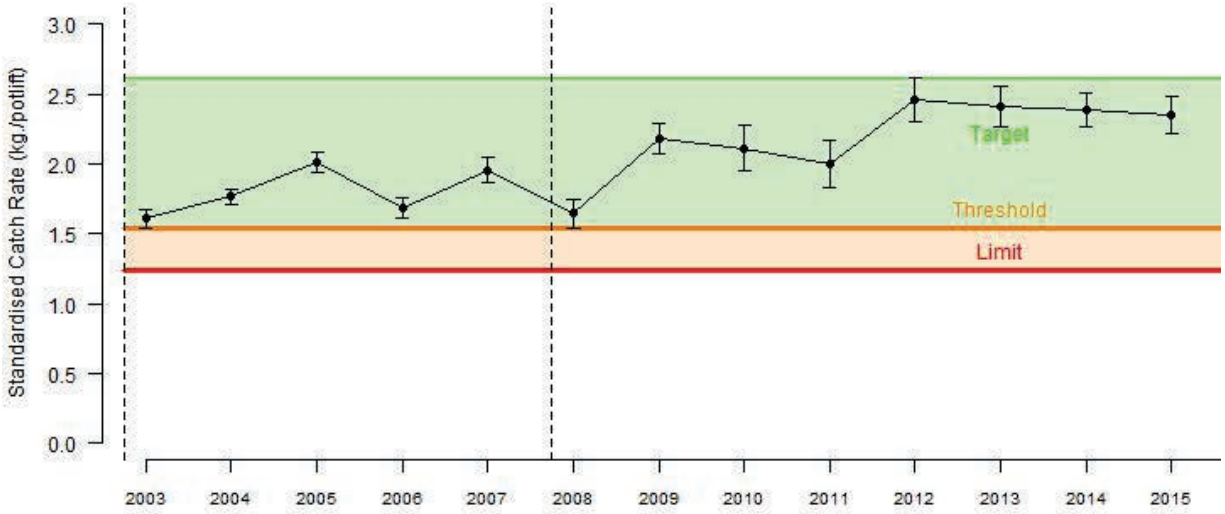
Crystal crabs are a deep-water species occurring on the continental shelf at depths of 300 – 1200 m. On the west coast of WA crystal crabs are caught primarily in depths of 500 – 800 m, although they are found over a broader range on the south coast of WA (i.e. 400 – 900 m depths; Melville-Smith *et al*. 2006). The habitat within these depth ranges are generally sand / mud or broken shell (Wadley and Evans 1991; Jones and Morgan 1994). They are considered a single management unit in the West Coast and Gascoyne Coast Bioregions. Detailed information on the biology and fishery can be found at How *et al*. (2015). Female crystal crabs mature below the

legal minimum size (Melville-Smith *et al*. 2007) and berried females are totally protected.

All lines of evidence, with the exception of spawning biomass, indicate that it is likely the stock biomass is above its threshold level and therefore **adequate**. The standardised catch rate of legal crystal crabs in 2015 was 2.35 kg/pot-lift (Deep Sea Crustacean Figure 2) which was a slight decline from 2014 (potentially due to changes in fishing personnel) but still within the upper end of the target range. Similarly, an examination of video camera comparisons of actual discards compared to those from logbooks, show an underestimate of actual discards in 2015 which may account for the apparent decline in spawning biomass.



DEEP SEA CRUSTACEAN FIGURE 1. *Annual landings of crystal crab in the West Coast Deep Sea Crustacean Fishery and its associated total allowable catch (TAC, green) and catch threshold level (orange).*



DEEP SEA CRUSTACEAN FIGURE 2. *Annual standardised catch rate (kg / pot-lift) of legal crystal crabs (± 95 CI) with their associated target (green) and threshold region (orange) and limit reference point.*

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch: 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.

Protected Species: There have been no reported interactions of WCDSC gear with protected species in 2015.

The by-catch and protected species performance measures for the fishery are that:

a) Fishing impacts are considered to generate an acceptable level of risk to all bycatch species' populations, i.e. moderate risk or lower;

b) Less than three interactions with any particular ETP species in a year; and

c) Fishing impacts are considered to generate an acceptable level of risk to all ETP species' populations, i.e. moderate risk or lower.

All of the measures were met.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat: Potting is also considered to have a low impact on the habitat over which the fishery operates.

Ecosystem: The effects of the removal of deep sea crabs has been assessed for the West Coast Deep Sea Crustacean Fishery as having negligible food chain effects by the removal of crabs. Therefore, at current catch levels, it is unlikely that removal crabs is likely to result in food chain effects.

The habitat and ecosystem 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;

b) Fishing impacts on each ecological resource / asset impacts are considered to generate an acceptable level of risk, i.e. moderate risk or lower.

c) The area fished is ≤ 113 (10' x 10') blocks; and

d) Fishing effort is ≤ 169 000 trap lifts

All of the measures were met.

SOCIAL AND ECONOMIC OUTCOMES

Social

The WCDSC is considered to have a low social amenity. This fishery is based on vessels that employ a skipper and two or three crew with no recreational fishery. The product is landed live at ports between Carnarvon and Fremantle, generating some additional economic activity and benefits. There were two vessels operating in 2015.

Economic

The beach value of the fishery was about $3.8 million in 2015 with the majority of the catch sold live to Asian markets both locally and internationally.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels (Acceptable)

For the 2015 season (1 January 2015 – 31 December 2015) the quota was 154 t. With an annual tolerance range of > 90%, based on the catch of 153t, the TAC is considered taken and therefore the annual fishing level is **acceptable**.

Harvest Strategy

The West Coast Deep Sea Crustacean Harvest Strategy 2015-2020 (see Fisheries Management Paper No. 272) has been formally adopted by industry and is the basis for the setting of the Total Allowable Catch (TAC) for the West Coast Deep Sea Crustacean Managed Fishery (the fishery). For 2015:

- The TAC was achieved
- The standardised catch rate of legal crystal crabs is within the target range
- The standardised catch rate of the secondary performance indicators; berried females were below but undersized crabs were above their respective threshold reference points which resulted in a **"Review Triggered"**. A summary of the review outcomes are presented in the stock assessment section.

Consequently, for 2016 the TAC remained at 154 tonnes for crystal crabs, and 14 tonnes for giant and champagne crabs combined.

Compliance

Compliance program is developed using a risk assessment process, and intelligence led investigations, particularly TAC verification.

Consultation

Consultation occurs between the department and the commercial sector either through Annual Management Meetings convened by WAFIC. Consultation with other interested stakeholders is conducted through specific meetings and the Department's Website.

Management Initiatives (Minor Adjustments)

Management initiatives will primarily focus addressing conditions raised as part of the MSC assessment process. These include separation of the B Class TAC into separate quotas for each of giant and champagne crabs as well as the establishment of a memorandum of understanding with the industry regarding the use of approved bait sources.

EXTERNAL DRIVERS (*Low Risk*)

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.

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GASCOYNE DEMERSAL SCALEFISH RESOURCE STATUS REPORT 2016

G. Jackson, H. Zilles and S. Turner

OVERVIEW

The Gascoyne Demersal Scalefish Resource (GDSR) includes 60+ demersal species inhabiting marine waters deeper than 20 m in the Gascoyne Coast Bioregion. Commercial vessels in the Gascoyne Demersal Scalefish Managed Fishery (GDSMF) fish with mechanised handlines and target pink snapper (*Chrysophrys auratus*) and goldband snapper (*Pristipomoides multidens*).Other demersal species caught include other tropical snappers, emperors, cods, mulloway and trevallies. A limited number of licensed charter vessels and a large number of recreational vessels fish out of Denham, Carnarvon and around the Ningaloo-Exmouth area and catch a similar range of demersal species.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2015	353 t	92-104 t*
Fishing Level	Unacceptable	Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Inshore Demersal	Sustainable - Recovering	Annual: Catch Periodic**: Spawning Biomass, Fishing Mortality, SPR
Offshore Demersal	Sustainable - Adequate	Annual: Catch

EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Negligible Risk	**Listed Species**	Negligible Risk
Habitat	Negligible Risk	**Ecosystem**	Low Risk
Social	High Amenity Moderate Risk	**Economic**	GVP Level 2 ($1-5 million) Moderate Risk
Governance	Stable	**External Drivers**	Moderate Risk

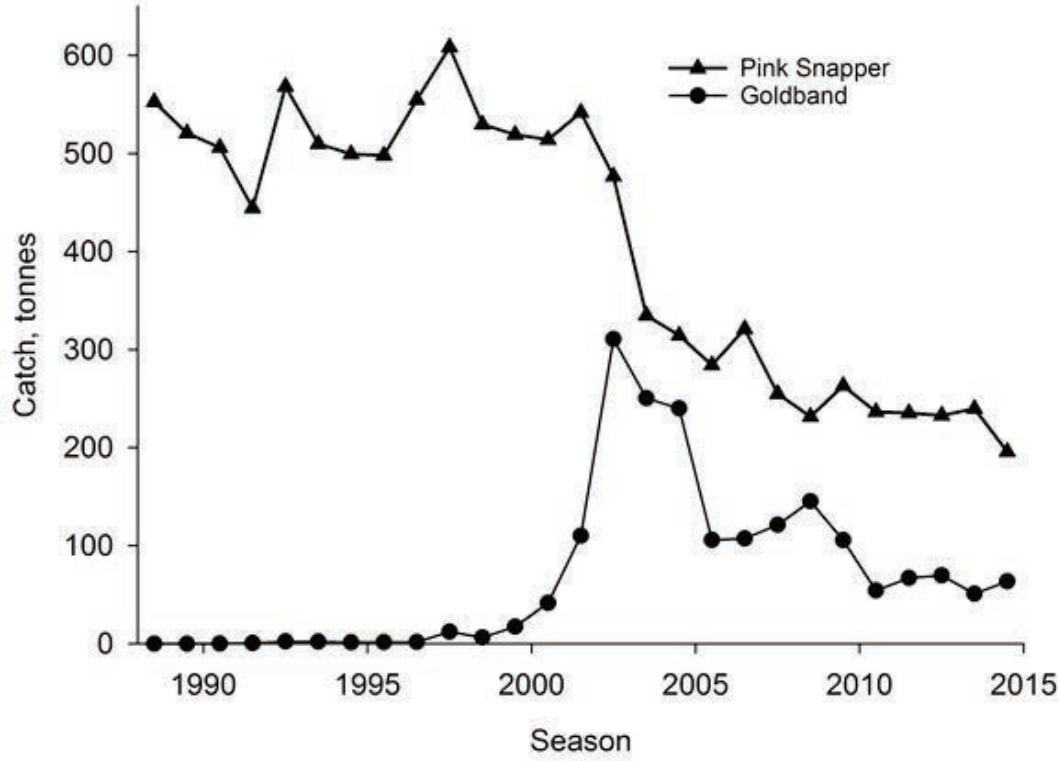
**Top 10 demersal species only from 2013/14 survey (Ryan et al. 2015); ** pink snapper stocks only.*

CATCH AND LANDINGS

In 2014/15, the total commercial catch reported by the GDSMF was 353 t, comprising 196 t pink snapper, 64 t goldband snapper and 93 t of other mixed species (Gascoyne Demersal Scalefish Table 1). In 2013/14, the boat-based recreational catch of demersal species was estimated to be 98 t (se 6.2 t) (top 10 species only) (Ryan *et al*. 2015). The charter catch of demersal species (same 10 species) reported in 2015 was 40 t.

GASCOYNE DEMERSAL SCALEFISH TABLE 1. *Total catches of scalefish taken by GDSMF in previous five years.*

Species	2010/11	2011/12	2012/13	2013/14	2014/15
Pink Snapper	228.1	235.5	232.8	240.0	195.8
Goldband Snapper	37.4	61.0	69.5	50.9	63.5
Other Jobfish	4.3	4.9	3.8	3.4	4.3
Red Emperor	9.0	13.2	8.0	10.1	10.9
Ruby Snapper	8.4	7.3	2.8	4.2	5.1
Other Snappers	1.7	1.6	1.0	1.1	1.7
Spangled Emperor	3.7	0.4	2.3	2.0	2.5
Redthroat Emperor	9.0	10.5	5.0	6.1	10.9
Other Emperors	0.5	1.1	0.2	0.3	1.3
Rankin Cod	6.2	12.2	6.2	6.9	8.0
Other Cods	6.6	11.7	8.3	11.2	11.3
Eightbar Grouper	2.0	4.0	4.3	3.5	1.9
Mulloway	4.6	3.0	4.0	8.6	9.0
Trevallies	6.1	5.6	4.6	6.8	7.9
Other Species	15.4	16.7	13.9	18.0	18.6
Total	343.0	388.7	366.7	373.1	352.7



GASCOYNE DEMERSAL SCALEFISH FIGURE 1. *Commercial catches of pink and goldband snapper taken in oceanic waters of the Gascoyne Coast Bioregion from 1988/89-2014/15.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Pink snapper Oceanic Stock (Sustainable-Recovering)

In Western Australia, pink snapper are divided into six management units, four of which are in the Gascoyne Coast Bioregion (Fowler *et al*. 2014). The Gascoyne oceanic stock is mostly fished by the GDSMF with the three separate biological stocks in inner Shark Bay predominantly fished by the recreational and charter sectors (see Inner Shark Bay Scalefish Resource Status Report).

In the Gascoyne, pink snapper live to a maximum age of approximately 30 years, mature around 3-5 years of age and, in the oceanic waters outside Shark Bay, form spawning aggregations on inshore reefs (~20-80 m depth) during May-August. Commercial fishing for pink snapper on these aggregations has a long history rising steadily from the early 1900s to an all-time peak of ~1,300 t in 1985. This triggered creation of the limited entry Shark Bay Snapper Managed Fishery (in 1987) that sustained catches at ~450-550 t through the 1980s-1990s (Marriot *et al.* 2012). The snapper component of the fishery became fully quota managed in 2001 with a Total Allowable Commercial Catch (TACC) set at 564 t.

Following the first integrated age-based assessment in 2002 which indicated this spawning stock was below the threshold (20% of unfished level) the TACC was reduced in 2003/04 from 564 t to 338 t and then again in 2006/07, to 277 t, to assist stock rebuilding.

The most recent (2016) assessment, which incorporates catch-at-age data up to 2014/15, indicated that the spawning biomass had been slowly rebuilding and was estimated to be 32-38% - i.e. above the threshold (30% unfished) but below the target (40% unfished).

Based on the weight of evidence available, especially with the recent declines in catch and catch rate, although the oceanic stock is still **recovering**, it is possible that under the current management settings, the stock may breach the threshold level during the next 5-year period.

Goldband snapper (Sustainable-Adequate)

Goldband snapper inhabit hard bottom mostly in depths of 80-150 m, live to approximately 30 years, mature around 4-5 years of age, and spawn in October-April in the Gascoyne. They are considered to be a separate stock from goldband snapper found in the Pilbara and Kimberley.

Commercial fishing for goldband snapper in the Gascoyne is relatively recent and began as the Shark Bay Snapper Managed Fishery developed into a more year-round fishery from around 2000 onwards with vessels moving offshore and outside the traditional peak pink snapper season (May-August) (Marriot *et al.* 2012). This resulted in a wider range of demersal species contributing to the overall catch with the commercial goldband snapper catch increasing rapidly over a few years to peak at ~300 t in 2002-2003 before stabilising in recent years at around 50-60 t.

Based on biological data collected during 2005-2008, the SPR was above threshold level. Based on the weight of evidence approach, the goldband snapper stock in the Gascoyne is considered to be **adequate** at the current levels of fishing.

BYCATCH

The GDSMF catch consists of a large number of demersal species of medium to high market value with very few species captured that are not retained and therefore is a **negligible risk**.

PROTECTED SPECIES INTERACTIONS

As line fishing is highly selective, direct interactions with protected species by commercial, charter and recreational fishers in the waters of the GDSMF are a **negligible risk**.

HABITAT

Line fishing for demersal scalefish by the commercial, recreational and charter sectors has virtually no direct impact on benthic habitats and represents a **negligible risk**.

ECOSYSTEM INTERACTIONS

Food chain effects due to commercial line fishing for demersal species are considered to be low because the quota system restricts overall GDSMF catches to a relatively small percentage of the total biomass available.

The juvenile components of demersal fish 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. The fishery

therefore represents a **low risk**.

SOCIAL AND ECONOMIC OUTCOMES

Social

In 2015, 17 GDSMF vessels fished during the entire season, 10 of which fished for more than 10 days during the peak (pink snapper) 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 especially during the winter months and school holidays. There was an estimated 53,832 (se 3,603) boat fishing days in Gascoyne Coast Bioregion in 2013/14 (Ryan *et al*. 2015).

The GDSR therefore provides a high social amenity with **moderate risk.**

Economic

The estimated GVP of GDSMF was in the range $1-5 million in 2015 t that represents a **moderate risk.** Product from this fishery entirely supplies domestic fish markets, mostly in Perth.

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.

GOVERNANCE SYSTEM

Allowable Catch/Catch Rate Tolerance Levels

Commercial:

Pink snapper - The pink snapper Total Allowable Commercial Catch (TACC) has been set at 277 t since 2006/07. For a range of economic and operational reasons the entire TACC cannot realistically be caught in any season. Consequently, the landed pink snapper catch has mostly been ~230-240 t since 2006/07, a range considered to be the level where the TACC has effectively been reached. The catch of 196 t landed in 2014/15 was substantially lower than the 'annual tolerance' range.

The pink snapper catch rate has fallen below the threshold level of 500kg/standard boat day and is therefore **not acceptable**. While recent discussions with fishers suggest that a number of factors contributed to this, including loss of experienced skippers to the industry, low peak season prices and an increased level of interaction with sharks (depredation) which has resulted in recent changes in fishing operations such as gear used and locations and times fished. Updated stock assessment and review of catch and catch rate will be completed by March 2017.

Goldband snapper – Within the combined TACC for other mixed demersal species (see Harvest Strategy) there is a maximum limit of 100-120 t for goldband. The catch of 64 t landed in 2014/15 was **acceptable**.

Recreational:

Catch tolerance levels for recreational and charter pink snapper catch are under development.

Harvest Strategy

The current harvesting strategy for the GDSMF is based on a *constant catch approach* (where catch is kept constant) where a stock is in recovery, and a *constant exploitation approach* (where the catch varies in proportion to variations in stock abundance) where the stock is close to the target.

In line with this harvesting approach, the GDSMF is primarily managed using output controls via an ITQ system with a separate pink snapper TACC, and a combined TACC for other demersal scalefish species (since 2015/16 season only). The fishers also have to comply with gear restrictions, spatial closures and size limits that are in place for some species.

The recreational and charter fishery in the Gascoyne Coast Bioregion is also primarily managed using output controls, including size limits for some species, and daily bag and possession limits. Recreational fishers operating from a boat are required to hold a current Recreational Fishing from Boat Licence. Charter operators are also required to hold a Fishing Tour Operators Licence.

Compliance

The GDSMF is managed through a combination of area closures, gear restrictions and the use of input controls in the form of individual transferable quota allocations. Compliance with nomination requirements and area boundaries is effectively monitored through a satellite-based Vessel Monitoring System (VMS). The Department undertakes regular compliance inspections at sea and landing ports. Catch and Disposal Records must be lodged for pink snapper and other demersal scalefish separately at the designated landing ports (Coral Bay, Carnarvon and Denham only).

Consultation

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. The harvest strategy is being developed using an independent chair and working group.

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

Management Initiatives

With the annual catch rate performance level triggered, an updated stock assessment will be undertaken. The Department is also currently undertaking a review of the management settings for pink snapper within the GDSMF. A formal harvest strategy is being developed as part of the fishery undergoing full certification for MSC and to deal with inter-sectoral issues associated with proposals by the commercial sector to potentially return to the use of traps.

EXTERNAL DRIVERS

Under the Offshore Constitutional Settlement, commercial vessels licensed by the Commonwealth may operate in state waters off the Gascoyne coast, outside the 200 m isobath, as part of the Western Deepwater Trawl Fishery (WDWTF) (Chambers and Bath 2015). There was no fishing activity reported by WDWTF vessels in these waters in 2015 (AFMA unpublished data).

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. An FRDC-funded project assessed the effects of climate change on key fisheries in Western Australia (Caputi *et al.* 2014). Pink snapper was a case study species within this project with potential impacts of climate change likely to include a southward shift in the centre of its 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. These drivers represent a **moderate risk**.

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GASCOYNE INNER SHARK BAY SCALEFISH RESOURCE STATUS REPORT 2016

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

OVERVIEW

The Inner Shark Bay Scalefish Resource (ISBSR) comprises 20-30 species taken by commercial beach seine and recreational fishing in the waters of the Eastern Gulf, Denham Sound and Freycinet Estuary in inner Shark Bay. The commercial fishery targets four species/groups: whiting (*Sillago schomburgkii* and *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 hook and line to catch pink snapper (*Chrysophrys auratus*, three separate stocks), grass emperor (*Lethrinus laticaudis*), western butterfish (*Pentapodus vitta*), whiting (*Sillago spp.*), school mackerel (*Scomberomorus queenslandicus*), tailor, blackspot tuskfish (*Choerodon schoenleinii*) and goldspotted rockcod (*Epinephelus coioides*). A limited number of licensed charter vessels operate out of Denham and Monkey Mia.

SUMMARY FEATURES 2016

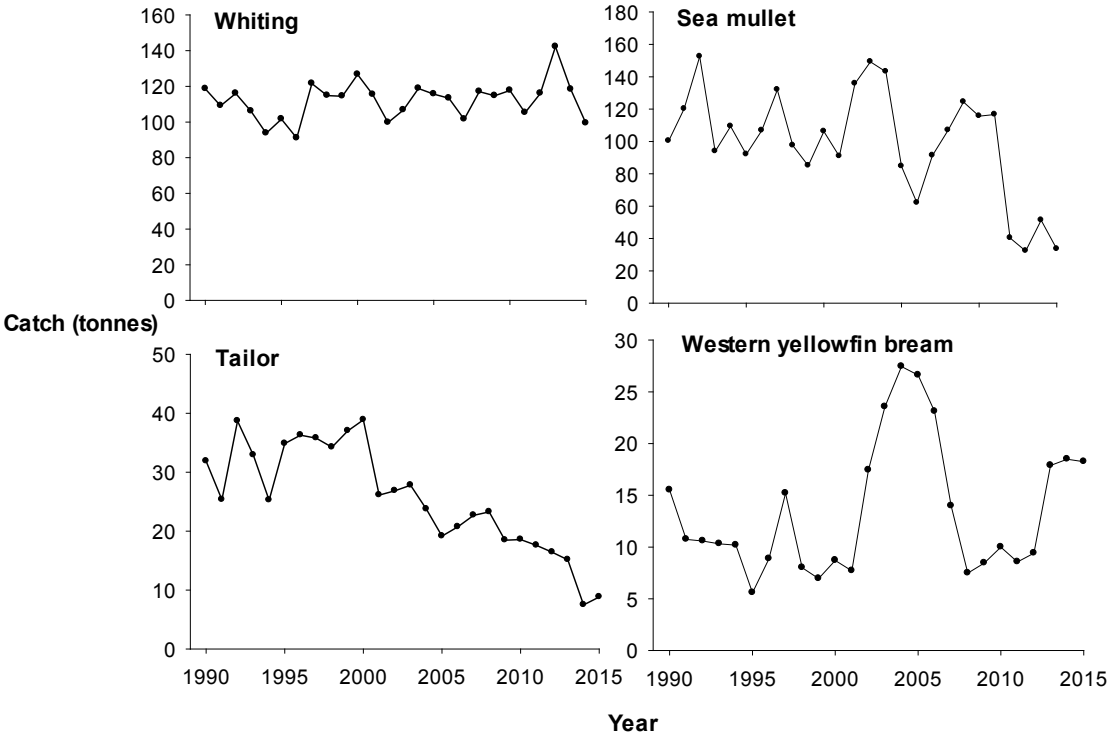
Fishery Performance	Commercial	Recreational
Total Catch 2015	164 t	~15-20 t (pink snapper only)*
Fishing Level	Acceptable	Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Demersal	Sustainable – Adequate	Annual: Catch, Catch rate; Periodic: Spawning biomass, Fishing mortality, SPR
Nearshore	Sustainable - Adequate	

EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low risk	**Listed Species**	Negligible Risk
Habitat	Negligible Risk	**Ecosystem**	Low Risk
Social	High Amenity Moderate Risk	**Economic**	GVP Level 2 ($1-5 million) Moderate Risk
Governance	Stable	**External Drivers**	Moderate Risk

** Based on estimates from on-site boat ramp surveys conducted in 2010, includes reported charter catches in 2015*

CATCH AND LANDINGS

In 2015, the total catch reported by the commercial fishery (Shark Bay Beach Seine and Mesh Net Managed Fishery [SBBSMNF]) was 164 t, comprising 99 t of whiting, 33 t of mullet, 18 t of western yellowfin bream, 9 t of tailor and 4 t of other mixed species including 1 t of pink snapper (Inner Shark Bay Figure 1). The charter catch of pink snapper reported in 2015 was 2.5 t (Eastern Gulf, Denham Sound and Freycinet Estuary combined). The estimated recreational catch of pink snapper for the three inner gulf areas in 2010 was ~15-20 t (all three areas combined) (Wise *et al*. 2012). More recent estimates from a boat ramp survey for the period March 2016-February 2017 will be available in mid-2017.



INNER SHARK BAY FIGURE 1. *Commercial catches of whiting, tailor, sea mullet and western yellowfin bream taken by SBBSMNF 1990-2015.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS (*Sustainable-Adequate*)

Pink snapper Inner Gulf Stocks

In Western Australia, pink snapper are divided into six management units, four of which are in the Gascoyne Coast Bioregion (Fowler *et al*. 2014). The three separate biological stocks found in inner Shark Bay (i.e. Eastern Gulf, Denham Sound, Freycinet Estuary) are nowadays predominantly fished by the recreational and charter sectors while the Gascoyne oceanic stock is mostly fished by the Gascoyne Demersal Scalefish Managed Fishery (see Gascoyne Demersal Scalefish Resource Status Report).

In the Gascoyne, pink snapper live to a maximum age of approximately 30 years, mature around 3-5 years of age and, in inner Shark Bay, form spawning aggregations between May-September (Jackson *et al*. 2010).

Commercial catches of pink snapper in the inner gulfs are relatively small (~1-2 t) and limited to bycatch taken by the SBBSMNF. Recreational fishing in inner Shark Bay steadily increased from the 1960s through to the 1990s with all three snapper stocks becoming over-exploited. Reductions in catch levels were generated by the additional management progressively introduced from 1998 onwards, this included notional Total Allowable Recreational Catches (TARCs) implemented in each area in 2003.

The most recent stock assessments that incorporated catch-at-age data up to 2013 indicated that the spawning biomass of all three stocks was estimated to be above the target (40% of the unfished level) in 2015. On the basis of the evidence available, these pink snapper stocks are **adequate.**

Yellowfin whiting

Yellowfin whiting in WA are found in nearshore and estuarine waters from Exmouth to Albany (Brown *et al*. 2013). Although stock structure has not been investigated, connectivity between yellowfin whiting in the 'northern' (Gascoyne Coast) and 'southern' (West and South Coast) regions is likely limited, and so are treated as separate stocks for assessment and management purposes. The northern stock is mainly fished in inner Shark Bay while the southern stock is fished along the lower west coast (see West Coast Nearshore and Estuarine Finfish Resource Status Report).

In 2015, the commercial catch of yellowfin whiting taken by the SBBSMNF was 99 t, which is within the target catch range (93-127 t), and the Catch Per Unit Effort (CPUE) at 166 kg/boat day was well above the threshold catch rate (75 kg/boat day). The commercial catch of yellowfin whiting in inner Shark Bay has been relatively stable at ~90-120 t since 1990. Whiting species (mostly yellowfin) are the third most retained species group taken by boat based recreational fishers in inner Shark Bay.

A stock assessment based on biological data collected in 2014 indicated that fishing mortality was above threshold level. Based on the evidence available, the yellowfin whiting stock in inner Shark Bay is classified as **adequate**.

Sea mullet

Sea mullet occurs throughout WA. Stock structure has not been investigated however it is possible that multiple cryptic species of sea mullet exist on the west coast as has been found on the east coast of Australia (Durand *et al.* 2012, Krück *et al.* 2013). Sea mullet within each WA bioregion are currently regarded as discrete breeding stocks.

In 2015, the commercial catch of sea mullet taken by the SBBSMNF was 34 t, which is ~50 t below the long-term average, and continues the declining trend with four consecutive years of sea mullet catch below the target catch range (77-144 t). The CPUE at 56 kg/boat day in 2015 is also just below the threshold catch rate (62 kg/boat day). These declines are partly explained by lower market demand with the SBBSMNF targeting the higher-value whiting species, but may also be attributable to a change in the distribution of sea mullet due to ocean warming (see West Coast Nearshore and Estuarine Finfish Resource Status Report).

Based on the evidence available, the sea mullet stock in inner Shark Bay is classified as **adequate**.

Tailor

Tailor in WA occurs from Onslow to Esperance and is believed to constitute a single stock over this range (Smith *et al.* 2013).

In 2015, the commercial catch of tailor taken by the SBBSMNF was 9 t, the second lowest catch on record after 2014 and continues the declining trend with catches since 2004 below the target catch range (25-40 t). The CPUE (15 kg/boat day) was below the threshold level (21 kg/boat day). The low landings of tailor that have become a feature of the fishery in recent years are mostly attributed to local processing restrictions.

The tailor catch in inner Shark Bay represents approximately half of the total commercial catch taken in WA with the remainder taken in the West Coast Bioregion (West Coast Nearshore and Estuary Scalefish Status Report).

Based on the evidence available, the tailor stock is classified as **adequate.**

Western yellowfin bream

Western yellowfin bream (*Acanthopagrus morrisoni*) are endemic to north-west WA from the Dampier Peninsula to south of Shark Bay (Iwatsuki 2013). Western yellowfin bream in inner Shark Bay are assessed and managed as a separate stock.

In 2015, the commercial catch of western yellowfin bream taken by the SBBSMNF (18 tonnes) and CPUE (30 kg/boat day) were above the target catch range (7-15 t) and the threshold catch rate (5 kg/boat day), as was the case in 2013 and 2014. These increases are likely attributable to another strong year class entering the fishery, as was previously observed in 2002-2007.

Based on the evidence available, the western yellowfin bream stock in inner Shark Bay is classified as **adequate.**

BYCATCH

Bycatch is minimal in the SBBSMNF because netting operations selectively target specific schools of fish and is therefore **low risk**.

PROTECTED SPECIES INTERACTIONS

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 and therefore such interactions are a **negligible risk**.

HABITAT

Seine netting over shallow sand banks and other naturally dynamic nearshore environments combined with the low frequency of fishing in any one location represents a **negligible risk.**

ECOSYSTEM INTERACTIONS

Catch levels in the fishery have been relatively stable over many decades, despite a long-term reduction in effort, suggesting that recruitment of the main

target species has not been significantly affected by fishing mortality and that interactions are **low risk**.

SOCIAL AND ECONOMIC OUTCOMES

Social

In 2015, 6 vessels operated in the SBBSMNF, employing around 16 fishers. Commercial fishing and associated fish processing are important sources of employment and income in Denham.

Shark Bay is a popular recreational fishing destination especially during the winter months and school holidays. There was an estimated 53,832 (se 3,603) boat fishing days in the Gascoyne Coast Bioregion in 2013/14 (Ryan *et al.* 2015).

The Inner Shark Bay Scalefish Resource therefore provides a high social amenity with **moderate risk.**

Economic

The estimated GVP of the SBBSMNF in 2015 was in the range $1-5 million that represents a **moderate risk**. Product from this fishery entirely supplies domestic fish markets (Perth and Sydney). While a dollar value is difficult to assign to recreational and charter catches, the availability of quality fish underpins the local recreational fishing-based tourism industry and generates significant income for the regional economy.

GOVERNANCE SYSTEM

Annual Catch/Catch Rate Tolerance Levels

Commercial:

Total fishing effort in the SBBSMNF was 599 boat days in 2015 which was the lowest level on record. While the total commercial catch in 2015 at 164 t was below the lower limit of the target catch range (235–335 tonnes), viewed against the historically low levels of current effort, the commercial catch level is considered **acceptable**.

Recreational:

Recreational (includes charter) catch tolerance levels are only currently in place for pink snapper. Recreational catches of pink snapper in 2015 are assumed to be similar to those estimated in 2010 (more recent data will be available in 2017) and therefore within the respective notional TARCs in each area, are therefore **acceptable**.

Harvest Strategy

Although a formal harvest strategy has not been developed for the Inner Shark Bay Scalefish Resource, the current harvesting strategy for the SBBSMNF is based on a *constant exploitation approach* (where the catch varies in proportion to variations in stock abundance).

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.

The recreational and charter fishery in Shark Bay is managed using a combination of output controls including daily bag, possession, size and gear limits. Recreational fishers operating from a boat are required to hold a current Recreational Fishing from Boat Licence (RFBL) while net fishers require a Recreational Net Fishing Licence. Pink snapper stocks are tightly managed to notional TACs in the Eastern Gulf (11.25 t recreational; 3.75 t commercial), Denham Sound (11.25 t recreational; 3.75 t commercial) and Freycinet Estuary (3.75 t recreational; 1.25 t commercial).

Enforcement

The Department undertakes regular compliance at-sea and on-land inspections.

Consultation

The Department undertakes consultation directly with licensees on operational issues. Industry 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.

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

Management Initiatives

A number of new management initiatives were introduced in 2016 following the latest stock assessment (2015) that indicated the spawning biomass of all three inner gulf pink snapper stocks was above the target (40% of the unfished level). These initiatives were designed to increase the amenity of the recreational fishing and included the removal of the 70 cm maximum size limit of inner gulf pink snapper. The Freycinet Estuary tag lottery system, which was introduced in 2003 as a key component of the recovery strategy, was also removed and replaced by an individual possession limit of 1 day's bag limit of whole fish or 5kg of fillets

within the Freycinet Estuary management area.

EXTERNAL DRIVERS

The Inner Shark Bay system has been considered relatively stable as a result of its typically low-rainfall and arid environment. However, recent extreme but occasional events including cyclone-related riverine floods (occurred in the Gascoyne and Wooramel Rivers in 2010-2011) and a marine heatwave (summer of 2010/11) had significant impacts on some marine habitats (e.g. temperate seagrasses) and important invertebrate species (e.g. blue crabs and scallops) (Pearce *et al*. 2011, Caputi *et al*. 2014). The impact of these events on key scalefish species in inner Shark Bay is unknown.

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. An FRDC-funded project assessed the effects of climate change on key fisheries in Western Australia (Caputi *et al.* 2015). Pink snapper was 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.

These drivers represent a **moderate risk**.

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NORTH COAST BIOREGION

ABOUT THE BIOREGION

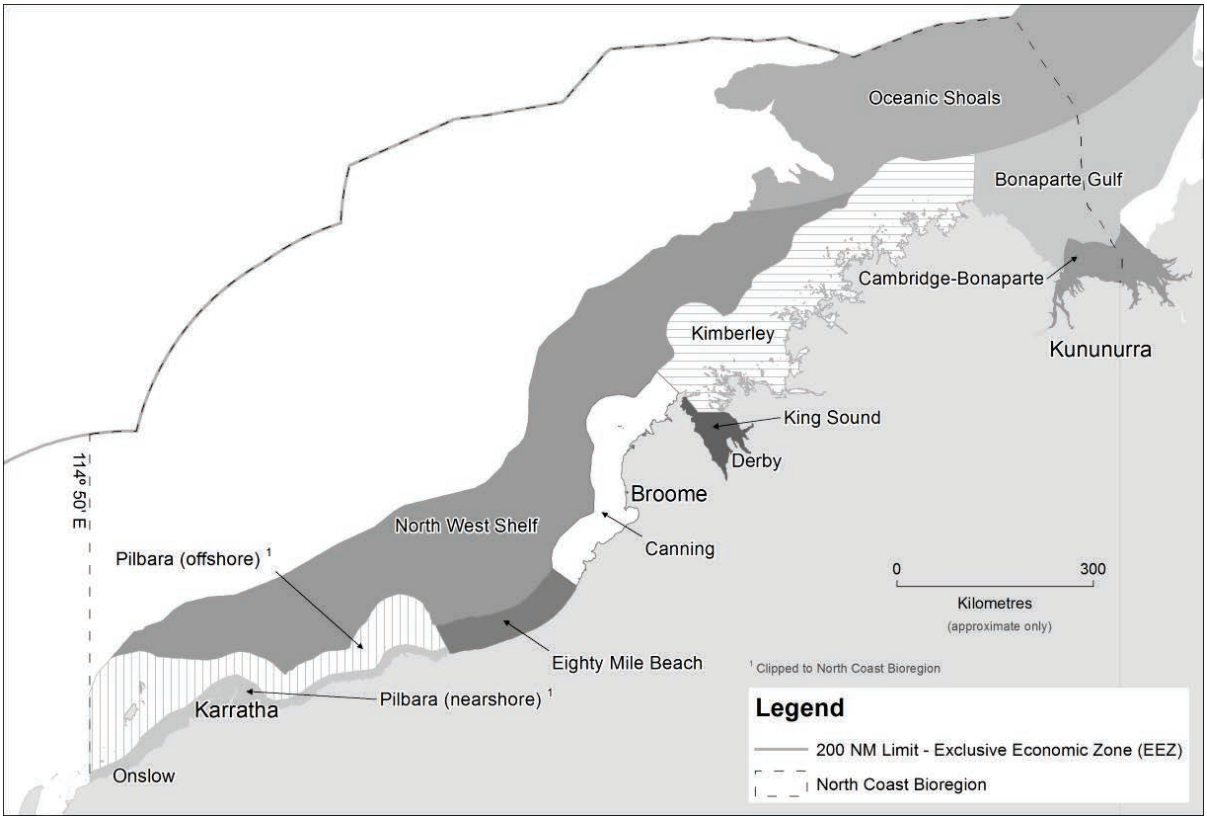
The oceanography of the North Coast Bioregion (North Coast Overview Figure 1) includes waters of Pacific origin that enter through the Indonesian archipelago bringing warm, low salinity waters polewards via the Indonesian Throughflow and Holloway Currents which flow seasonally and interact with Indian 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.



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.

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.

The ecosystem boundaries as defined by IMCRA (V 4.0) in the bioregion are depicted in Figure 1. The potential threats and risks to these ecosystems are often similar. For simplicity risk ratings were allocated by grouping the ecosystems into two broad groups, estuarine or marine. However, if a particular ecosystem is unique and/or is exposed to different or significant threats, risk was allocated to these ecosystems separately.

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 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 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.

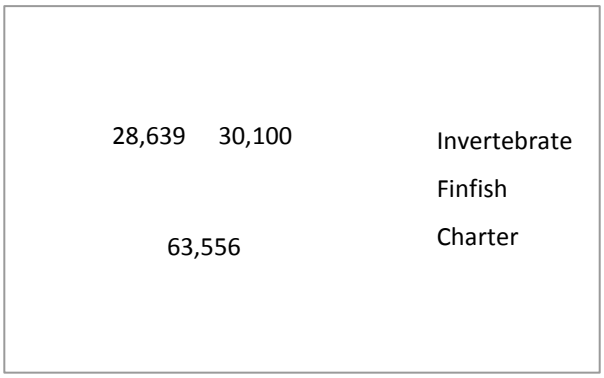
A traditional artisanal fishery also exists in an area around Roti Island, known as the MOU box. The MOU Box is an area within the Australian EEZ over which there is a bilateral agreement between Australia and Indonesia. The MOU allows Indonesian fishers to fish using traditional methods within Australian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

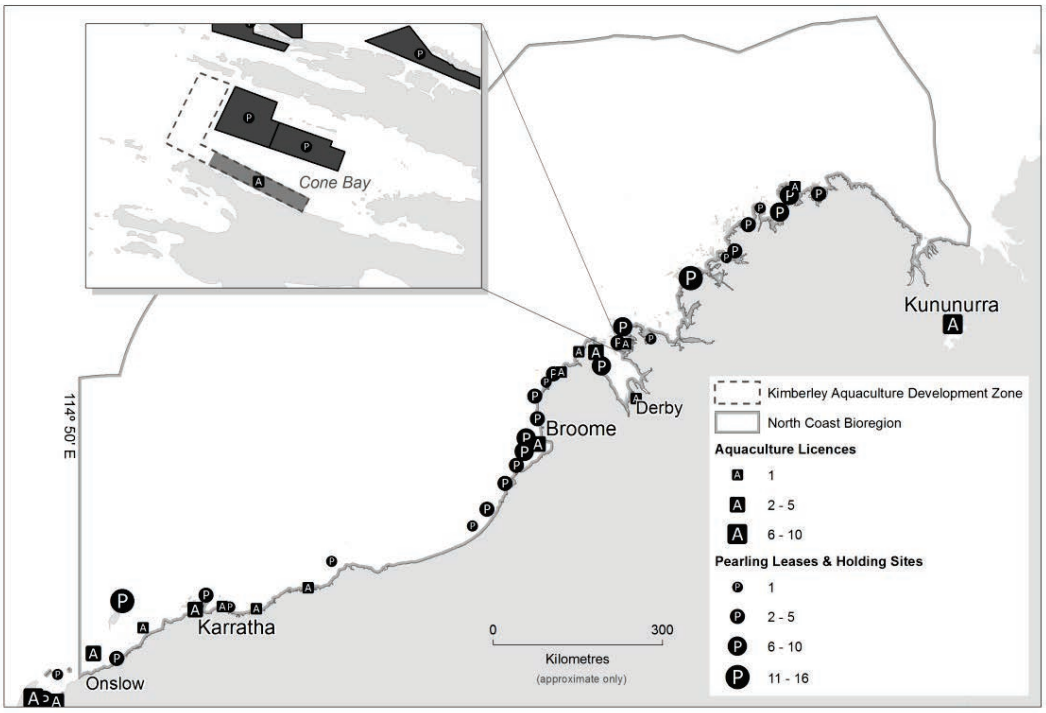


NORTH COAST OVERVIEW FIGURE 3

The North Coast Bioregion finfish and invertebrate catch numbers as assessed in the integrated survey of boat-based recreational fishing in WA 2013/14, and the charter boat catch numbers for the same 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.



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.

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 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 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.

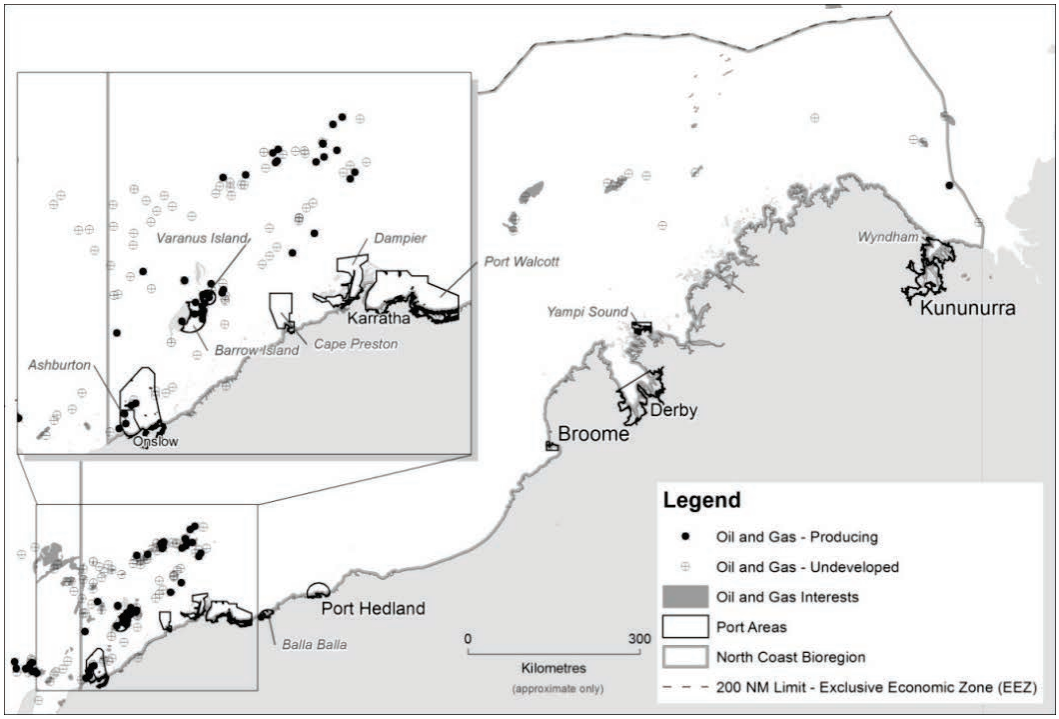
A company developing a project culturing marine microalgae for the production of bio-fuels, omega-3 lipid and protein biomass previously established a demonstration facility near Karratha. The company is currently assessing alternative sites for the project.

An indigenous project at One Arm Point operates a marine hatchery that focuses on a variety of ornamental and edible marine species.

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 Wyndam. Activities include charter fishing, diving, snorkeling, whale, turtle and dolphin watching, and sightseeing cruises.

Sites of greatest interest 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.



NORTH COAST OVERVIEW FIGURE 5

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

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.

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.

BIOREGIONAL SPECIFIC ECOSYSTEM MANAGEMENT

Within each Bioregion there are a range of management measures that have been implemented to manage the potential impact of activities (See the Ecosystem Management Section for an overview). Management measures specific to the North Coast Bioregion 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. 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.

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 2012*[1]; North Coast Ecosystem Management Table 1).

In addition to these habitat related marine protected area closures, the Bioregion has a number of other marine protected areas 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 was under review by the current Government.

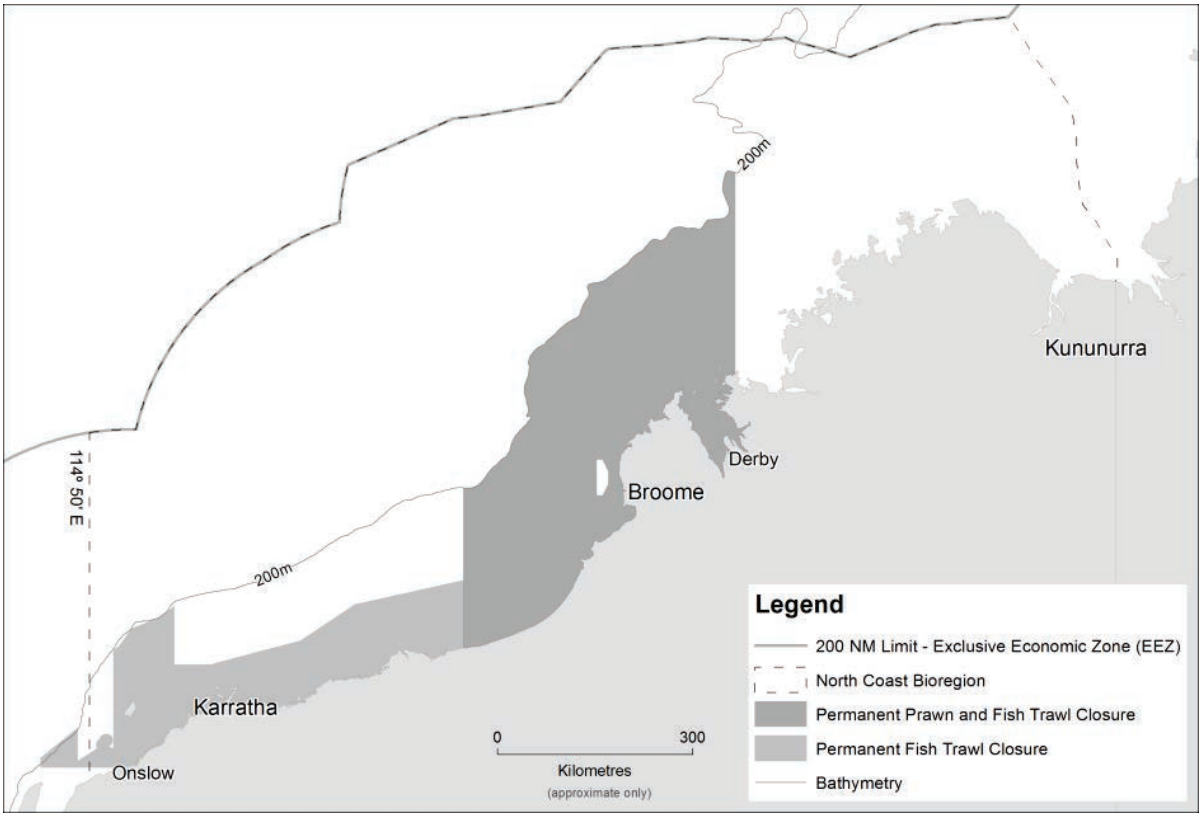
1 Dudley N. (editor) 2008. Guidelines for applying protected area management categories. *IUCN*. Gland, Switzerland.

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

NORTH COAST ECOSYSTEM MANAGEMENT TABLE 1

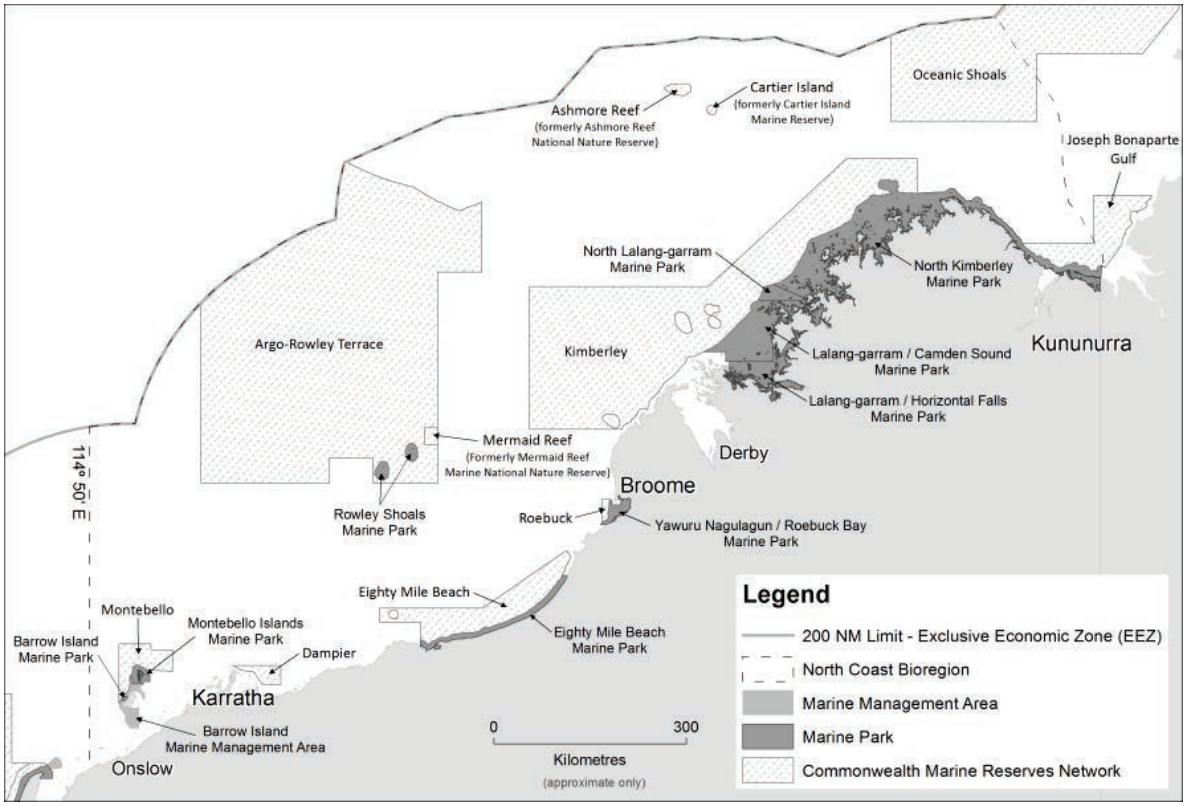
The areas and proportions of the North Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which are consistent with the IUCN criteria for classification as marine protected areas. This table does not yet include the closures that may be implemented by the Commonwealth as part of their marine planning zones.

IUCN category or equivalent	State Waters only (65,400 km^2)				All Waters (837,500 km^2 (including State waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km^2	%	km^2	%	km^2	%	km^2	%
I	0	0	0	0	0	0	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



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.

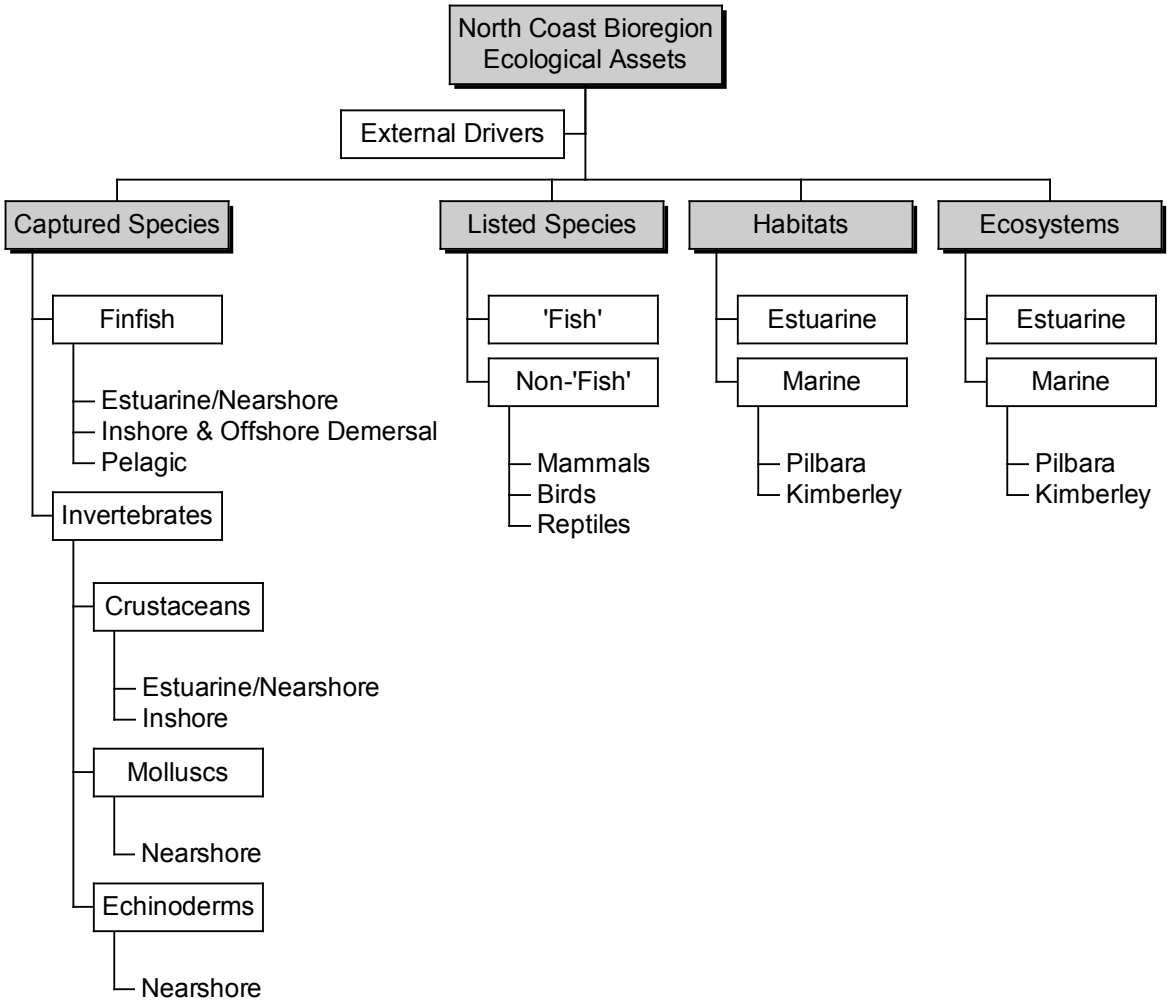


NORTH COAST OVERVIEW FIGURE 7

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

ECOSYSTEM MONITORING AND STATUS

In order to assess the adequacy of management arrangements aimed at ensuring sustainability of the ecological assets within the North Coast Bioregion, the Department must identify and monitor trends in the condition of these resources. This is achieved through application of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher, *et al*., 2010) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment. (See How to Use section for more details). These key ecological assets identified for the North Coast Bioregion are identified in North Coast Overview Figure 8 and their current risk status reported on in the following sections.



NORTH COAST OVERVIEW FIGURE 8

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

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 Drivers	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)[29] 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

29 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.

'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 Drivers	Current Risk Status
Introduced Pests	LOW
Introduced Diseases	LOW

The increase in international shipping movement and dredging activity associated with resource development in the North Coast Bioregion is considered to present a 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 see Appendix section entitled "Activities of the Marine Biosecurity Research Group during 2015/16".

Oil and Gas Development Activity

External Drivers	Current Risk Status
Oil and Gas Development	LOW

While there are a number of specific oil and gas related offshore developments that are proposed in this region, at the overall ecosystem level there is only a low risk that the ecosystem will be altered measurably. Some of the risks identified (e.g. increased turbidity) are being examined under WAMSI 2 projects. In addition, State and Commonwealth marine parks, including totally protected zones, are currently planned or in place.

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).

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	Estuarine/Nearshore	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. The primary target species are barramundi and threadfin salmon. 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. 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. 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. 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.

Crustaceans

Captured Species	Aquatic zone	Ecological Risk
Crustaceans (Crabs)	Estuarine/ Nearshore	LOW
Crustaceans (Prawns)	Inshore	MODERATE

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.

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.

Molluscs

Captured Species	Aquatic zone	Ecological Risk
Molluscs (Pearls)	Nearshore	MODERATE
Molluscs (Trochus)	Nearshore	MODERATE

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.

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.

Echinoderms

Captured Species	Aquatic zone	Ecological Risk
Bêche-de Mer	Nearshore	MODERATE

The majority of the effort for bêche-de-mer has been expended in the Kimberley region, although there have been several years with substantial effort directed into the Pilbara region.

Listed Species

A number of endangered, threatened and protected[30] (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);

30 Note that being on a listed species list does not automatically indicate that a species is either threatened or endangered.

- 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)[31];
- 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 Nickol 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
Fish	MODERATE

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	Risk
Mammals	LOW
Reptiles and Birds	MODERATE

Dolphins are captured by the Pilbara trawl fishery, but dolphin excluder devices have reduced this incidence to acceptable levels, with further refinements in net design currently being trialled. The Pilbara fish trawl fishery recently secured a three year WTO with further conditions around dolphin and sawfish interactions and monitoring.

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.

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.

31 Further information on the CMS, JAMBA, CAMBA and ROKAMBA is provided at www.environment.gov.au/biodiversity/migratory/index.html

Habitats and Ecosystems

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). If the areas that are not trawled is taken into account, 89 % of statewide benthic habitats out to the 200 m isobath are, in practical terms, fully protected and may never have been trawled (North Coast Ecosystem Management Table 1). In addition to fisheries-related closures, the North Coast Bioregion has a number of marine protected areas described under the preceeding “spatial closures” section.

The Department identifies and monitors trends in the condition of ecosystems and their associated habitats to ensure the long term sustainability of both these key ecological assets and the fisheries that depend on them.

Habitats

Habitats	Aquatic zone	Current Risk Status
North Coast	Estuarine	LOW
Kimberley	Marine	LOW
Pilbara	Marine	MODERATE

The majority of these fishing activities occur in mud/sand habitats in estuaries, tidal creeks and

embayments . Trawl activities are considered to have the highest relative impact of the methods used within the bioregion which also includes low impact activities of trap, gillnets and hand collection based fisheries. However, the spatial extent of trawling activities is small, and there are a variety of measures in place to manage any impacts. The spatial distribution of all fishing activities are also managed through the use of seasonal and area closures to protect sensitive habitats.

Ecosystems

Ecosystems	Aquatic zone	Current Risk Status
North Coast	Estuarine	NEGLIGIBLE
Kimberley	Marine	LOW
Pilbara	Marine	MODERATE

There are a number of oil and gas related offshore and onshore developments exist or are proposed in this bioregion. While some specific areas may be locally impacted, these still only pose a low risk to the overall ecosystem of this Bioregion.

Given the large areas closed to both trawling and to all commercial fishing, there is only a low risk that the level of fishing in this region is changing the regional-level community structure to an unacceptable level. Assessments of the community structure and trophic level of all commercially caught fish species in the region over the past 30 years found no evidence that there have been any systematic changes. (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.

NORTH COAST PRAWN RESOURCE STATUS REPORT 2016

E. Sporer, M. Kangas, S. Wilkin, I. Koefoed, P. Cavalli and L. Pickles

OVERVIEW

The four northern prawn managed fisheries all use low opening, otter prawn trawl systems to target western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), and endeavour prawns (*Metapenaeus endeavouri*). High opening, otter trawl systems are also used when targeting banana prawns (*Penaeus merguiensis*) which is the target species for two of these fisheries. Management of these fisheries is based on input controls, including limited entry, gear controls (maximum headrope units) seasonal and area openings and closures.

The fisheries have Commonwealth export approval for the next ten years.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2015	273 t	Not applicable
Fishing Level	Acceptable	

Stock/Resource Performance	Stock Status	Assessment Indicators
Nickol Bay	Adequate	Catch, Effort, Rainfall-Catch Relationships
Kimberley	Adequate	Catch, Effort, Biomass, Rainfall-Catch Relationships
Broome	Adequate	Catch, Effort
Onslow	Adequate	Catch, Effort

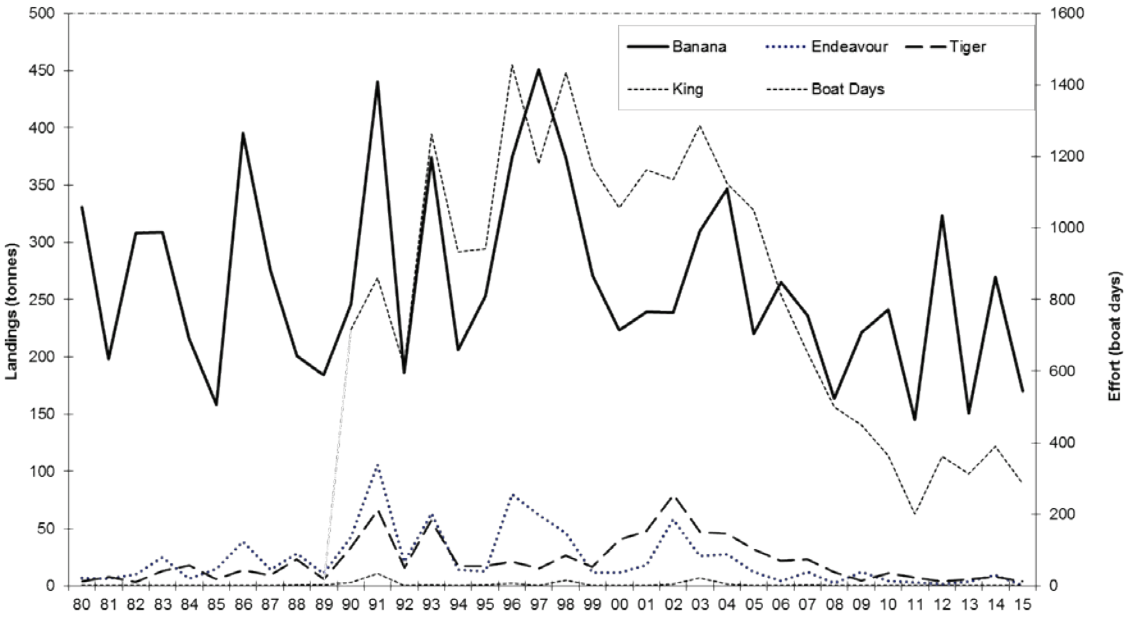
EBFM Performance Asset	Level	Asset	Level
Bycatch	Low Risk	**Listed Species**	Low Risk
Habitat	Low Risk	**Ecosystem**	Low Risk
Social	Amenity Score 1 Risk Level 1	**Economic**	KPMF: Level 2 ($1 – 5 million) BPMF: Level 1 ($<1 million) NBPMF: Level 2 ($1 – 5 million) OPMF: Level 1 ($<1 million) Risk Level 4
Governance	Kimberley - Plan review	**External Drivers**	Risk Level 4 (climate)

CATCH AND LANDINGS

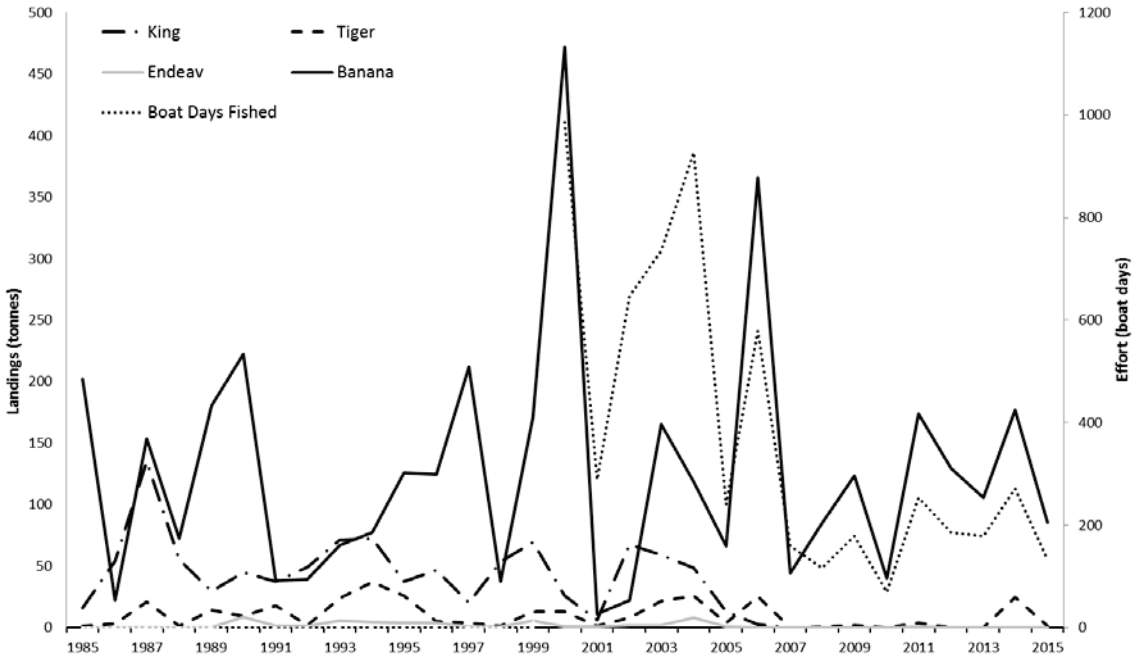
Kimberley Prawn Managed Fishery

The total landings in 2015 for the KPMF were 175 t, similar to the levels caught during the past 8 years. This catch comprised 170 t of banana prawns, 4 t of brown tiger prawns and 1 t of endeavour prawns (North Coast Prawn Figure 1).

Fishing occurred in both fishing periods however the second part of the season had much reduced fishing effort compared to previous years. Negligible quantities of byproduct were reported.



NORTH COAST PRAWN FIGURE 1. *Annual prawn landings (t) and fishing effort (total adjusted hours) for the Kimberley Prawn Managed Fishery 1980-2015.*



NORTH COAST PRAWN FIGURE 2. *Annual prawn landings (t) and fishing effort (total adjusted hours) for the Nickol Bay Prawn Managed Fishery 1985-2015.*

Broome Prawn Managed Fishery

Minimal effort and landings were recorded in 2015. This included 0.3 t of western king and 0.8 t of coral prawns. The byproduct caught was <0.1 t of cuttlefish.

Nickol Bay Prawn Managed Fishery

The total landings of major penaeids for the 2015 (North Coast Prawn Figure 2) season was 87 t, which was similar to levels caught over the past 7 years. The 85.2 t banana prawns landed was slightly above the predicted range (49 – 73 t) plus there was 1.6 t of brown tiger prawns, and negligible amounts of western king and endeavour prawns.

Onslow Prawn Managed Fishery

The total landings of major penaeids for the 2015 season were 10.1 t, comprising <0.1 t of western king prawns, 5.6 t of brown tiger prawns, 0.5 t of endeavour prawns and 4.0 t of banana prawns.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Kimberley Prawn Managed Fishery – Banana prawns (Adequate)

Banana prawns are distributed from Exmouth Gulf across to northern New South Wales. They live between one and two years and prefer shallow estuarine and intertidal areas and with limited burrowing capacity they are generally restricted to turbid waters to avoid predation (Penn 1984). Which in the Kimberley, turbid habitats can occur a significant distance from the coast.

Since the change in the economics of fishing in about 2005, there was a marked reduction in the number of fishers with fishing effort (vessel-days) now well below historical levels. Catch levels have been maintained with an increase in catch rates and estimated levels of fishing mortality from a preliminary biomass dynamic model which all indicate the breeding stock is **adequate**.

Broome Prawn Managed Fishery – Western king prawns (Adequate)

The western king prawn is widely distributed throughout the Indo-West Pacific region. They are nocturnal so their catchability is influenced by lunar cycles and temperature.

No fishing takes place during the breeding season and there is minimal overlap of fishing on the breeding stock due to the widespread nature of this species and the current low level of fishing effort. The breeding stock is therefore considered **adequate**.

Nickol Bay Prawn Managed Fishery – Banana prawns (Adequate)

On the basis of annual trends in catch and effort, and more recently with annual catch rates and the outputs of preliminary stock production models and a biomass dynamics model the stock is being fished at a sustainable level with the breeding stock considered **adequate**.

Onslow Prawn Managed Fishery – Brown Tiger and Western King Prawns (Adequate)

The breeding stock of brown tiger prawns is protected with low landings and low effort primarily due to marginal profit opportunities.

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Low Risk*)

Bycatch levels for all these fisheries are relatively low by tropical trawl fisheries standards, with few species of significance to other fishing sectors being taken. In addition to grids, secondary bycatch reduction devices (square mesh panels) were implemented in all nets in 2005. All boats also use hoppers (in-water catch sorting systems), which adds another level of improvement for bycatch survival and product quality.

While protected species including dugongs, turtles and sea snakes occur in the general area, only sea snakes and occasionally turtles are encountered in the trawl catches. Both species are typically returned to the sea alive. Grids have largely eliminated turtle and other large animal captures.

Protected species interactions recorded in the daily logbooks for each fishery in 2015 are;
Kimberley: One turtle was reported as being caught and returned alive, one dead sawfish was recorded; 28 sea snakes were recorded as being caught with 26 returned to the sea alive.

Broome: The fishery operates in relatively deep water, combined with the short season, restricted trawl area and very low effort results in minimal interaction, and no interactions were reported.

Nickol Bay: Two turtles were reported caught which were all returned alive, whilst seven sea snakes were released alive and six were returned

dead. Four sawfish were reported with two released alive and the other two dead. There were no reported interactions with protected species in the **Onslow** fishery.

HABITAT AND ECOSYSTEM INTERACTIONS (*Low Risk*)

Owing to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little physical impact. Overall, the nature of these fishery and controls on effort indicate that its environmental effect is likely to be low. The area fished in the four northern prawn fisheries where fishing was undertaken ranged from 1.4% in the Kimberley fishery to <1% in the Broome fishery, within the boundaries of these fisheries. The fisheries are generally restricted to clean sand to mud substrates where trawling activity has minimal long term physical impacts.

Although the prawn species are managed at 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.

SOCIAL AND ECONOMIC OUTCOMES

Social

The estimated employment in the fisheries for the year 2015 was 40 to 50 including skippers and other crew for all north coast fisheries combined.

Economic

Ex-vessel (beach) prices for prawns vary, depending on the type and quality of product and the market forces operating at any one time. The total estimated value of the fisheries includes byproduct; KPMF - $2.1 M, BPMF - negligible, NPMF - $1.0 M and OPMF - $0.1 M.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

KPMF: banana prawns, 200 - 450 t: (**Acceptable**) Banana prawn landings were below the target range as well as the predicted range due to low fishing effort.

BPMF: western king prawns, 35 -170 t: (**Acceptable**) Minimal fishing occurred in 2015.

NPMF: banana prawns, 40 - 220 t: (**Acceptable**) The brown tiger prawn catch was just below the target range (2 - 40 t) and the western king prawn landings were extremely low and below the target range for this species.Total landings were just below the allowable range, but landings of banana prawns, were within their normal catch range and slightly above their predicted catch range.

OPMF: brown tiger prawns, 10 - 120 t and western king prawns, 10-55 t: (**Acceptable**) Effort and catch were minimal in 2015.

Harvest Strategy

Management arrangements for all four fisheries are designed to keep fishing effort at levels that will maintain a sufficient spawning biomass of prawns (particularly brown tiger prawns). For the KPMF an upper limit effort cap of 1500 vessel days is set. Bycatch reduction devices (BRDs) and a secondary fish escape devices (FED) are mandatory under the EPBC Act.

Compliance

It is a requirement that all vessels in these fisheries are fitted with an Automatic Location Communicator (ALC). The implementation of an ALC enables the Department of Fisheries (Department) to monitor the fleet using a Vessel Monitoring System (VMS) and manage compliance with temporal and spatial closures. The Department also undertakes regular vessel inspections to ensure fishing is being undertaken in accordance with the governing legislation (e.g. gear requirements, catch reporting).

Consultation

Meetings between the Department of Fisheries, WAFIC 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.

Management Initiatives/Outlook

Review of the KPMF Management Plan is scheduled in 2016/17, 2017/18.

EXTERNAL DRIVERS

A positive relationship has been observed with summer rainfall and banana prawn landings, particularly in the NBPMF (Caputi *et al*. 2014a).

High water temperatures are also having a negative effect on western king prawn catches in

recent years (Caputi *et al*. 2014b, 2016) which may be impacting these northern prawn fisheries that target western king prawns. Brown tiger prawns were ranked as a **high risk** to climate change effects and western king prawns as **medium-high** so both these species need to be monitored (Caputi *et al.* 2014b, 2015).

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NORTH COAST NEARSHORE AND ESTUARINE RESOURCE STATUS REPORT 2016

S. Newman, C. Skepper and P. Dobson

OVERVIEW

The Kimberley Gillnet and Barramundi Fishery (KGBF) operates in the nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129ºE) to the top end of Eighty Mile Beach, south of Broome (19ºS). It encompasses the taking of any fish by gillnet in inshore waters and the taking of barramundi (*Lates calcarifer*) by any means. The principal species landed are barramundi (*Lates calcarifer*) and two species of threadfin (king threadfin *Polydactylus macrochir* and blue threadfin *Eleutheronema tetradactylum*). Small quantities of Elasmobranchs (sharks and rays), black jewfish (*Protonibea diacanthus*) and tripletail (*Lobotes surinamensis*) are also landed.

The main areas of operation for the commercial fishery are the river systems and tidal creek systems of the Cambridge Gulf (including Ord River), the Ria coast of the northern Kimberley (six small river systems), and King Sound. Access to the KGBF is limited to five licences, following the buyout of the two licences from the Broome coast (Roebuck Bay) in 2013. Commercial fishing is now prohibited between 19º00′ S and 17º44′ S latitude (north of Willie Creek) within three nautical miles of the high water mark. There are commercial fishing area closures around major town sites and recreationally important fishing locations, namely Derby Jetty, the Fitzroy River and all its creeks and tributaries south of 17º27′ S, Whistle Creek and Admiral Bay, and the lower Ord River upstream of Adolphus Island.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2015	82 t	15 t (11 - 19 t 95% CIs)
Fishing Level	Acceptable	Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Barramundi	Sustainable – Adequate	Level 1 – Catch Range
King Threadfin	Sustainable - Adequate	Level 1 – Catch Range

EBFM Performance Asset	Level	Asset	Level
Bycatch	Negligible Risk	**Listed Species**	Low Risk
Habitat	Negligible Risk	**Ecosystem**	Negligible Risk
Social	Low Risk	**Economic**	Moderate Risk Level 3 GVP (< $1 mill)
Governance	New Marine Parks being progressed	**External Drivers**	Low Risk

CATCH AND LANDINGS

The total reported catch of all species in the KGBF in 2015 was 82 t (North Coast Nearshore and Estuarine Table 1). The total landings of barramundi in 2015 were 52.4 t (North Coast Nearshore and Estuarine Table 1), an increase on the 2014 catch of 44.2 t. The 2015 landings of threadfin from the KGBF were 26.2 t (North Coast Nearshore and Estuarine Table 1), which represented a slight increase to those reported in 2014 (23.4 t).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Barramundi (Sustainable-Adequate)

The barramundi catch in 2015 was 52 t, above the target catch range but below the limit range. The increased catch was obtained with high catch rates (136.1 kg/block day) across the fishery suggesting there was a higher stock abundance. There is a need to update the stock assessment for barramundi and also a need to re-evaluate the effort measure used in the fishery.

The above evidence indicates that the biomass of these stocks is unlikely to be recruitment overfished and that current levels of fishing mortality (catch) are unlikely to cause the stock to become recruitment overfished. Thus the breeding stock is classified as **adequate/sustainable**.

King threadfin (Sustainable-Adequate)

Threadfin catches are dominated by king threadfin. Catches of king threadfin in 2015 was 25 tonnes (t), similar to that reported in 2014 and are stable at this low level. Catches are well below the average of 74.5 t for the 10-year period from 2004–13. This is due to the low effort levels now available in the fishery. This follows the removal of two fishing licenses from the Broome coast area, with this area now closed to commercial fishing. King threadfin are landed by recreational and charter fishers, but only in small quantities (1 t). The above evidence indicates the biomass of this stock is unlikely to be recruitment overfished and that the current fishing pressure is unlikely to cause the stock to become recruitment overfished.

On the basis of the evidence provided above, the breeding stock of King Threadfin is classified as a **adequate/sustainable**.

NORTH COAST NEARSHORE AND ESTUARINE TABLE 1. *Summary of the reported catch (t) in the Kimberley Gillnet Barramundi Fishery in 2015 and the percentage composition of each of the major species retained.*

Species	Catch (tonnes)	Composition %
Threadfin	26.2	31.9
Barramundi	52.4	63.9
Tripletail	0.2	0.3
Black jewfish	1.4	1.7
Sharks	1.0	1.2
Other fish	0.8	1.0
Total	82.0	100

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch: (**Negligible Risk**) 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 impose a negligible risk to the stocks involved.

Protected Species: (**Low Risk**) The fishing gear used for this fishery (gillnets) is known to result in the bycatch of protected crocodiles (*Crocodylus porosus*) and sawfish (Family Pristidae). These species are generally released alive or avoided as far as is practicable. Because of the low effort levels and the low spatial intensity of fishing effort, these impacts are unlikely to pose a significant

threat to the sustainability of the stocks of these species. In 2015, listed species interactions were reported for both crocodiles and sawfish.

Catches of the speartooth shark (*Glyphis glyphis*) or the northern river shark (*Glyphis garricki*), which are listed under the Environment Protection and Biodiversity Conservation Act 1999 as critically endangered and endangered, respectively, are rare in the KGBF. However, as these species look similar to other whaler shark species, they may be captured but misidentified. Given the fishery's overall low effort levels, particularly inside the freshwater drainages in which these species are most likely to occur, the fishing operations of the KGBF are unlikely to pose a significant threat to the sustainability of the stocks of these species. Effort levels inside freshwater drainages will be monitored.

HABITAT AND ECOSYSTEM INTERACTIONS (*Negligible Risk*)

This fishery poses a negligible risk on the nearshore and estuarine ecosystem of the Kimberley region due to the low spatial density of fishing effort. 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 AND ECONOMIC OUTCOMES

Social (Low Risk)

During 2015, four vessels fished in the KGBF with an average crew level of approximately 2.4 people, with an estimate of at least 9 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.

A significant number of recreational and charter anglers also fished across the region. Recreational fishing attracts many visitors to the North Coast Bioregion, particularly in nearshore areas over the winter dry season (April – October). This provides employment through local charter fishing services and fishing tackle outlets around key population centres, as well as more remote charter operations offering wilderness fishing experiences in the north Kimberley region. The social amenity definition for the KGBF is Important (this fishery is an important asset locally and/or the use or existence of the asset is important to the broader community).

Economic (Moderate Risk)

The fishery's score value in 2015 was estimated to be Level 1 (i.e. Risk level – **Low**; Economic value – < $1 million). The new marine parks may impact on the economic viability of the KGBF.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels (Acceptable)

The target commercial catch range was calculated based on catch information from 1989 – 1999, a period during which the fishery was stable and levels of exploitation were considered to have been sustainable. However, 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 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. Monthly catch and effort data from the commercial fishery are used to assess the status of barramundi populations targeted by the fishery.

Harvest Strategy

The harvest strategy for barramundi in the Kimberley Gillnet and Barramundi Managed Fishery in the Kimberley region of Western Australia is based on a constant commercial catch policy where the annual commercial catches of barramundi are allowed to vary within the target catch range, which is based on a historical catch range during which the fishery was stable and levels of exploitation were considered to be sustainable.

Compliance

The KGBF is managed primarily through input controls in the form of limited entry, seasonal and spatial area closures and gear restrictions. There is a closed season in which fishing is prohibited in the KGBF. In the southern KGBF (west of Cunningham Point, 123º08.23´ E longitude) the closure extends from 1 December to 31 January the following year, while in the northern section of the KGBF (east of Cunningham Point) the closure extends from 1 November to 31 January the following year. There

are also limits on the length of net and mesh sizes to be used in the fishery.

Recreational fishing activities are concentrated around key population centres, with a seasonal peak in activity during the dry season (winter months). 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. 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.

Consultation

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are now convened by the Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department. Consultation processes for the recreational fishing sector are facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues.

Management Initiatives (New Marine Parks)

The KGBF management plan was amended in June 2012 to modernise the fishery management arrangements. The next management review of the fishery is scheduled after the 2016 /17 financial year. New marine parks are currently being developed for the Kimberley region.

EXTERNAL DRIVERS (*Low Risk*)

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 sectors on barramundi stocks needs to be monitored.

Furthermore, the smaller, isolated stocks along the arid Pilbara coastline are likely to experience highly variable recruitment due to environmental fluctuations (e.g. the amount of rainfall). These stocks will be subject to increased exploitation pressure from recreational fishers (driven by regional population growth resulting from gas and mining developments), and specific management arrangements may be needed in the future.

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

NORTH COAST DEMERSAL RESOURCE STATUS REPORT 2016

S. Newman, C. Wakefield, C. Skepper, D. Boddington, R. Jones and P. Dobson

OVERVIEW

There are a number of commercial and recreational fisheries which target demersal scalefish resources in the North Coast Bioregion of Western Australia. These fisheries catch the following tropical, demersal fish species (in order of gross tonnage); goldband snapper (*Pristipomoides multidens*), crimson snapper (*Lutjanus erythropterus*), red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*), saddletail snapper (*Lutjanus malabaricus*), rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and Moses' snapper (*Lutjanus russelli*).

Commercial fisheries landing demersal scalefish resources include the Northern Demersal Scalefish Managed Fishery (NDSMF) in the Kimberley region (east of 120° E longitude), and the Pilbara Demersal Scalefish Fisheries (PDSF) in the Pilbara region (west of 120° E longitude). The Pilbara Demersal Scalefish Fisheries include the Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF), the Pilbara Trap Managed Fishery and the Pilbara Line Fishery. The PDSF collectively use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures. The main species landed by these fisheries are bluespotted emperor, red emperor, and rankin cod.

The permitted means of operation within the NDSMF (Area 2 – offshore area) includes 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. Area 2 of the NDSF is divided into 3 zones; A, B and C. Zone B comprises the area with most of the historical fishing activity. Zone A is an inshore area and Zone C is an offshore deep slope developmental area representing waters deeper than 200 m. The main species landed by this fishery are goldband snapper and red emperor. The inshore area of the NDSMF (Area 1) permits line fishing only, within a boundary between the high water mark and a line approximating the 30m isobath.

Recreational fishing activities in the North Coast Bioregion are mostly line based fishing from boats which are concentrated in inshore areas around key population centres. The recreational fishery for demersal fish is managed through the use of input controls (e.g. recreational licenses, size limits) and output controls (e.g. bag and /or boat limits). The recreational and charter sectors do not catch significant quantities of most species targeted by the commercial fisheries that target demersal scalefish.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2016	Kimberley : 1,046 t Pilbara: 1,779 t	North Coast Bioregion: 56.2 t* (±4.1 t SE)
Fishing Level	Kimberley: Acceptable Pilbara: Acceptable	Kimberley: Acceptable Pilbara: Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Kimberley Demersal	Sustainable - Adequate	Annual: Catch, Catch Rate Periodic: Spawning Biomass, SPR, Fishing Mortality
Pilbara Demersal	Sustainable - Adequate	Annual: Catch, Catch Rate Periodic: Spawning Biomass, SPR, Fishing Mortality

EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Kimberley: Low Risk Pilbara: Low-Moderate Risk	**Listed Species**	Kimberley: Negligible Risk Pilbara: Low-Moderate Risk
Habitat	Kimberley: Low Risk Pilbara: Moderate Risk	**Ecosystem**	Kimberley: Negligible Risk Pilbara: Low Risk
Social	Kimberley: Low Risk Pilbara: Low Risk	**Economic**	Kimberley: Level 3 ($5-10 million) Pilbara: Level 3 ($5-10 million)
Governance	Stable	**External Drivers**	Low Risk

**Top 10 demersal species only from 2013/14 survey (Ryan et al. 2015)*

CATCH AND LANDINGS

Kimberley

Since 2008, NDSF annual catches have exceeded 1,000 t. The 2015 catch of 1,046 t is within the acceptable catch range of 903– 1,332 t (see Allowable Catch Tolerance Levels) for the fishery. Total catches in each zone (A, B and C) of the NDSF were also within the range of those recorded since 2008. The catch in Zone B (893 t) was the lowest since 2011.

Pilbara

The PDSF annual catches from the domestic trawl, trap and line fisheries peaked at 3,600 t in 1996, but have not exceeded 2,000 t since 2008. In 2015, 66% (1,172 t) of the total commercial catches of demersal scalefish in the Pilbara (1,779 t) were landed by the trawl sector, with 29% (510 t) taken by the trap sector and 5% (97 t) taken by the line sector.

Total trawl catches have reduced from an annual average of approximately 2,500 t during the period 1995-2004 to an annual average of 1,159 t since 2008, in response to the effort reductions imposed on the PFTIMF since 2008. The total demersal scalefish catch in the PFTIMF was within the acceptable catch range in 2015 (i.e. 940-1,416 t).

The total annual catch taken by the trap and line sectors have remained relatively consistent over the past decade, averaging 438 t and 97 t per year, respectively. The total catch of the trap and line fisheries were within the acceptable catch ranges in 2015 (i.e. 241-537 t for trap and 36-127 t for line).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Kimberley (Sustainable-Adequate)

Due to the resource comprising a large number of species, indicator species have been selected from the suite of demersal scalefish (based on their inherent vulnerability, management importance and overall risk to sustainability) for assessing the status of the overall resource. The demersal indicator species for the Kimberley region are red emperor (*Lutjanus sebae*) and goldband snapper (*Pristipomoides multidens*).

The stocks of these indicator species are assessed periodically (~ every 5 years) using an integrated age-structured model fitted simultaneously to age composition, catch and catch rate data to estimate spawning stock biomass. For all retained species, risk (vulnerability) assessments are also undertaken to identify if there have been any substantial changes in the catches of these species, relative to historical levels. For each assessment, the relevant performance indicator is compared to specified biological (target, threshold and limit) reference points to determine current stock status.

A 2015 assessment of the two indicator species in the Kimberley estimated the spawning biomass of red emperor stock to be currently around the target level (1.33 B_{MSY}). Similarly, the spawning biomass of the goldband snapper stock was estimated to be currently above the threshold level (which corresponds to B_{MSY}).

Representative age structure samples of each indicator species in the Kimberley region are due to be collected in late 2016 and early 2017, and will be processed and used to update the stock assessments in 2017/18. The life history

parameters for these species are also currently being reviewed and updated to better inform the assessment model and support MSC full assessment.

On the basis of the evidence provided above, the biological stock is classified as a **sustainable** stock.

Pilbara (Sustainable-Adequate)

Due to the resource comprising a large number of species, indicator species have been selected from the suite of demersal scalefish (based on their inherent vulnerability and overall risk to sustainability) for assessing the status of the overall resource. The three demersal indicator species for the Pilbara region are red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*) and rankin cod (*Epinephelus multinotatus*). The indicator species' stocks are assessed periodically (~ every 5 years) using an integrated age-structured model fitted simultaneously to age composition, catch and catch rate data to estimate spawning stock biomass. For all retained species, risk (vulnerability) assessments are also undertaken to identify if there have been any substantial changes in the catches of these species, relative to historical levels. For each assessment, the relevant performance indicator is compared to specified biological (target, threshold and limit) reference points to determine current stock status.

A 2016 assessment of the three indicator species in the Pilbara estimated the spawning biomass of red emperor stock to be currently **above** the threshold level (which corresponds to B_{MSY}). The stocks of bluespotted emperor and Rankin cod are **well above** the target spawning biomass levels.

Representative age structure samples of each indicator species in the Pilbara region collected in 2015 will be processed and used to update the stock assessments in 2017/18. The life history parameters for these species are also currently being reviewed and updated to better inform the assessment model and support MSC full assessment for the Pilbara trap fishery. On the basis of the evidence provided above, the biological stock is classified as a **sustainable** stock.

NORTH COAST DEMERSAL TABLE 1. *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 2015.*

Species	Pilbara catch		Kimberley (NDSF) catch		Total catch
	tonnes	% total	tonnes	% total	tonnes
Red emperor	116.4	47	131.7	53	248.1
Saddletail snapper	74.1	43	99.4	57	173.5
Crimson snapper	158.6	80	38.7	20	197.3
Brownstripe snapper	112.2	86	18.3	14	130.5
Goldband snapper	208.9	31	457.2	69	666.1
Spangled emperor	44.4	72	16.9	28	61.3
Bluespotted emperor	238.8	84	45.1	16	283.9
Rankin cod	84.0	62	51.5	38	135.5
Frypan snapper	29.3	>99	< 0.1	<1	29.3
Rosy threadfin bream	86.5	>99	0.2	<1	86.7
Moses snapper	29.5	69	13.2	31	42.7
Longnose emperor	7.0	66	3.6	34	10.6
Mozambique bream	24.8	88	3.5	12	28.3
Grass emperor	0.3	13	2.1	88	2.4
Barcheek coral trout	15.5	81	3.7	19	19.2
Other demersal scalefish	549.0	77	161.1	23	710.1
Total all demersal scalefish	**1779.3**	**63**	**1046.4**	**37**	**2825.7**

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Kimberley Trap / Pilbara Trap

There is a limited quantity of non-retained bycatch in these fisheries. The most common bycatch species is the starry triggerfish (*Abalistes stellaris*), but the numbers taken are considered to pose a negligible risk to the sustainability of this species.

Using trap gear in continental shelf regions is very unlikely to interact with listed species. Previous 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. However, potato cod rarely enter traps due to their large size and girth limiting their capacity to pass through the entrance funnel into the traps.

The Kimberley and Pilbara trap fisheries regularly capture sea snakes. In 2015, the Pilbara and Kimberley trap fisheries reported ~300 and 199 sea snakes, respectively. Sea snakes are returned to the water alive.

Pilbara Fish Trawl

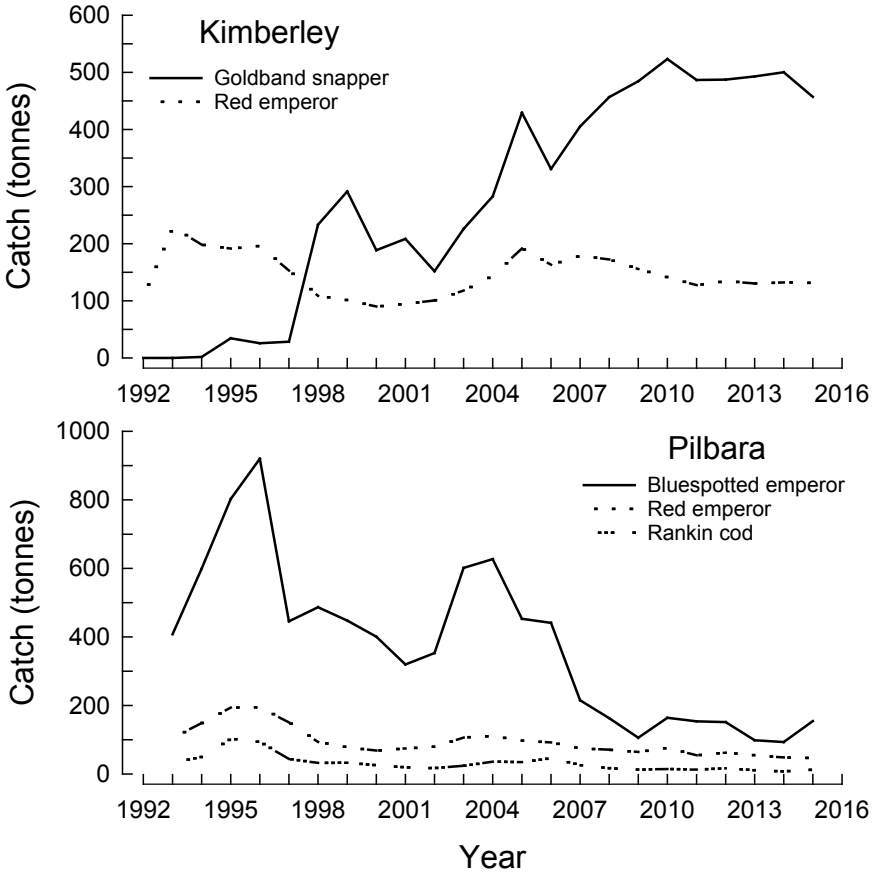
Species of teleosts caught as bycatch by the trawl fishery are typically small bodied and/or short lived. Such species are considered less vulnerable compared to longer-lived teleost species based on their population production potential. Thus, the indicator species used in the weight-of-evidence stock assessments for the Pilbara demersal scalefish resources are considered to provide an adequate indication for similar or less vulnerable retained and bycatch species.

The use of Bycatch Reduction Devices (BRDs) have been mandatory in the PFTIMF since 2006. Overall, ~27% of day-trawls have no chondrichthyan, reptile and dolphin megafauna bycatch, with BRDs resulting in 38.3% of megafauna being expelled rapidly through the escape hatch (91.4% in < 5 minutes). BRDs are highly effective in reducing reptile (turtles and sea snakes) bycatch. Bottlenose dolphin interactions with BRDs are rare (5.2 per 1,000 trawls) despite high levels of attendance and depredation during trawling. Loss of targeted teleosts through the BRD hatch is also rare (1.3% of fish during day trawls). Based on high levels of subsurface observer coverage in 2012 (60% of day trawls or 56% of day trawl hours), the subsurface expulsion of megafauna in poor condition was negligible (see Wakefield *et al*. 2014; Wakefield *et al*. 2016).

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.

NORTH COAST DEMERSAL TABLE 2. *Reported bycatch of listed species by skippers in the Pilbara trawl fishery in 2015. *Where the condition was not reported, the animal was considered deceased.*

Species	Number released Alive	Number deceased*	Total Reported
Bottlenose dolphins	2	16	18
Pipefish	3	34	37
Green sawfish	6	11	17
Narrow sawfish	8	7	15
Seahorses	2	8	10
Sea-snakes	51	31	82
Turtles	6	0	6



NORTH COAST DEMERSAL FIGURE 1. *Annual commercial catches of indicator species from the Kimberley and Pilbara demersal scalefish fisheries from 1993 to 2015.*

HABITAT AND ECOSYSTEM INTERACTIONS

Kimberley Trap / Pilbara Trap and Line

As a result of the gear design, these fisheries have little impact on the habitat overall, although there may be some rare interactions with coral habitats which are not common in areas where the fisheries operate.

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.

Pilbara Trawl

The Pilbara Fish Trawl Interim Managed Fishery is restricted to less than 5% of the North West Shelf (North Coast Demersal 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, monitoring has indicated that approximately 10% of the sessile benthic fauna (e.g. sponges) are detached per year. 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.

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 and thus represents a low risk to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

Kimberley: Seven vessels fished in the 2015 fishing season, and at least 24 people (3-4 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.

Pilbara: It is estimated that 14 fishers on 3 vessels were directly employed during 2015 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 37 people (e.g. 3-4 crew per vessel) were directly employed in the Pilbara Demersal Scalefish Fisheries.

Recreational fishing attracts many visitors to the North Coast Bioregion, particularly in inshore areas over the winter dry season (April – October). This provides employment through local charter fishing services and fishing tackle outlets around key population centres, as well as more remote charter operations offering wilderness fishing experiences in the north Kimberley region, as well as offshore locations such as the Rowley Shoals. There was an estimated 45,604 (SE 3,603) boat fishing days in the North Coast Bioregion in 2013/14 (Ryan *et al*. 2015).

The North Coast Demersal Scalefish Resource provides a high social amenity to recreational fishing and diving and to consumers via commercial fish supply to markets and restaurants. There is currently a **low** level of risk to these values.

Economic

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.

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 $1-5 million. For social amenity some of the species may be caught recreationally and/or there is some specific interest in the resource 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 they also have social amenity value. For the line fishery the economic value is < $1 million and social amenity is low because there is little recreational fishing for these offshore species and no specific broader community interests.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels (Acceptable)

Kimberley

For the 2015 calendar year, the total allowable effort was set at 986 standard fishing days in Zone B of the fishery, and 616 and 1,100 standard fishing days in Zone A and C of the fishery, respectively. 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 903–1,332 t. The 2015 catches were within this range.

Pilbara

The total catch of the trawl, trap and line fisheries were within the **acceptable** catch ranges in 2015.

Harvest Strategy

A harvest strategy for the North Coast Demersal Scalefish Resource is in development to support the full MSC assessments for the trap fisheries. It will provide a description of the objectives, performance indicators, reference levels, and associated control rules that articulate pre-defined, specific management actions designed to maintain the resource at target levels.

The harvest strategy focuses on the exploitation and stock status of the indicator species in the Kimberley and Pilbara demersal scalefish fisheries. These indicator species include red emperor and goldband snapper in the Kimberley, and red emperor, bluespotted emperor, and rankin cod in the Pilbara. Periodic assessments of selected non-indicator species are also occasionally undertaken to validate the indicator species approach and ensure that the status of other retained species remains at acceptable levels. The assessment and harvest strategies of these species are primarily based on estimates of spawning stock biomass (or an appropriate proxy for biomass), relative to internationally accepted target, threshold and limit reference levels.

The commercial sectors are managed primarily through input controls in the form of a total allowable effort allocation system via individually transferable effort allocations. The recreational and charter sector are primarily managed using size limits for some species, and daily bag and possession limits. Recreational fishers operating from a boat are required to have a current Recreational Fishing from Boat Licence (RFBL). Charter operators are required to have a Fishing Tour Operators Licence.

Compliance

The primary management measures of gear time usage and spatial zone access for North Coast trap and trawl fisheries are monitored and enforced using a satellite-based vessel monitoring system (VMS). The annual fishing effort capacity limits the amount of effort available in the fishery to achieve the notional target total allowable catch. Additional management measures include size limits, and limits on the numbers of fish that can be taken by individual recreational fishers and by recreational fishers fishing from boats.

Consultation

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

Management Initiatives/Outlook Status

Kimberley

Age structure data for the indicator species will be collected in late 2016 and early 2017 in order to revise the next assessment scheduled for mid-2017.

The Northern Demersal Scalefish Fishery Operators Guide to the Management Arrangements 2016 (DoF, 2016) was published in July 2016, and is a plain English guide to the management arrangements, designed to assist licence holders.

Pilbara

In 2016, the Department is collaborating 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 a logbook validation program, through electronic monitoring.

EXTERNAL DRIVERS

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 trap fisheries are in the process of undergoing MSC full assessment.

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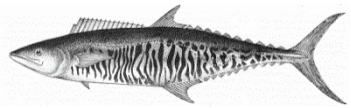
STATEWIDE LARGE PELAGIC FINFISH RESOURCE STATUS REPORT 2016



P. Lewis and R. Jones

OVERVIEW

The large pelagic resource is distributed throughout Western Australia (WA) and includes a range of tropical and temperate pelagic species. The three indicator species are Spanish mackerel (*Scomberomorus commerson*) and grey mackerel (*Scomberomorus semifasciatus*) representing the Tropical suite, and Samson fish (*Seriola hippos*) for the Temperate suite (DOF 2011).

Commercially the resource is predominantly accessed by the Mackerel Managed Fishery (MMF) in the North Coast (NCB) and Gascoyne Coast Bioregions (GCB) targeting Spanish mackerel. In the West Coast (WCB) and South Coast Bioregions (SCB) the major retained temperate species is Samson fish as bycatch (see relevant chapters for more details). The recreational fishery for large pelagic fish is dominated by Spanish mackerel with the majority of the catch released (Ryan *et al*. 2015). For further details see the Statewide Large Pelagic Scalefish Resource Assessment Report (in prep) and SAFS (2016).

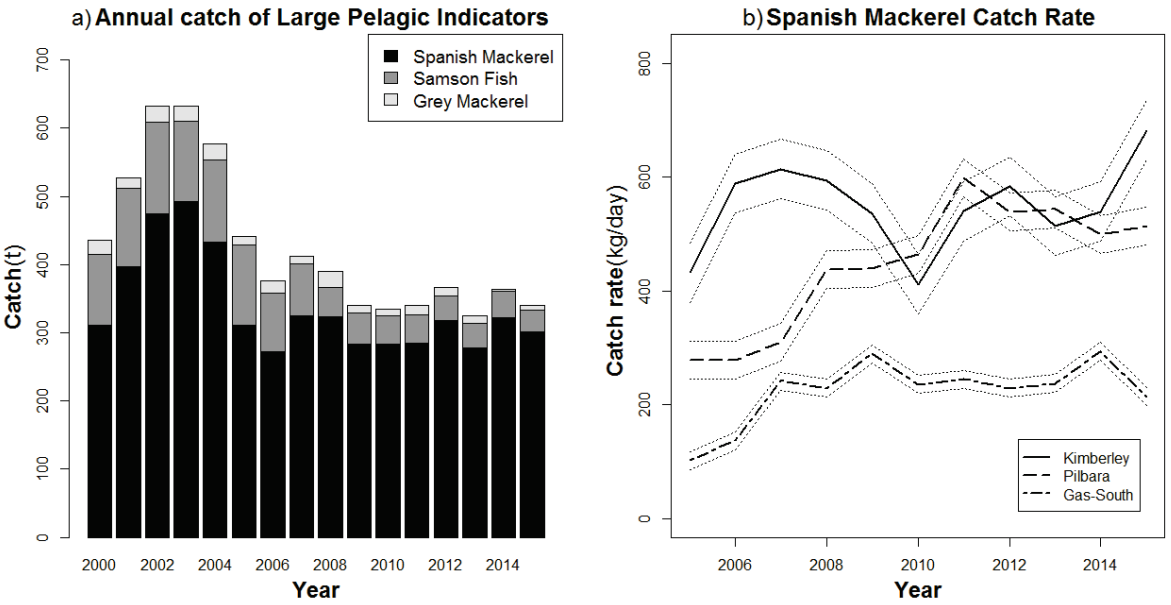
SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	302 t	75-107 t (Statewide - indicator species)	
Fishing Level	Acceptable (≤ 430 t)	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Tropical Large Pelagic	Sustainable - Adequate	Annual: Catch; Catch Rate	
Temperate Large Pelagic	Sustainable - Adequate	Annual: Catch	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Negligible Risk	**Listed Species**	Negligible Risk
Habitat	Low Risk	**Ecosystem**	Low Risk
Social	Moderate Amenity Negligible Risk	**Economic**	GVP Level 2 –($3-5 million) Low Risk
Governance	Stable	**External Drivers**	Low Risk

CATCH AND LANDINGS

The commercial catch of Spanish mackerel by the MMF was 302 t in 2015 and has been 270-330 t since quotas were introduced in 2006 (Large Pelagic Finfish Figure 1a). The commercial landings of other large pelagic species in the NCB and GCB were all <10 t in 2015. In the WCB and SCB only the annual catch of Samson fish was >10 t, at 35 t in 2015.

The estimated state-wide recreational boat based harvest of the three large pelagic indicator species in 2013/14 was 75-107 t (95% CI) of which Spanish mackerel contributed 63-86 t (Ryan *et al*. 2015). A similar or higher amount is released or discarded.



LARGE PELAGIC FINFISH FIGURE 1. *a) Annual statewide commercial catch (t) for the three large pelagic indicator species and b) Annual catch rate of Spanish mackerel in the MMF by area, with dotted line around each representing +/- standard errors.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Spanish mackerel (*Sustainable-Adequate*)

Spanish mackerel are fast growing, moderately long lived (to 26 years), grow to a large size (to 40 kg), high fecundity and have a young age at sexual maturity (less than 2 years) (Mackie *et al*. 2003) indicating resilience to fishing pressure. Spanish mackerel in WA are likely a shared biological stock with the Northern Territory.

Following management changes in 2006, catch and effort throughout the MMF have been relatively stable. This suggests that the overall spawning stock is stable or increasing. The recreational catch has also remained stable between the 2011/12 and 2013/14 boat based surveys at 57-80 t and 63-86 t, respectively with similar numbers kept as discarded (Ryan *et al*. 2015). The spawning biomass of Spanish mackerel in Western Australia is therefore considered to be **adequate**.

Grey mackerel (*Sustainable-Adequate*)

Grey mackerel in WA likely constitute a single biological stock (Newman *et al*. 2010). Grey mackerel are fast growing, relatively short lived (to 12 years) and have a young age at sexual maturity (less than 2 years) (Cameron and Begg 2002) indicating resilience to fishing pressure.

Grey mackerel catches in the MMF since 2000 have been relatively low at 3.5 to 24 t (Large Pelagic Finfish Figure 1a). This level of catch is well below the TACC (60 t for each of the three management areas) for grey mackerel. The low levels of catch are likely to reflect the gear limitations (line only) and limited targeting of the species in the MMF. The recreational catch of grey mackerel is also low at an estimated 2-6 t and has been consistent between the 2011/12 and 2013/14 boat based surveys (Ryan *et al.* 2015). On the basis of the evidence provided above, the breeding stock is classified as **adequate**.

Samson fish (*Sustainable-Adequate*)

Samson fish in WA is likely to constitute a shared biological stock with South Australia. The species are moderately long lived (to 29 years), can grow to a large size (40kg+), mature at four years of age, undertake large scale movements and are able to withstand capture from deep water (Rowland 2002), indicating resilience to fishing pressures.

In 2015 the statewide commercial catch of Samson fish was 31 t, split between the WCB and SCB. Since 2008 catches have been at historically low levels of <45 t (Large Pelagic Finfish Figure 1a), due primarily to reductions in the WCB since management changes in the WCDSMF and TDGDLMF. Over the past 5 years the catches of Samson fish have been 9-19 t in both the SCWL and WCDSF, and 7-11 t in the TDGDLMF. The

species is targeted recreationally with the majority (>70%) discarded. Statewide recreational landed catch estimates have been consistent between the 2011/12 and 2013/14 boat based surveys at 8-14 and 12-20 t, respectively (Ryan *et al*. 2015). On the basis of the evidence provided above, the breeding stock is classified as **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Negligible Risk*)

Bycatch: The non-mackerel bycatch taken by the MMF are predominantly other large pelagic species which annually contribute <1 t (2012). Thus, there is **negligible risk** to the breeding stocks of other finfish species, by fishers targeting the large pelagic resource.

Protected species: Due to the selectivity of the fishing methods used by commercial and recreational fishers targeting large pelagic species, and the rarity of interactions with protected species by the MMF there is considered to be a **negligible risk** to listed species.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat: The surface and midwater troll fishing methods used by the MMF and recreational fishers targeting large pelagic species does not impact with the benthic marine environment (DEWHA 2009). On longer fishing trips the vessels may anchor but the impacts from anchoring are considered to be minimal, as anchors are set in naturally dynamic environments.

Ecosystem: The amount of Spanish mackerel removed from the ecosystem is unlikely to impact trophic interactions, as mackerel are generalist carnivores and consume a wide range of fish and invertebrate species from both pelagic and demersal habitats (Mackie *et al*. 2003).

Therefore, the fishery is considered to be a **low risk** to both habitat structure or ecosystem interactions.

SOCIAL AND ECONOMIC OUTCOMES

Social

Approximately 33 people were directly employed in the MMF during the 2015 mackerel fishing season. The estimated participation rate for recreational fishing in the population of WA is 29.6% in 2013/14 (DoF 2015). Recreational boat based surveys indicated that Spanish mackerel is in the top 5 of retained species by number in the NCB and GCB (Ryan *et al*. 2015) while other iconic large pelagic species are targeted but released/discarded in high numbers.

The large pelagic resource provides a moderate social amenity to recreational fishing and diving and to consumers via commercial fish supply to markets and restaurants. There is currently a **negligible** level of risk to these values.

Economic

In 2012, the estimated value (to fishers) of the Spanish mackerel annual catch was level 2 approximately $ 3 million. The value of the annual catch of grey mackerel and other Large Pelagic species was estimated at less than $500,000. There is currently a **low** level of risk to this return.

GOVERNANCE SYSTEM

Governing Legislation

Mackerel Managed Fishery Management Plan 2011 (Management Plan): The MMF is the only WA commercial fishery licensed to land mackerel species. The MMF is controlled by Individual Transferrable Quota system (ITQs) to control catch and has annual catch tolerance ranges established. The recreational and charter fishers are managed by output controls including daily bag limits for the resource.

Annual Catch Tolerance Levels (Acceptable)

The target commercial catch range for Spanish mackerel in the MMF is 246-430 t. The annual catch tolerance ranges for the three areas of the MMF are Kimberley Area is 110 – 225 t, the Pilbara Area is 80 – 126 t and Gascoyne/West Coast Area is 56 – 79 t. The 2015 Spanish mackerel catch of 204 t in the Kimberley is within the range while the catches of 71 and 27 t in the Pilbara and Gascoyne/West Coast, respectively, are below the ranges but have been for most years since 2006 and the catch rates are stable so deemed **acceptable**.

Harvest Strategy (Under development)

For Spanish mackerel the current method of assessment focuses on analysis of catch and catch rates (Levels 1 and 2), with previous analyses having been used to determine the Tolerance Levels and TACC.

A draft harvest strategy has been developed for the MMF using reference levels for the catch rates of Spanish mackerel which have been derived from data collected over a reference period (2006 to 2011) when fishing was considered sustainable (DoF in prep).

Compliance

All boats in the MMF are fitted with an Automatic Location Communicator (ALC) which enables the Department to monitor the fleet using a Vessel Monitoring System (VMS). Masters of an authorised boat within the MMF are also required to submit logbook records and catch and disposal records (CDRs) The Department also undertakes vessel inspections at sea to ensure fishing is being undertaken in accordance with the governing legislation (e.g. gear requirements, catch reporting).

Consultation

Annual Management Meetings are held between the Department and MMF licensees, in conjunction with the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC).

Consultation on recreational fishing regulations or relevant commercial management changes is undertaken through the peak body, Recfishwest.

Management Initiatives (Stable)

In August 2015, the Fishery received an exemption from the export controls of the EPBC for a period of ten years.

The Department increased the capacity (TACC) of the Kimberley Area of the MMF by 20t (10%) for the 2016 season. This was completed through a management plan amendment with consultation occurring prior to this being implemented.

A review of the nomination requirements within the MMF is currently occurring with the implementation of any outcomes expected to occur in 2016/17.

A review of size limits for finfish in WA is also currently underway with all minimum legal lengths for large pelagic species proposed to be abolished (DoF 2016).

EXTERNAL DRIVERS (*Low Risk*)

Many large pelagic species experience annual variations in recruitment strength and adult movement due to environmental fluctuations. The changing marine environment off the WA coast may benefit some tropical species in the southern parts of their range, as seen during the marine heatwave of WA when Spanish mackerel distribution shifted southwards (Pearce *et al*. 2011). Other external factors on the fishery include the petroleum industry restricting access to fishing grounds in some parts of the Pilbara Area, the high proportion of discarded fish and the unknown level of mortality rates and in some areas the increased mortality of hooked and discarded large pelagic species by depredation.

However, these external factors constitute an overall **low risk** to WA's Large Pelagic resource, with possible impacts varying among individual species.

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NORTH COAST PEARL OYSTER RESOURCE STATUS REPORT 2016

A. Hart, D. Murphy and R. Jones

OVERVIEW

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 coast bioregion and targets the silver lipped pearl oyster (*Pinctada maxima*). The fishery is currently managed under its own *Act* and uses output controls in the form of a total allowable catch (TAC) divided up into individually transferable quotas (ITQs). Fishing for *P. maxima* is one component of the pearling industry's activities with seeding and grow-out of pearl oysters to produce pearls.

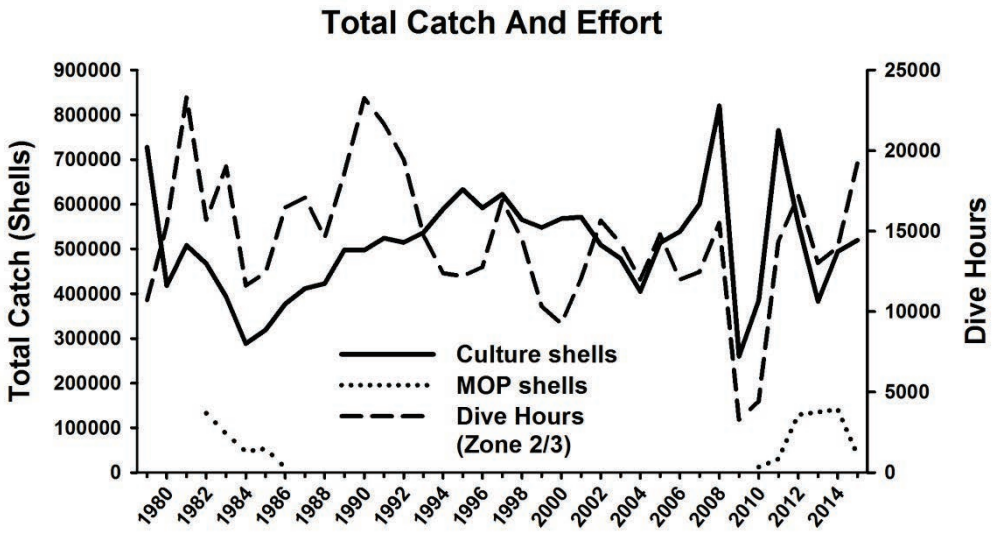
This fishery has been accredited for export under the EPBC Act for a period of ten years (re-assessment in 2025) and is currently undergoing an MSC certification process. Further information can be sourced from Hart *et al*. (2016).

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	560,005 shells	NA	
Fishing Level	Acceptable	NA	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Silver-lipped Pearl Oyster	Sustainable - Adequate	Annual: Level 3 Surveys, Catch Rate Predictions, Standardised Catch Rates	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Negligible Risk	**Listed Species**	Negligible Risk
Habitat	Negligible Risk	**Ecosystem**	Negligible Risk
Social	Moderate Amenity	**Economic**	GVP – ($78 million)
	Negligible Risk		Low Risk
Governance	Fishery undergoing MSC certification. New ARMA will subsume Pearling Act	**External Drivers**	Moderate - High Risk

CATCH AND LANDINGS

In 2015, catch was taken in Zones 1, 2, and 3 and the number of wild-caught pearl oysters was 560,005 comprising of 519,743 culture shells and 40,262 MOP shells (Pearl Oyster Figure 1). Total effort was 20,455 dive hours (Pearl Oyster Figure 1), an increase of 45% from the 2014 effort of 14,011 hours. Of this total effort, 19,743 hours was focused on culture shell fishing, and the remaining 712 hours was applied to MOP fishing. Fishing continued in Zone 1 for the second year, after a hiatus from 2008 to 2013, however was only a minor proportion (3%) of the catch. In 2015, the number of wild-caught pearl oyster shell in Zone 1 was 19,504 comprising of 19,341 culture shells and 163 MOP shells.



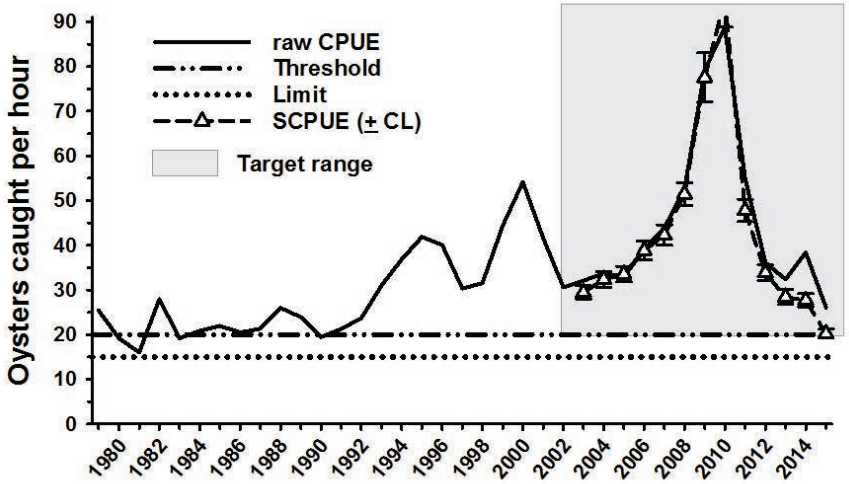
PEARL OYSTER FIGURE 1. *Total pearl shell catch (all areas) and effort (Zone 2/3). 'Culture shells' are pearl oysters ≥100 and <175 mm shell length, 'MOP shells' are pearl oysters ≥175 mm.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Silver-lipped pearl oyster (Sustainable-Adequate)

A stock assessment of the *P. maxima* fishery was undertaken for the 2015 fishing season based on catch and effort statistics, estimates of age 0+ and 1+ relative abundance, length-frequency sampling, shell discard rates by size and location, population dive surveys, and an evaluation of the predictive capacity of 0+ and 1+ spat settlement data.

The culture-shell catch rate achieved by the fishery in Zone2/3 is an indicator of the abundance of pearl oysters specifically targeted for pearl production. A standardised catch per unit effort (SCPUE) are used to inform the TAC setting under the harvest strategy (DoF, 2016). In 2015 the SCPUE was 20 shells per hour, compared to 28 shells per hour in both 2014 and 2013 which is close to the threshold level (Pearl Oyster Figure 2). This indicates stock levels have returned to more normal levels after record high levels observed in 2008 - 2011 as a result of good spat settlement in 2005.



PEARL OYSTER FIGURE 2. *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.*

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Negligible Risk*)

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 pearl oysters are returned to the substrate. Therefore bycatch impact is **negligible**.

There is no interaction between the pearl oyster fishing operation and protected species (Hart *et al*., 2016).

HABITAT AND ECOSYSTEM INTERACTIONS (*Negligible Risk*)

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. 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 AND ECONOMIC OUTCOMES

Social (Low Risk)

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 pearl oysters. 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 2015 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 pearl oyster operations and a number of other pearl oyster farm functions throughout the year.

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 oyster farms. However the impact of the GFC resulted in a substantial reduction in personnel employed in the pearling industry and current full-time FTEs is estimated around 300.

Economic (High Risk)

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 2015 was considered to be approximately $78 million, which is 16% higher than to 2015 when it was $67 million.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels (Acceptable)

TAC (667,350 pearl oysters in 2015) to be caught in 14,071-20,551 dive hours.

Commercial catch (pearl oysters) for season 2015: 560,005 oysters at 20,079 dive hours.

Both the catch and effort levels were **acceptable**.

Harvest Strategy (Formal)

The harvest strategy for *P. maxima* is a constant exploitation approach, operationalised through an annual TAC, divided into ITQs. The TAC is set in proportion to overall stock abundance. Harvest control rules determine the TAC according to the relation of predicted catch rates in comparison to target, threshold, and limit reference levels (DoF, 2016).The control rules in place ensure that the catch is reduced when predicted recruitment is low, in order to provide increased protection to the stock, but also allows the catch to be raised in years when predicted abundance is high.

Compliance

The pearling industry is highly regulated by the Department. Access to the wildstock pearl oysters is limited to holders of the relevant pearling (wildstock) licence, and attached quota. Similarly companies producing hatchery-reared pearl oysters must hold the appropriate hatchery

licence(s), pearling (seeding) licence- hatchery quota if seeding is occurring, health certification and transport approvals when appropriate and pearl oyster farm leases. Applications for a pearl oyster farm lease are reviewed and approval by the Department. The total area a company holds is linked to the pearl oyster quota and stock holding held by that company.

Consultation

The Department undertakes consultation directly with the Pearl Producers Association (PPA) and licensees on operational issues. Formal license holder engagement is convened by the West Australian Fishing Industry Council (WAFIC) under a Service Level Agreement with the Department. The stock assessment and sustainable harvest levels are discussed by the Stock Assessment Working Group (SAWG) and with licence holders, the PPA and WAFIC at the Annual Management Meeting (AMM) each year. SAWG advice, a summary of discussions at the AMM and a PPA letter are provided to the Director General when determining the annual TAC for the pearl oyster fishery.

Management Initiatives (MSC Certification/New Act)

The full-assessment for Marine Stewardship Council (MSC) approval has continued throughout 2015 for the pearling industry. Currently the reports are being reviewed with the expectation of an announcement on full accreditation in late 2016 or early 2017.

A new State Act of Parliament to ensure the sustainability and management of all WA's aquatic biological resources was 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 reviewing the current legislative framework ahead of the introduction of the new Act to transition the pearl oyster fishery and activities associated with pearl culture.

EXTERNAL DRIVERS

External influences include other activities and factors that occur within the pearl oyster fishery that may or may not impact on the productivity and sustainability of fisheries resources and their ecosystems. The main external influences included here are catch from other fisheries, environmental factors (i.e. cyclones and climate variation), market influences, tourism, liquid natural gas (LNG) exploration, disease and introduced species. Pearl oysters were ranked as a **moderate-high risk** to climate change effects.

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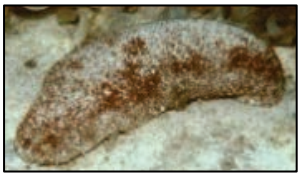
Hart A, Travaille KL, Jones R, Brand-Gardner S, Webster F, Irving A, and Harry AV. 2016. Marine Stewardship Council Report Series No 5: Western Australian silver-lipped pearl oyster (*Pinctada maxima*) Industry. Department of Fisheries, Western Australia. 316pp.

NORTH COAST SEA CUCUMBER RESOURCE STATUS REPORT 2016

A. Hart, D. Murphy and P. Kalinowski



OVERVIEW

The Western Australian sea cucumber fishery is a commercial only fishery, with animals caught principally by diving, and a smaller amount by wading. It targets two main species; sandfish (*Holothuria scabra*) and redfish (*Actinopyga echinites*). Fishing occurs in the northern half of the state from Exmouth Gulf to the Northern Territory border and is managed through input controls including limited entry, maximum number of divers, species-dependent minimum size limits, and gear restrictions. This fishery is undergoing assessment for Marine Stewardship Council certification.

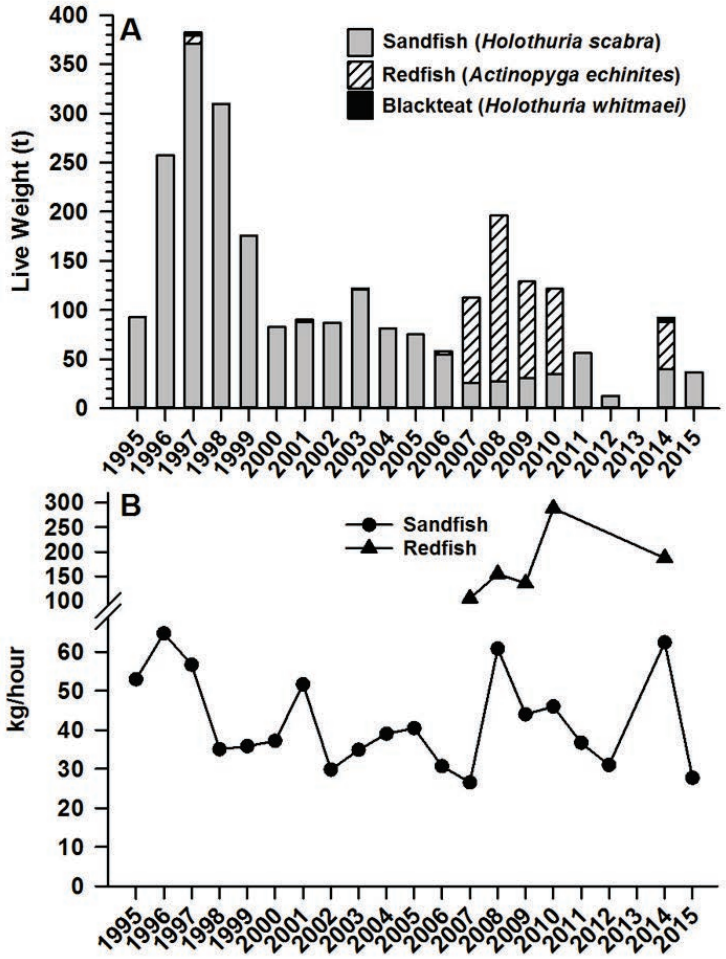
SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2015	37 t	NA
Fishing Level	Acceptable	NA
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Sandfish	Sustainable - Adequate	Annual: Catch, CPUE
Redfish	Sustainable - Adequate	Annual: Catch, CPUE
		Periodic: Surveys

EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Negligible Risk	**Listed Species**	Negligible Risk
Habitat	Negligible Risk	**Ecosystem**	Negligible Risk
Social	Low Amenity	**Economic**	GVP (< $1 million)
	Low Risk		Low Risk
Governance	MSC assessment and review planned	**External Drivers**	Low Risk

CATCH AND LANDINGS

In 2015, only sandfish (*H. scabra*) was targeted, with a total catch of 37 t (Sea Cucumber Figure 1). The industry has generally adopted a rotational fishing strategy for both sandfish and redfish with no catch taken for either species in 2013, and only a very limited amount in 2012.



SEA CUCUMBER FIGURE 1. *A) Production (tonnes/live weight) by species, and B) catch rate (kg per hr) for the two main species from the Western Australian Sea Cucumber fishery.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Sandfish (Sustainable-Adequate)

The main indicator of stock status for both species is the catch rate derived from a daily catch and effort logbook (Sea Cucumber Figure 1). Sandfish catch rate declined in 2015, however is still within historical ranges, and above the species performance measure of 25 kg/hr. Estimates of Maximum Sustainable Yield (MSY) of sandfish for the entire WA fishery using a biomass dynamics model are updated every year. Current average catch of sandfish is well below the MSY (Sea Cucumber Table 1), indicating that the level of fishing is **sustainable**.

Redfish (Sustainable-Adequate)

Redfish was not harvested in 2015, however in 2014, the catch rate was around 180 kg per hour, which is above the species performance measure of 60 kg/hr. A population survey of redfish which is primarily located at the Montebello Islands, has recently been undertaken and will be used to estimate **sustainable** harvest levels in this species.

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Negligible Risk*)

Given the hand only method of fishing no bycatch is taken by the fishery and there are no known protected species interactions.

SEA CUCUMBER TABLE 1. *Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Sea Cucumber Fishery.*

Area	MSY	Current average catch (2006-2015)	Parameter Estimates		
			Intrinsic rate of increase	Carrying capacity (Virgin biomass)	Catchability or fishing power
Entire Fishery	152 t	32 t	0.86	997 t	0.18

HABITAT AND ECOSYSTEM INTERACTIONS (*Negligible Risk*)

Divers collect sea cucumber 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. 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. Due to the toxins present in their body tissues, it is highly unlikely they are a major diet for higher-order predators.

SOCIAL AND ECONOMIC OUTCOMES

Social effects (Low Risk)

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 (Low Risk)

The estimated annual value for 2015 was $110,100 based on an average product price of $3.00 per kg live weight and total catch of 36.7 tonnes. This is a farm-gate value and supports a substantial processing and value adding sector.

GOVERNANCE SYSTEM

Annual Catch Tolerance Range (Acceptable)

Commercial: sandfish 20-100 t, redfish 40-150 t. The catch of sandfish was within the catch tolerance range and the catch rate was above threshold levels in 2015. There was no fishing for redfish in 2015.

Harvest Strategy

The harvest strategy has evolved over time, due to improved understanding of the dynamics of the fishery and improved accuracy and resolution of monitoring data. As part of stock assessment, catch and catch rate indices are compared against species-specific target catch ranges and annual catch rate target, threshold and limit values. Relevant harvest control rules, linked to catch and catch rate performance indicators, are applied to ensure that fishing does not reduce spawning biomass to a point which there is an unacceptable risk that recruitment could be compromised.

The Sea Cucumber Fishery is currently undergoing an MSC certification process and, as part of this process, the existing harvest strategy is being reviewed and updated, and is expected to include a new series of performance indicators, threshold levels, and control rules.

Compliance

There are no current issues.

Consultation

Industry Annual Management Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), under a Service Level Agreement with the Department.

Management Initiatives (MSC Assessment and Review Planned)

A review of the sea cucumber fishery is planned for 2016. It is anticipated that this review will result in the fishery transitioning from Exemption

based to interim managed. 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. The WA Sea Cucumber Fishery is currently undergoing an MSC assessment and certification process.

EXTERNAL DRIVERS

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. Currently, lack of experienced fishers and suitable vessels is restricting catch to low levels.

Climate change could have positive or negative impacts on sea cucumber populations. It has been reported that higher sea temperatures will have a positive effect i.e. higher production and yields given the expected faster growth rates leading to larger sizes and increased fecundity.

NORTH COAST CRAB RESOURCE STATUS REPORT 2016

D. Johnston, R. Marks, C. Marsh and E. Smith

OVERVIEW

Blue swimmer crabs (*Portunus armatus*) are targeted by the Pilbara Developmental Crab Fishery, within inshore waters around Nickol Bay, using hourglass traps. Recreational fishers for this species use drop nets or scoop nets, with diving for crabs becoming increasingly popular. Management arrangements for the commercial and recreational fisheries include minimum size, protection of breeding females, seasonal closures with effort controls for the commercial fishery (Johnston *et al*., 2015).

Mud crabs are targeted by the Kimberley Developing Mud Crab Fishery using crab traps between Broome and Cambridge Gulf. The commercial fishery includes two broad groups: Aboriginal community commercial mud crab exemption holders and commercial exemption holders. There is also a small recreational fishery for mud crabs. All crab fisheries have been through the pre-assessment process for Marine Stewardship Council (MSC) certification and draft harvest strategies were developed.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	64.3 t	5.9 t (Boat survey May 13-Apr 14)	
Fishing Level	Pilbara BSC: Acceptable Kimberley MC: Acceptable	Pilbara BSC: Acceptable Kimberley MC: Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Pilbara BSC	Sustainable - Adequate	Level 2 Catch Rate	
Kimberley Mud Crab	Sustainable - Adequate	Level 2 Catch Rate	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Negligible Risk	**Listed Species**	Low Risk
Habitat	Low Risk	**Ecosystem**	Low Risk
Social	High Amenity Low Risk	**Economic**	GVP Level 1 (<$1mill) Low Risk
Governance	Stable	**External Drivers**	Moderate Risk

CATCH AND LANDINGS

Commercial Sector

The total commercial catch of crabs in the North Coast Bioregion for 2015 was 64.3 t. The catch of blue swimmer crabs increased 7% on that taken in 2014 including some from a developmental licence in Cambridge Gulf. The North Coast catch accounts for < 9% of the state commercial blue swimmer crab catch of 561 t for 2015.

The catch of mud crab for the Kimberley Developing Mud Crab Fishery represents the entire mud crab catch landed in WA in 2015. The catch in 2015 was approximately 20% higher than 2014 and is the highest catch on record. In 2015 the majority of catch was recorded as green mud crab, while a small proportion was recorded as brown mud crab.

Recreational Sector

The recreational crab catch estimated by the statewide survey of boat-based recreational fishing in 2013/14 estimated the retained blue swimmer crabs of 4.2 t (S.E.±0.9 t) for the North Coast Bioregion, representing approximately 6% of the state's recreational catch (Ryan *et al*., 2015). This survey also estimated the mud crab catch for the North Coast Bioregion of 5.9 t (S.E.±0.89 t), representing

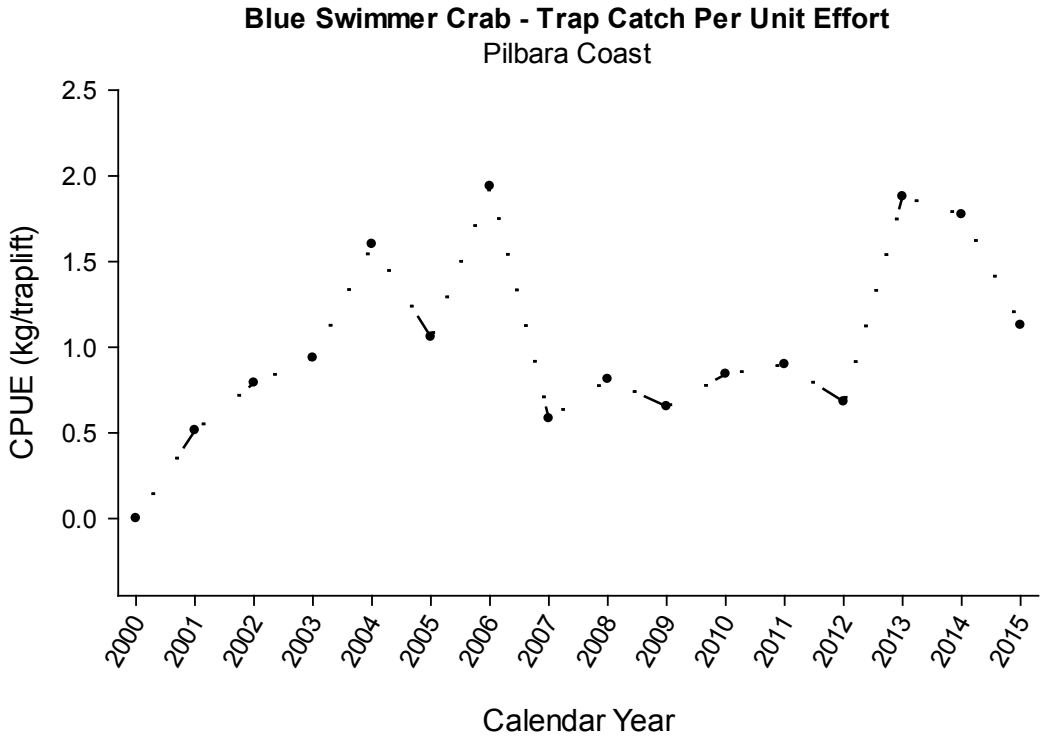
approximately 81 % of the state's recreational catch with 3.5 t caught in the Kimberley and 2.4 t in the Pilbara (Ryan *et al*., 2015).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Blue swimmer crab (Sustainable-Adequate)

It is likely that stocks of blue swimmer crabs in Port Hedland, Nickol Bay and Onslow are genetically similar with potential for mixing. The reproductive biology and life cycle of blue swimmer crabs are likely to be similar to that in Shark Bay with spawning occurring year round and growth being rapid, with female maturity reached at about 92mm CW within 10-12 months and attaining commercial size (135 mm CW) within 15 months.

Catch rates from the Pilbara trap fishery provide an index of abundance to assess fishery performance. Crab trap catch rates increased steadily during the first three years of exploratory fishing 2000-2003 (North Coast Crab Figure 1) along the Pilbara coast. The increase in catch rate can be attributed to improvements to fishing gear and vessels and fisher knowledge. Favourable environmental conditions led to a significant increase in catch rates (1.6-1.8 kg/traplift) from 2004 to 2006 and 2012 to 2013, before returning to longer-term mean catch rates of 1.1 kg/traplift for 2015 (North Coast Crab Figure 1). Catch rates remain above the draft harvest strategy threshold of 0.6 kg/traplift, so currently the breeding stock is considered **adequate**.



NORTH COAST CRAB FIGURE 1. *Annual commercial trap catch per unit effort (cpue) (kg/traplift) for the Pilbara Developmental Blue Swimmer Crab (Portunus armatus) Fishery since 2000.*

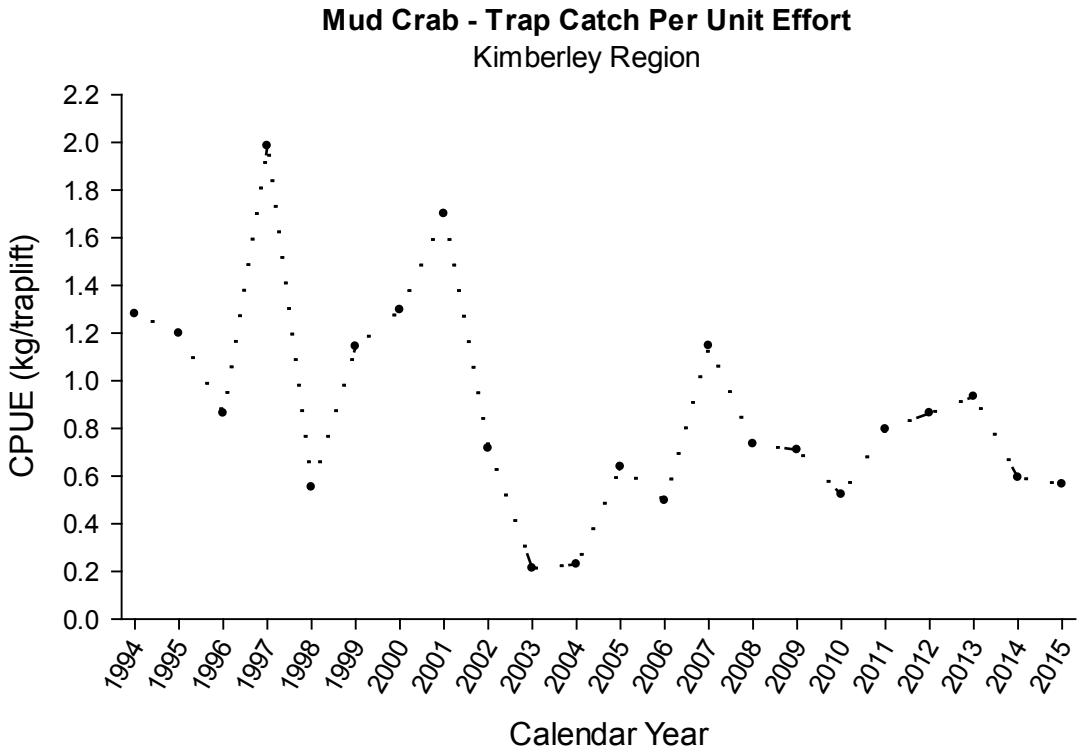
Mud Crab (Sustainable-Adequate)

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). The stock structure of the mud crab population in the Kimberley has not been documented but is assumed to be one single stock of *Scylla serrata* and *Scylla olivacea* throughout the Kimberley. The maximum size reported for green mud crabs is between 250 - 280 mm carapace width (CW) and 135 - 139 mm CW for brown mud crabs. The green mud crab is predominantly found in estuarine habitats in north-western Australia, from the Northern Territory border to Shark Bay, but have also been

found as far south as the Wilson Inlet at Denmark in years of strong southern coastal Leeuwin Current flow. The brown mud crab has a more restricted distribution limited to northern embayments, with most catches from King Sound, 200 km northwest of Broome.

The minimum legal size at first capture is 150 mm 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 86-96 mm CW for brown mud crab fisheries in the North Coast Bioregion. Consequently, breeding stock levels are expected to be adequate to maintain stocks in all current fishing areas under normal environmental conditions.

Catch rate over the past 6 years (2010 – 2015) has fluctuated between 0.5 and 0.9 kg/traplift, with a catch rate of 0.6 kg/traplift reported in 2015, which is a slight decline compared to 2014 (North Coast Crab Figure 2). But it remains above the draft harvest strategy threshold of 0.5 kg/traplift, so currently the breeding stock is considered **adequate**.



NORTH COAST CRAB FIGURE 2. *Annual commercial trap catch per unit effort (cpue) (kg/traplift) for mud crab in the Kimberley region since 1994 when permissive conditions of fishing boat licenses were issued. The Kimberley Developing Mud Crab Fishery commenced by exemption in 2006.*

BYCATCH

Blue swimmer crab

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.

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, therefore posing a negligible risk to bycatch species. The gear is required to be pulled regularly, and undersized and berried crabs must be returned to the water.

PROTECTED SPECIES INTERACTIONS

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 of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities and is considered a **negligible risk**.

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 and a **negligible risk**.

HABITAT

Blue swimmer crab

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, posing a **low risk** to benthic habitat.

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, posing a **low risk** to benthic habitat.

ECOSYSTEM INTERACTIONS

As the commercial take of blue swimmer and mud 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 and are a **low risk** to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

Blue swimmer crab

North Coast blue swimmer crab fisheries provide a high social amenity to recreational fishing and diving and to consumers via commercial crab supply to markets and restaurants. During 2015, 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

The Kimberley mud crab fishery provides a high social amenity to recreational fishing and to consumers via commercial mud crab supply to markets and restaurants. 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 2015, with effort concentrated between June and October with one operator fishing throughout the year.

Economic

The estimated gross value of product (GVP) for the crab fishery within the Northern Bioregion for 2015 was $500k- $1 million (Level 1 <$1 million).

Blue Swimmer Crabs: The average beach price for trap caught blue swimmer crabs across all Western Australian fisheries for 2015 was around $5.36/kg. The crab catch from the Pilbara region was sold through local and interstate markets.

Mud Crabs: The average beach price for green (uncooked) mud crabs in the Kimberley for 2015 was around $30.97/kg (value is based on a small

proportion of total catch from an individual processor Aboriginal corporations may also trade and barter product adding value to the local communities that cannot be estimated.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

Pilbara BSC: n/a

Kimberley Mud Crab: n/a

Blue swimmer crab

While no formal tolerance range has been developed for the Pilbara Developmental Crab Fishery current effort levels in the fishery are considered acceptable. 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.

Harvest Strategy

The breeding stock of crab fisheries are protected by effort control, legal minimum size (127–130 mm) well below the size at maturity (86–98 mm carapace width), and seasonal closures in some fisheries.

Blue Swimmer Crabs: Preliminary harvest strategy have been determined for the Pilbara Developmental Crab Fishery where the primary performance indicator is nominal annual commercial catch rates, specifically within the Nickol Bay area due to the majority of fishing historically occurring in this area. The reference period is between 2005 and 2011 as defined by the period when the developing fishery status commenced but following the period of 2001-2004 when exploratory fishing occurred.

As the indicator was above the threshold, no changes to the management will occur for the 2017 season.

Mud Crabs: A preliminary harvest strategy has been determined for the Kimberley Developing Mud Crab Fishery where the primary performance indicator is nominal annual commercial catch rate. The reference period is between 2006 and 2011 as defined by when the developing fishery status commenced under exemptions.

As the indicator was above the threshold, no changes to the management will occur for the 2017 season.

Compliance

Current risks to enforcement are low for North Coast Bioregion crab fisheries.

Consultation

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.

Management Initiatives

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 which could be retained. It is proposed that permitting the retention of blue swimmer crabs as bycatch will be incorporated into future exemptions for the mud crab fishery. A new Management Plan is being developed for the mud crab fishery which is expected to commence in early-2017. The Management Plan is proposed to permit the take of portunid crabs (including blue swimmer crabs).

An increase of 200 traps (total 600 traps) was allocated in 2016 for Pilbara Developmental Crab Fishery, with the traps able to be used across two vessels. As a precautionary measure to this increase in traps numbers, an annual season

closure between 15 August and 15 November (inclusive) was implemented to protect berried and mated pre-spawning female. A new Management Plan is being developed for the Pilbara developmental crab fishery which is expected to commence in late-2017.

EXTERNAL DRIVERS

Levels of recruitment to many of the crab fisheries fluctuate considerably. These are 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. Blue swimmer crabs were rated a **high risk** to climate change due to their sensitivity to water temperature changes.

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SOUTH COAST BIOREGION

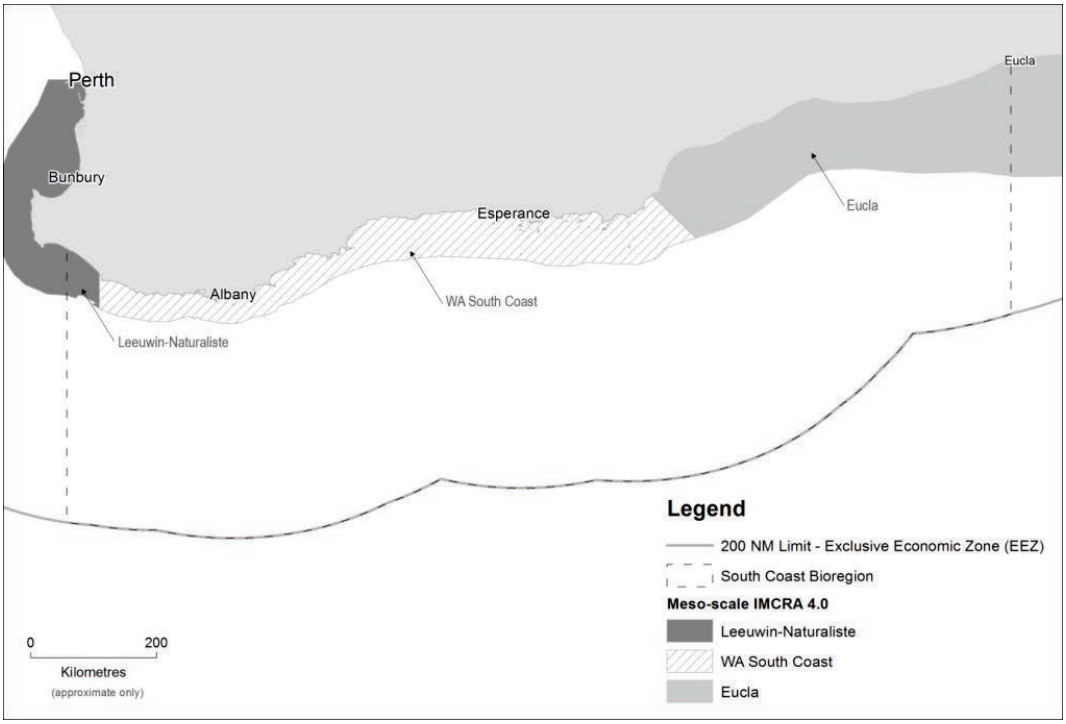
ABOUT THE BIOREGION

The continental shelf waters of the South Coast Bioregion (South Coast Overview Figure 1) 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 local 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, an extensive length (160km) of high limestone cliffs and mixed arid coastline to 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.



SOUTH COAST OVERVIEW FIGURE 1
Map showing the South Coast Bioregion and IMCRA (V 4.0) meso-scale regions: South Coast and Eucla.

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.

The ecosystem boundaries as defined by IMCRA (V 4.0) in the bioregion are depicted in South Coast Overview Figure 1. The potential threats and risks to these ecosystems are often similar. For simplicity risk ratings were allocated by grouping the ecosystems into two broad groups, estuarine or marine. However, if a particular ecosystem is unique and/or is exposed to different or significant threats, risk was allocated to these ecosystems separately.

SUMMARY OF ACTIVITIES POTENTIALLY IMPACTING THE BIOREGION

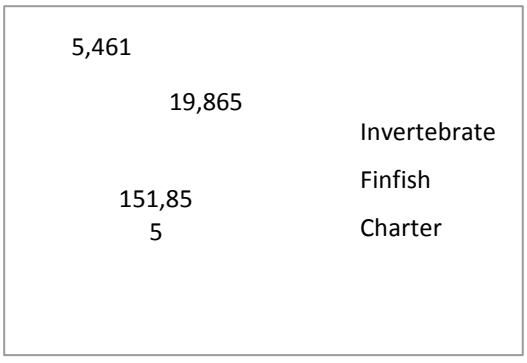
Commercial Fishing

The major commercial fisheries of the South Coast Bioregion are the abalone fishery, the purse seine fishery targeting pilchards and other small pelagics, and the demersal gillnet fishery for sharks and scalefishes. 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 trawl fishery. There is also a commercial net fishery for finfish operating in a number of South Coast estuaries and commercial fishers also target demersal scalefish offshore with droplines and handlines under general commercial 'wetline' provisions. South Coast commercial fishing vessel operators often hold a number of licences to create a viable year-round fishing operation.

SOUTH COAST OVERVIEW FIGURE 2
Relative contribution of finfish and invertebrates to the total commercial wild fishery catch originating from the South Coast Bioregion. Numbers represent total catch (in tonnes) based on all major assessed fisheries identified in the Overview section of this report (South Coast Overview Table 1).

Recreational Fishing

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 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.



SOUTH COAST OVERVIEW FIGURE 3
The South Coast Bioregion finfish and invertebrate catch numbers as assessed in the integrated survey of boat-based recreational fishing in WA 2013/14, and the charter boat catch numbers for the same period.

Aquaculture

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).

Tourism

Tourism is a regionally-important industry across the South Coast Bioregion, with much of the industry spread across rural areas and away from the major population centres of Albany and Esperance. Tourist infrastructure and development are generally small-scale and focussed on natural and wilderness experiences, thus tourism activities have a relatively low environmental impact, particularly in relation to the extensive length of coastline, which is only accessible via a limited number of four-wheel drive tracks. A significant portion of the bioregion's coastline is encompassed by national parks and nature reserves, particularly to the east of Bremer Bay. Whale watching, including expeditions to the largest known group of killer whales in the Southern Hemisphere at the head of the Bremer Canyon, and other marine wildlife experiences are also popular tourist activities.

Shipping and Maritime Activity

Significant volumes of bulk commodities such as iron ore, grain, other agricultural products and wood chips are exported from commercial port facilities in Albany and Esperance. Cruise vessels also visit the Ports of Albany and Esperance, providing significant economic input into the local community and surrounding regions during their visits. In addition, many international shipping routes to and from eastern Australia, traverse the South Coast Bioregion without coming to port. Seismic surveying has been conducted in the east of the bioregion to inform prospective oil and gas exploration in the western Great Australian Bight. At present though, no exploration drilling has been conducted in this area.

BIOREGIONAL SPECIFIC ECOSYSTEM MANAGEMENT

Within each Bioregion there are a range of management measures that have been implemented to manage the potential impact of activities (See Chapter 3 for an overview). Management measures specific to the South Coast Bioregion include:

Spatial Closures

Extensive fisheries closures in coastal and offshore waters have been introduced to manage trawling by Australian vessels (South Coast Overview Figure 4). Trawling is currently only permitted in 1% of shelf waters (South Coast Ecosystem Management Table 1).

The inshore marine habitats of the South Coast are relatively unaffected by human activities due to their remoteness, low population density across the bioregion and the extent of coastal management (national parks, nature reserves, etc.). While there are few permanent closures to demersal fishing methods in this region, the geographic footprint of demersal fishing activities is very small with about 98% of the region not affected at all by these methods.

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' Marine Ecology Monitoring Section currently 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.

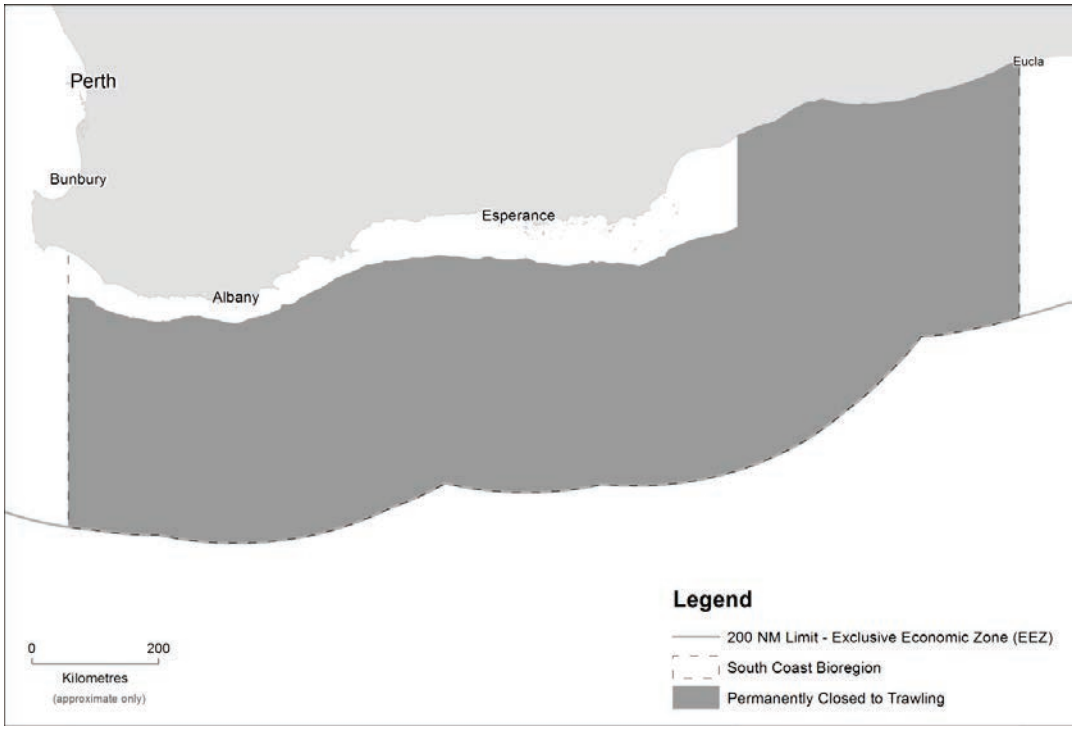
Following completion of the Commonwealth Government's Marine Bioregional Planning process for the South-West marine region (between Kangaroo Island, South Australia and

Shark Bay), zoning arrangements for Marine Protected Areas off the South Coast of WA are being developed (South Coast Overview Figure 5).

SOUTH COAST ECOSYSTEM MANAGEMENT TABLE 1

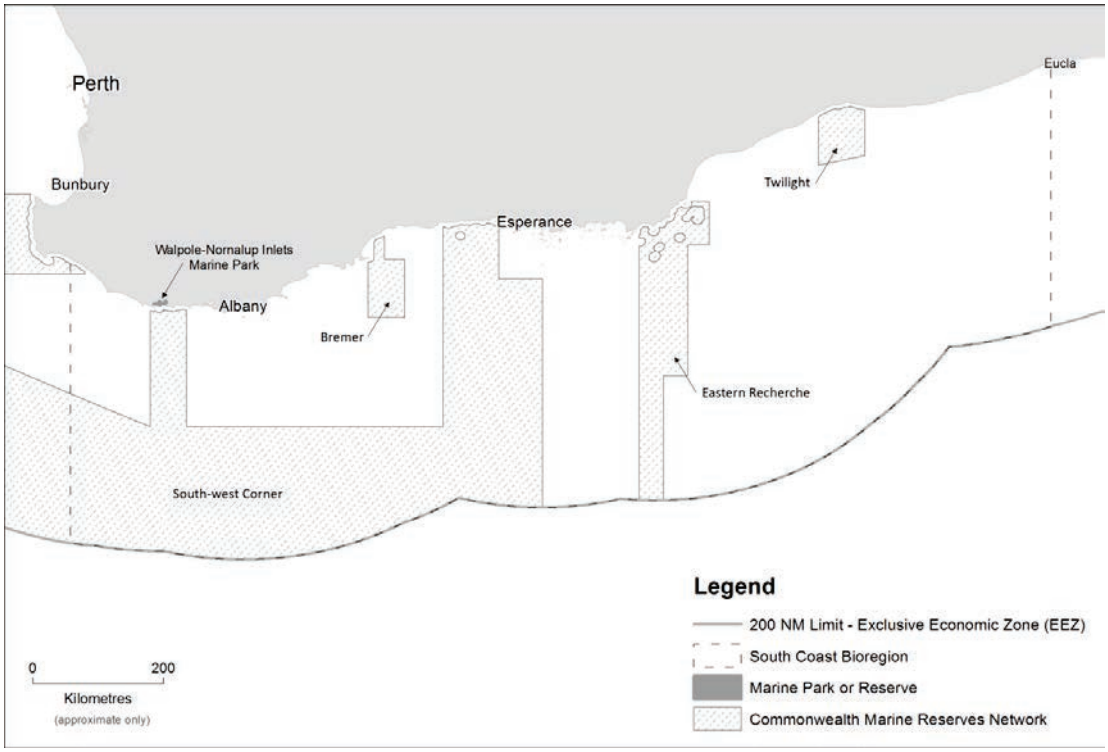
The areas and proportions of the South Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which meet the IUCN criteria for classification as marine protected areas. This table does not yet include the closures that may be implemented by the Commonwealth as part of their marine planning zones.

IUCN category or equivalent	State Waters only (17,116 km^2)				All Waters (534,016 km^2 (including State Waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km^2	%	km^2	%	km^2	%	km^2	%
I	0	0	0	0	0	0	0	0
II	1	< 1	0	0	1	< 1	0	0
III	0	0	0	0	0	0	0	0
IV	2,400	14	15	< 1	2,400	< 1	15	< 1
V	0	0	0	0	0	0	0	0
VI	14,700	86	0	0	531,600	99	0	0



SOUTH COAST OVERVIEW FIGURE 4

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

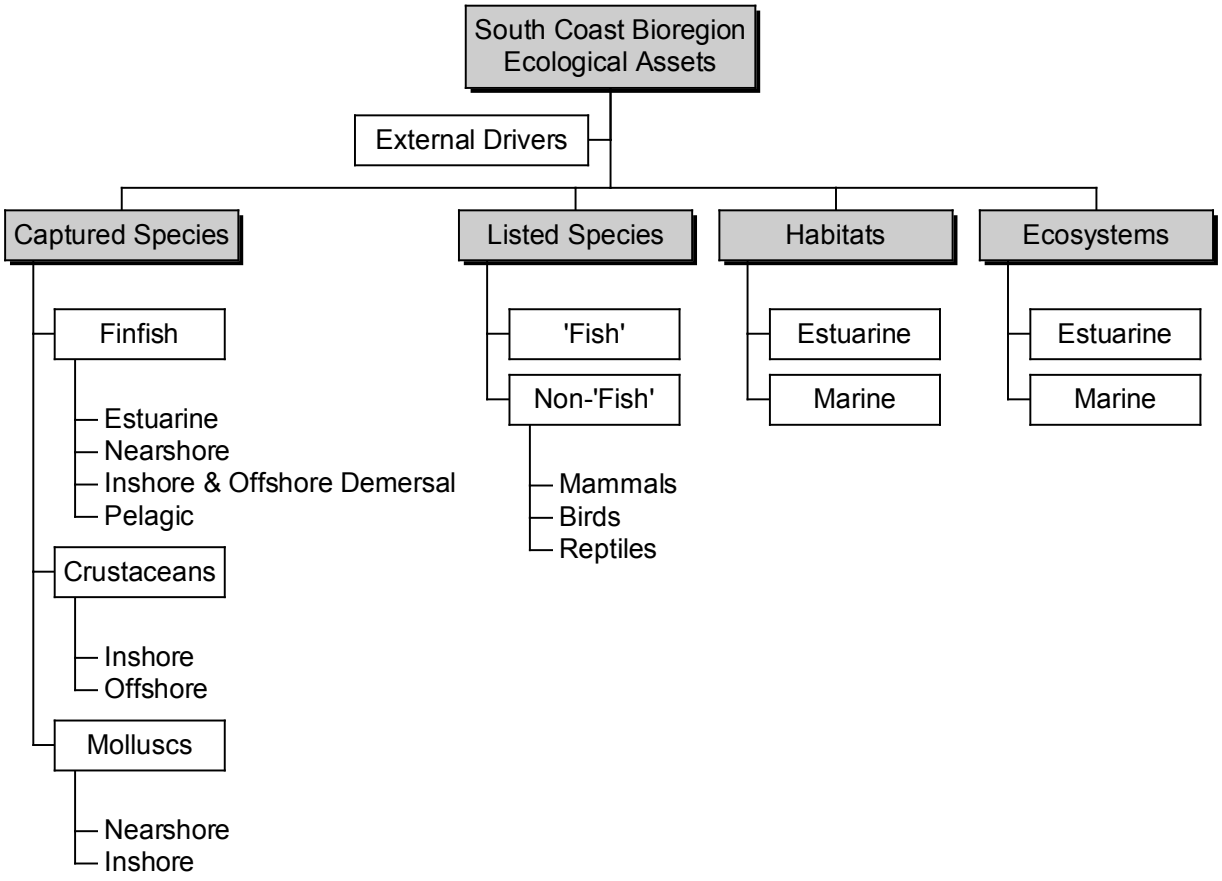


SOUTH COAST OVERVIEW FIGURE 5
Map showing the South Coast Bioregion and current and proposed state and Commonwealth marine parks and reserves along the southern WA coast.

ECOSYSTEM MONITORING AND STATUS

In order to assess the adequacy of management arrangements aimed at ensuring sustainability of the ecological assets within the South 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[32]) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment. (*See How to Use section for more details*). These key ecological assets identified for the South Coast Bioregion are identified in South Coast Overview Figure 6 and their current risk status reported on in the following sections.

32 Fletcher WJ, Shaw J, Metcalf SJ, and Gaughan DJ. 2010. An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. Marine Policy 34, 1226–1238.



SOUTH COAST ECOSYSTEM MANAGEMENT FIGURE 6
Component tree showing the ecological assets identified and separately assessed for the South Coast Bioregion.

External Drivers

External factors that potentially impact marine and estuarine ecosystems at the bioregional-level may not fall within the direct control of Fishery legislation (e.g. climate change). An understanding of these factors, which are typically environmental (storms, ocean currents, rainfall, etc.) is necessary to properly assess the risks to ecological resources. The main external drivers identified with potential to affect the South Coast Bioregion include climate and introduced pests and diseases.

Climate

External Drivers	Current Risk Status
Climate	LOW

This area is unlikely to be impacted by climate change in the near future.

Introduced Pests and Diseases

External Drivers	Current Risk Status
Introduced Pests	LOW
Introduced Diseases	LOW

The identification of the pest algae *Codium fragile fragile* in Albany highlights the issues that now face many ports in Australia.

Captured Species

Finfish

Estuarine

Captured Species	Aquatic zone	Ecological Risk
Finfish	Estuarine	SIGNIFICANT

Stocks of estuarine cobbler are considered inadequate. In addition, there is concern for some estuarine fish stocks mainly due to external (non-fishing) factors (e.g. poor water quality and other environmental factors).

Nearshore (0-20m depth)

Captured Species	Aquatic zone	Ecological Risk
Finfish	Nearshore	MODERATE

Catches and catch rates of the nearshore indicator species (Australian salmon) have been declining since the mid-late 1990s due to reduced market demand and also environmental factors. Australian herring captures have also 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.

Inshore (20-250m depth) and offshore (>250m depth) demersal

Captured Species	Aquatic zone	Ecological Risk
Finfish	Demersal	MODERATE

An NRM-funded project that concluded in 2016, assessed the risks to inshore demersal indicator species as low (western blue groper) to medium (bight redfish, snapper and blue morwong). Targeted fishing effort in deeper offshore areas is low and intermittent.

Pelagic

Captured Species	Aquatic zone	Ecological Risk
Finfish	Pelagic	NEGLIGIBLE

While the spawning biomass of sardines has returned to appropriate levels, their catches and those of other pelagic fish have not returned to pre-virus levels due to market factors and changed fish behaviour.

Invertebrates

Crustaceans

Captured species	Aquatic zone	Ecological Risk
Crustaceans (Lobsters)	Inshore	MODERATE
Crustaceans (Crabs)	Offshore	MODERATE

The catch levels of lobsters and deep sea crabs remain at relatively low and consistent levels.

Molluscs

Captured species	Aquatic zone	Ecological Risk
Molluscs (Abalone)	Nearshore	MODERATE
Molluscs (Scallops)	Inshore	NEGLIGIBLE

The stocks of abalone are maintained at appropriate levels. The abundance of scallops varies inter-annually due to recruitment fluctuations and fishing only occurs when stocks are sufficiently abundant.

Listed species

A variety of endangered, threatened and protected[33] (ETP) species can be found within the South Coast Bioregion, including cetaceans, sealions, 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*.

Fish

Listed species	Risk
Fish	NEGLIGIBLE

There are few risks to the listed fish species in this region. This includes the white shark

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

(*Carcharodon carcharias*) which is protected under State and Commonwealth legislation throughout this and all bioregions.

Non-Fish

Listed species	Risk
Mammals	HIGH
Birds and Reptiles	MODERATE

Although captures of Australian sea lions are rare and significantly fewer than they were historically due to substantial reductions in permitted levels of demersal gillnet fishing effort, small numbers have intermittently been reported from demersal and nearshore/estuarine gillnets (see Appendix 3). In addition, concerns about potential captures of juvenile sea lions in South Coast Crustacean Managed Fishery pots, have led to the requirements for Sea Lion Excluder Devices to be fitted to pots when they are fished in proximity to breeding colonies.

Reported captures of shearwaters in purse seine operations have declined in recent years (Appendix 3) due to mitigation measures implemented through a code of conduct. These measures, which apply during a "special mitigation period" (March and April) when entanglement rates historically peaked, include a dawn closure, measures to prevent slack and folds occurring in nets, communication and avoidance protocols and gear modification trials.

Habitats and Ecosystems

The South Coast Bioregion, extending from just Black Point (east of Augusta) to Israelite Bay (east of Esperance) (South Coast Overview Figure 1).

South Coast Bioregional ecosystems are generally temperate, although the tropical Leeuwin Current maintains temperatures above those normally expected at such latitudes, especially under La Niña conditions. Tropical species can therefore occur across much of the bioregion, although they are unlikely to form breeding populations. Due to the influence of the Leeuwin current and limited freshwater discharge, South Coast Bioregion ecosystems are relatively oligotrophic, although localised upwelling along the outer edge of the continental shelf may be locally-important sources of productivity, e.g. the head of the Bremer Canyon is a recognised biodiversity hotspot in the region.

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:

- **Rocky shores**: The most conspicuous of the marine habitats in the South Coast Bioregion are the rocky shores. The south coast is exposed to the most extreme wave energy of the entire Australian coastline, due to the narrow continental shelf and lack of protection from offshore reefs and islands. Along this coast, granitic and gneissic slopes exposed to heavy wave action are usually smooth and populated with moderate to large numbers of gastropod molluscs, barnacles and macrophytes showing distinct vertical zonation.
- **Algae**: Macroalgae along the southwestern and southern coasts of Australia are highly diverse, with an estimated 62 % of macroalgal species endemic to the south coast. Algal assemblages are important as a food source, nursery grounds and shelter for a variety of organisms. Macroalgae also contribute to marine nutrient and carbon cycling in the Bioregions.
- **Sand**: The South Coast Bioregion seabed largely composed of soft, unconsolidated sediments. These sediments provide an important habitat for benthic infauna, with sediment structure an important influence on the distribution, abundance and community of these species .
- **Seagrasses**: The diversity of seagrasses in temperate south-western Australia is the highest for any temperate region in the world and reflects the broad distribution of seagrasses in estuaries, coastal embayments and nearshore sheltered environments through to exposed coastal nearshore and offshore areas that are battered by ocean swells. Seagrasses perform the following important ecosystem functions: primary production, nutrient cycling, stabilising sediments and habitat provision.
- **Sponges**: In southwestern Australia, sponges are found in areas where algae are less dominant, which includes areas deeper than 30 m and caves.

The IMCRA ecosystem boundaries are illustrated in South Coast Overview Figure 1. The risk status for

ecosystems and habitat is simplified into two broad categories: estuarine and marine.

Habitats

Habitats	Aquatic zone/category	Current Risk Status
South Coast	Estuarine	MODERATE
South Coast	Marine	NEGLIGIBLE

The footprint and intensity of demersal fishing methods (i.e. trawling, gillnetting, potting, droplining and longlining) on benthic habitats is extremely low (<1%) relative to the geographic scale of the bioregion. Trawling and demersal gillnetting also take place away from potentially sensitive hard-substrate habitats due to target species' distributions and to avoid damage to fishing gear. Some estuaries (e.g. Wilson and Hardy Inlets) are in poor condition due to reduced rainfall and other environmental factors.

Ecosystems

Ecosystems	Aquatic zone/category	Current Risk Status
South Coast	Estuarine	MODERATE (non fishing)
South Coast	Marine	LOW

An assessment by Hall and Wise (2011)[34] of finfish community structure using commercial fishery data for the past 30 years, concluded that trends mean trophic level, mean length and a Fishery-In-Balance indicator had stabilised in the South Coast Bioregion and that there were, thus, no concerning trends in available ecosystem-based indices.

The most likely cause of any changes to community structure in estuarine regions is changing rainfall levels and changes in tidal exchange due to opening and closing of sand-bars at river mouths.

34 Hall NG, and Wise BS. 2011. Development of an ecosystem approach to the monitoring and management of Western Australian fisheries. FRDC Report – Project 2005/063. *Fisheries Research Report*, No. 215. Department of Fisheries, Western Australia. 112pp.

SOUTH COAST CRUSTACEAN RESOURCE STATUS REPORT 2016

J. How and G. Baudains

OVERVIEW

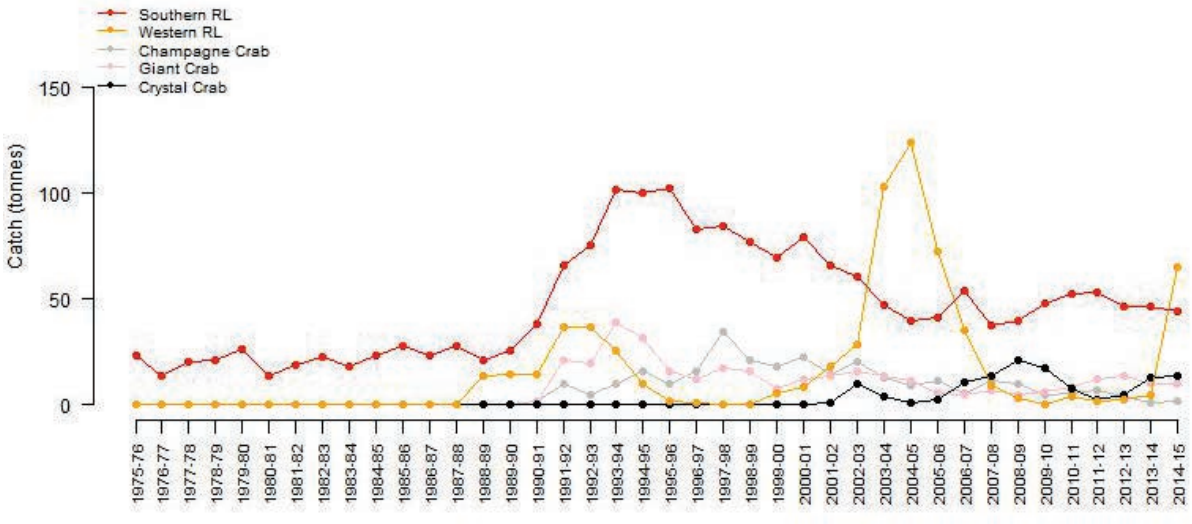
The South Coast Crustacean Fishery (SCCF) is a multi-species, effort-controlled pot based fishery, with catches of southern rock lobster (*Jasus edwardsii*) and western rock lobster (*Panulirus cygnus*) as well as deep-sea crab species namely, giant crab (*Pseudocarcinus gigas*), crystal crab (*Chaceon albus*) and champagne crab (*Hypothalassia acerba*).

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	135 t	< 5 t	
Fishing Level	Acceptable	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
	Sustainable - Adequate	Annual: Catch and Catch Rates	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low Risk	**Listed Species**	Moderate Risk
Habitat	Low Risk	**Ecosystem**	Low Risk
Social	Moderate Amenity Moderate Risk	**Economic**	GVP Level 3 -$7.6 million Moderate Risk
Governance	Stable	**External Drivers**	Moderate Risk

CATCH AND LANDINGS

The total landings of crustacean from this offshore resource in 2014-15 accessed by the South Coast Crustacean Fishery (SCCF) was 135 t, with 109.1 t of rock lobster (southern and western combined) and 26.2 t of deep sea crabs retained (South Coast Crustacean Figure 1).



SOUTH COAST CRUSTACEAN FIGURE 1. *Total landings in the South Coast Crustacean Fishery by species.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Zone 1 – Augusta / Windy Harbour (Western rock lobster-Adequate)

The assessment for this zone is determined using western rock lobster as the indicator species. Western rock lobster (*Panulirus cygnus*) can live for over 20 years and weigh of up to 5.5 kg, more typically they live for 10 to 15 years and weigh less than 3 kg. They are considered as a single genetic stock throughout its geographic range (Thompson *et al*. 1996, Johnson 1999, Kennington et. al. 2013). For more details on the western rock lobster resource see de Lestang *et al*. (2016).

Commercial catch rates in this zone have improved markedly and are approaching historic high levels (South Coast Crustacean Figure 2a). It is likely that the current level of overall stock depletion in this region is minimal. The western rock lobster stock in this area represents the southern edge of the distribution of the stock. Evidence suggests that the source of recruitment for western rock lobsters in the SCCF is the West Coast Rock Lobster Managed Fishery (WCRLF). The WCRLF is MSC certified and has spawning biomass estimated as near record **high** levels.

Zone 2 – Albany (Crystal Crab-Adequate)

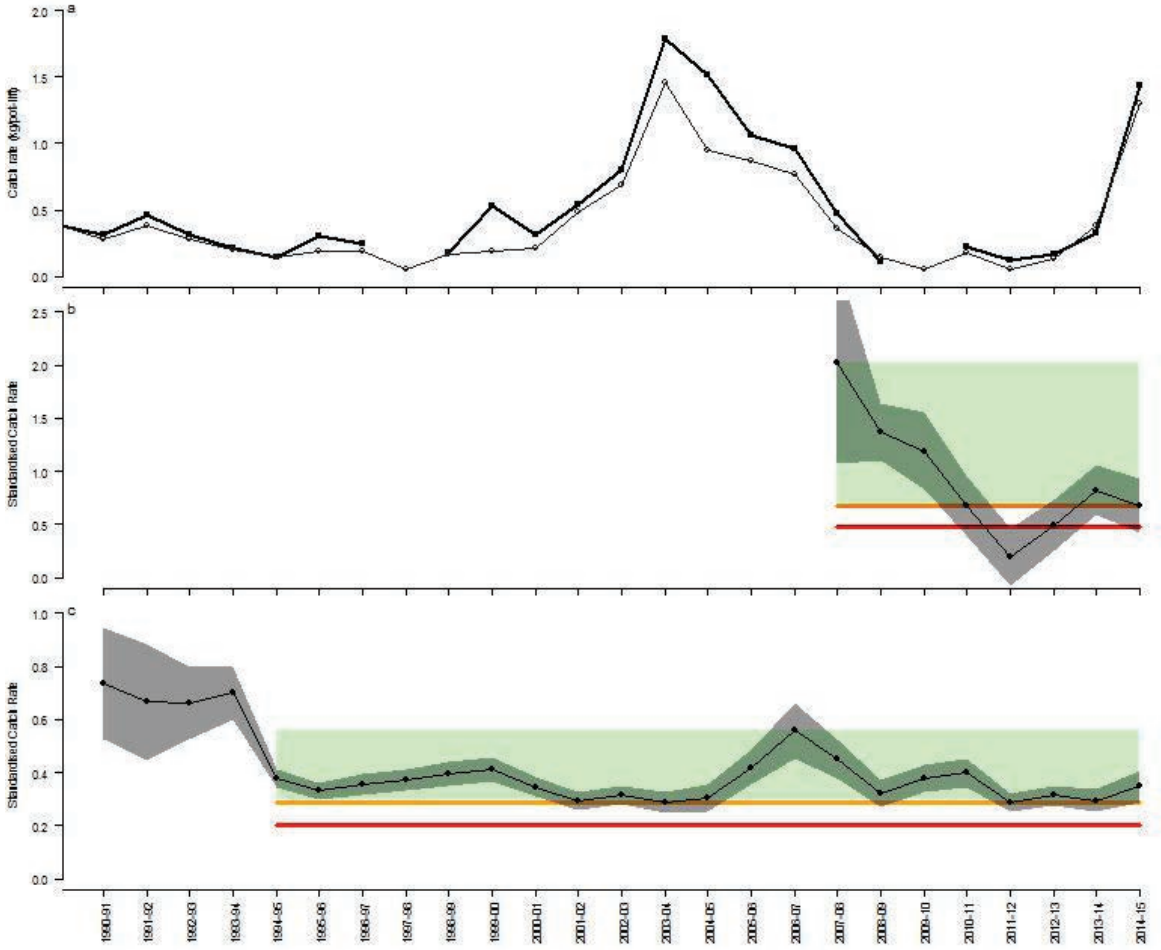
Crystal crab (*Chaceon albus*), which is found on the west and south coasts of Western Australia is the indicator species within this zone. It is a deep water species typically caught between 500 – 800 m. (For more details see How *et al*. 2015).

Landings of crystal crabs have increased in the 2014/15 season by about 1 t to 13.9 tonnes (South Coast Crustacean Figure 1). The standardised commercial catch rate declined slightly from the 2013/14 season and is now just above threshold levels. This slight decline occurred after a progressive increase the standardised catch rate from a record low in 2011/12 (South Coast Crustacean Figure 2b). It is likely that the stock biomass is above its proposed threshold level and is therefore **adequate**.

Zone 3 – Esperance and Zone 4 – Bight (Southern Rock Lobster-Adequate)

The assessment for these zones are determined using southern rock lobster as the indicator species. Southern rock lobster (*Jasus edwardsii*) is considered to be a single genetic stock across the southern waters of Australia where it is caught (Ovenden *et al*. 1992). This is a major commercial species for a number of southern Australian states with a national stock assessment showing the overall status of the stock being sustainable (Linnane *et al*. 2014) and the relative catches of southern rock lobster from WA are minimal. For more details see Linnane *et al*. (2014).

Catches of southern rock lobsters in the SCCF have declined slightly in recent seasons, with catch landings outside of the target catch range of 50-80 tonnes (Figure 1). Standardised commercial catch rates have improved slightly from the previous season and remain within the proposed target range for this species (South Coast Crustacean Figure 2c). It is likely that the current level of overall stock depletion is **acceptable** (i.e. overall a low-medium sustainability risk) and the SCCF stock biomass is above its threshold level and is therefore **adequate**.



SOUTH COAST CRUSTACEAN FIGURE 2. *Annual catch rate (grey line open circles), targeted catch rate (heavy line solid circles) and standardised catch rate (line and open circles with grey 95CI) for a) western rock lobster, b) crystal crab and c) southern rock lobster. Target region (green), threshold (orange) and limit (red) reference points are presented when applicable.*

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch: 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.

Protected Species: The SCCF operates in areas adjacent to Australian Sea Lions (ASL) colonies. Pots fished in areas potentially frequented by juvenile ASL are required to be fitted with a sea lion exclusion device (SLED). These devices are designed to stop the entrance and accidental drowning of ASL. An exemption was granted in the 2015/16 season to assess the impact of SLEDs on catch composition and catch rate in Zone 3. Consultation is currently underway between Zone 3 fishers and the Department of Fisheries to establish suitable mitigation measures to reduce potential ASL interactions and minimising any impact on fisher catches.

In the 2014-15 season there was one whale entanglement reported by the SCCF. This whale was fitted with a makeshift tracking buoy, however recovery attempts yielded only the buoy which had come adrift of the entangled whale, therefore its status is unknown.

Turtles can also get caught in the float rigs of lobster pots. In 2015 no turtles were reported to have been entangled in lobster fishing gear.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat: Potting is considered to have a low impact on the habitat over which the fishery operates.

Ecosystem: 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.

SOCIAL AND ECONOMIC OUTCOMES

Social

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. There is a small recreational fishery for rock lobsters on the south coast of Western Australia.

Economic

The beach value of the fishery was about $7.6 million in 2014/15 with the majority of the catch sold live to Asian markets both locally and internationally. This is a substantial increase in the value of the fishery compared to 2013-14 due to the considerable increase in landings of western rock lobster from Zone 1 of the SCCF.

GOVERNANCE SYSTEM

Annual Catch Tolerances

Southern Rock Lobster – 50-80 t
Current fishing level – **Acceptable**

Under the SCCF Management Plan, the Fishery is managed through limited entry, input controls (including limiting the number of pots that can be used), size limits and seasonal closures. Through the establishment of the SCCF, the large amount of latent effort which existed in Zones 2 and 4 was dramatically reduced.

Harvest Strategy (Under Development)

A preliminary harvest strategy was developed as part of the Marine Stewardship Council (MSC) pre-assessment for this fishery. This continues to be refined, and will be formally presented to industry in upcoming seasons to ratify.

Compliance

Enforcement effort is either opportunistic or targeted. Practices include on-land and at-sea inspection of vessels, gear, authorisations and catch.

Consultation

Consultation occurs between the department and the commercial sector either through Annual Management Meetings convened by WAFIC. Consultation with RecFishWest and other interested stakeholders is conducted through specific meetings and the Department's Website.

Management Initiatives (Stable)

Management initiatives will primarily focus on refinement of management arrangement pertaining to SLED zones and ASL mitigation measures. Research priorities will be the increased participation in voluntary logbooks to provide greater spatial and temporal resolution of catch and effort data.

EXTERNAL DRIVERS *(Moderate Risk)*

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.

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SOUTH COAST GREENLIP/BROWNLIP ABALONE RESOURCE STATUS REPORT 2016

L. Strain, F. Fabris and S. Walters

OVERVIEW

The Greenlip/Brownlip Abalone Fishery is a dive fishery that operates in the shallow coastal waters off the south-west and south coasts of WA. The fishery targets two large species of abalone: greenlip abalone (*Haliotis laevigata*) and brownlip abalone (*H. conicopora*), both of which can grow to approximately 20 cm shell length. The commercial Greenlip/Brownlip Abalone Fishery is managed primarily through Total Allowable Commercial Catches (TACCs) for each species in three management areas, which are allocated annually as Individually Transferable Quotas (ITQs).

Recreational fishing only occurs in the Southern Zone with management arrangements that include a specific abalone recreational fishing licence, size limits, daily bag and possession limits, and temporal closures. Further details on the fishery can be sourced from Hart *et al*. (2017).

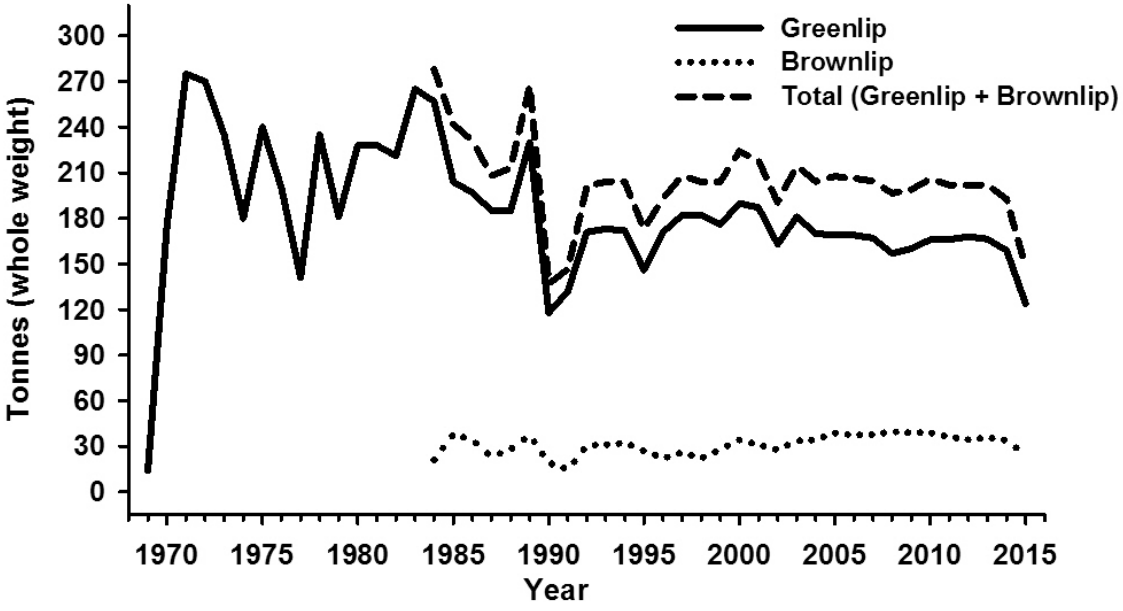
SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2015	152 t	8 t
Fishing Level	Not Acceptable	Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Greenlip abalone	Sustainable - Adequate	Annual: Catch, Catch Rates, Sizes, Surveys
Brownlip abalone	Sustainable - Adequate	Annual: Catch, Catch Rates, Sizes, Integrated Model

EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Negligible Risk	**Listed Species**	Negligible Risk
Habitat	Negligible Risk	**Ecosystem**	Negligible Risk
Social	Low Amenity	**Economic**	GVP - $6.6 million
	Low Risk		Moderate Risk
Governance	TACC Adjustments MSC full assessment underway	**External Drivers**	Moderate - High Risk

CATCH AND LANDINGS

In 2015 the total commercial greenlip/brownlip abalone catch was 152 t whole weight (greenlip 127 t and brownlip 25 t), which was 89% of the combined TACC (170 t whole weight; Greenlip/Brownlip Abalone Figure 1). The lower catch in 2015 was due to reductions in TACC (greenlip 20 t and brownlip 11 t) and a voluntary commercial reduction of 17 t greenlip abalone from the TACC set in Management Area 3. The combined recreational catch of both species estimated at 8 t, which was derived from a 2007 telephone diary survey, is still considered sufficiently accurate.



GREENLIP/BROWNLIP ABALONE FIGURE 1. *Commercial greenlip and brownlip abalone catch (t, whole weight) by season as recorded against the nearest calendar years.*

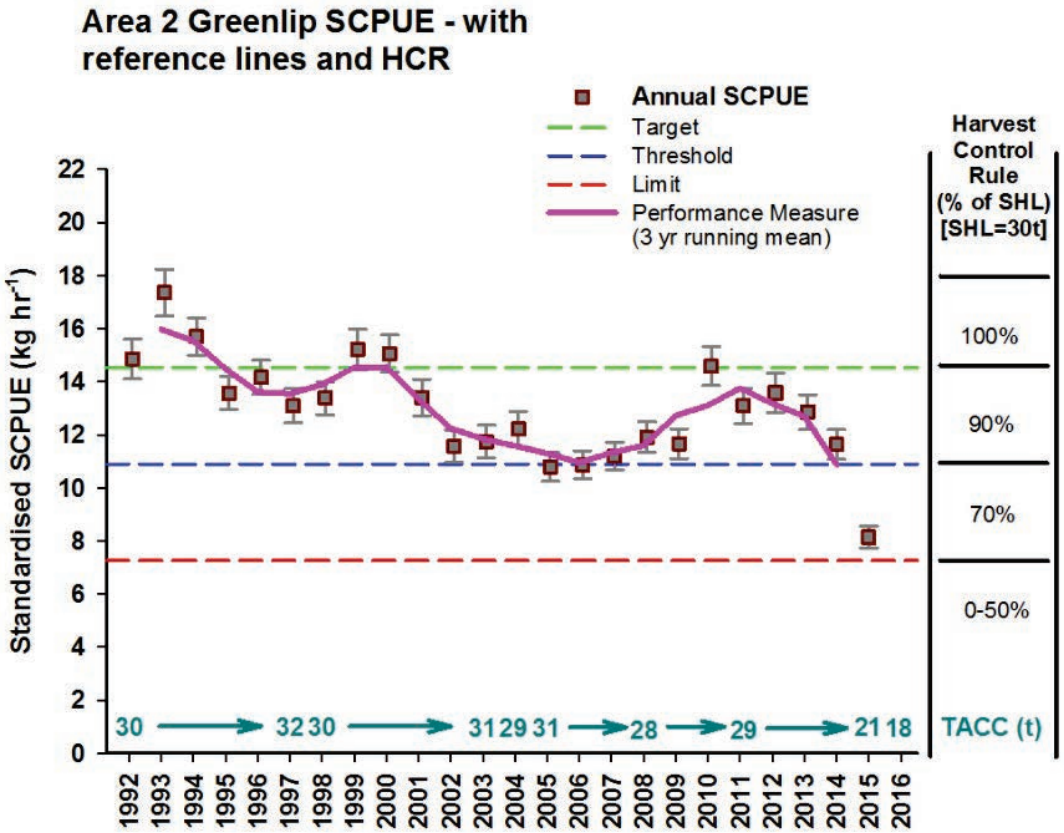
INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Greenlip abalone (Sustainable-Adequate)

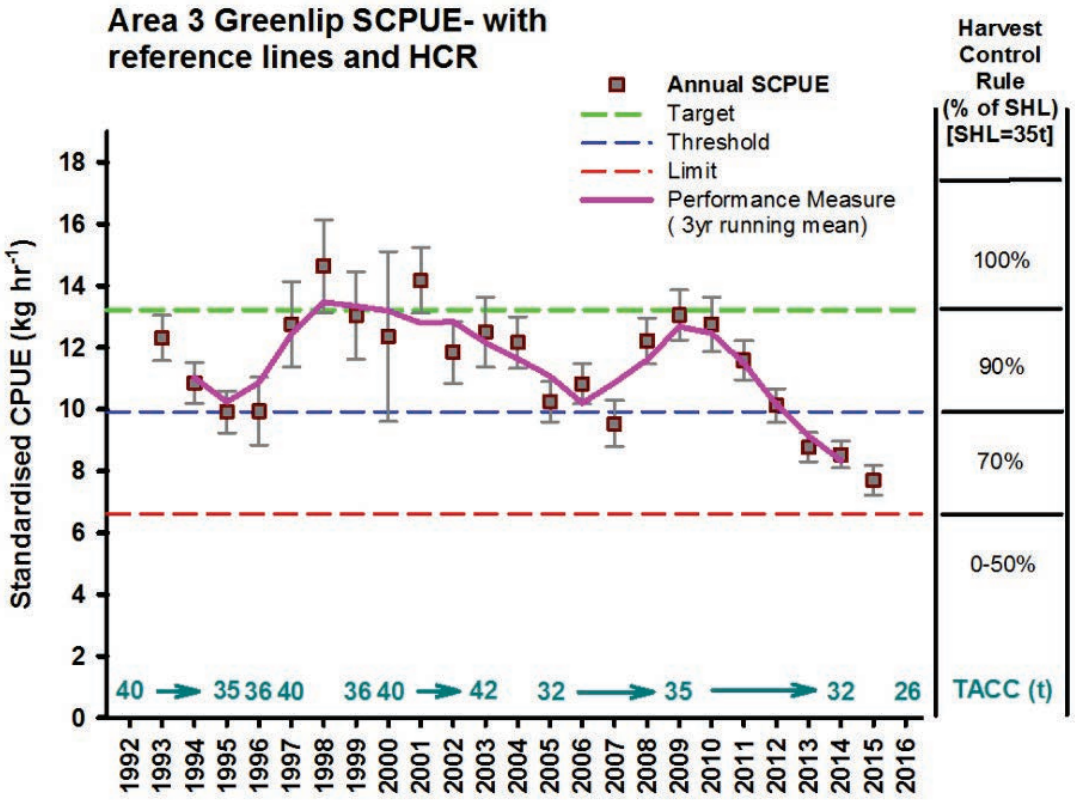
Greenlip abalone are distributed from south-west WA across southern Australia to Victoria and northern Tasmania. A recent genomic study suggests the existence of one single greenlip abalone population along the WA coast but with five adaptive populations (Sandoval-Castillo *et al*. 2015). The fishery has a legal minimum length of 14 cm, which allows 2–5 years of spawning to occur before recruitment to the fishery.

To determine the TACCs for each management area, the stock status is assessed by the primary indicator of standardised catch per unit effort (SCPUE) which uses commercial catch and effort statistics, and other indicators such as fisheries-independent sampling. In Management Area 2 (Esperance) there has been a declining trend in SCPUE since 2010-11, with a marked decline in 2015 and the SCPUE is now below the threshold but above the limit reference level (Greenlip/Brownlip Abalone Figure 2a). In Management Area 3 (Albany), since 2013 the SCPUE has declined to below the threshold but remains above the limit reference level (Greenlip/Brownlip Abalone Figure 2b). Analysis of raw catch rate, average meat weight per individual and length-frequency trends also support evidence of a declining trend (Hart *et al*. 2017). Fishery-independent surveys show evidence of a recent decline in juvenile (4 – 8 cm), recruit (14.5+ cm) and total densities but are not outside of historical ranges (Hart *et al*. 2017). Stock status of greenlip abalone is considered **adequate**.

a)



b)



GREENLIP/BROWNLIP ABALONE FIGURE 2. *The standardised CPUE (kg.hr^{-1}) for greenlip abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit), harvest control rule and TACCs (t, meat weight) in Management Area 2 (a) and Area 3 (b).*

Brownlip abalone (Sustainable-Adequate)

Brownlip abalone are limited to WA and distributed from the south-west to the WA/SA border. There is evidence to suggest brownlip abalone are genetically similar to, and can even be considered conspecific with blacklip abalone (*Haliotis rubra*) (Brown and Murray 1992), which are distributed east from WA/SA border to northern NSW and Tasmania. Estimates of biological characteristics can be found in Strain *et al*. (2017), and given the fishery has a legal minimum length of 14 cm it allows 2–3 years of spawning to occur before recruitment to the fishery.

The stock status is assessed using commercial catch and effort statistics, and an integrated model. Trends in the stock indicator (SCPUE) were used for the assessment of the 2016 TACC for each management area. In Management Area 2 (Esperance) the SCPUE for brownlip abalone was relatively stable above the target reference level between 1999 and 2012, however in 2013 and 2014 it declined markedly but has stabilised in 2015 at the threshold reference level.

In Management Area 3 (Albany) the SCPUE for brownlip abalone fluctuated greatly during 1999 to 2010 (above the target), before remaining relatively stable from 2011 to 2015 above the threshold reference level. The integrated length-based model was fitted to commercial catch and catch rate data, length composition data and modelled growth of brownlip abalone from Management Areas 2 and 3 combined (Strain *et al*. 2017). The integrated model estimated the ratio of spawning biomass to unfished levels in 2015 as above the target reference level. Consequently the stock status of brownlip abalone is considered to be **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Negligible Risk*)

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. The only potential listed species interaction is with the white shark (*Carcharodon carcharias*), which has been known to attack divers. Most divers now use diving cages and/or electronic shark deterrent devices for their personal protection, and are recording their encounters with white sharks.

HABITAT AND ECOSYSTEM INTERACTIONS (*Negligible Risk*)

The fishing activity makes minimal contact with the habitat, which typically consists of hard rock surfaces in a high wave-energy environment. As abalone are drift algae feeders, their removal is unlikely to result in any change to the algal growth cover in fished areas, and hence it is considered unlikely that the fishery has any significant effect on the food chain in the region.

SOCIAL AND ECONOMIC OUTCOMES

Social (Low Risk)

There are 20 vessels operating in the Commercial Greenlip/Brownlip Abalone Fishery, employing approximately 45 divers and deckhands. The dispersed nature of the Greenlip/Brownlip Abalone Fishery means that small coastal towns from Busselton to the WA/SA 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 16,965 licenses issued that would have allowed fishers to participate in the recreational abalone fishery, although most of these would have targeted the Roe's abalone fishery in the Perth metropolitan area.

Economic (Moderate Risk)

Estimated annual value (to fishers) for 2015 was $6.6 million, based on the estimated average price received by commercial fishers of $107/kg meat weight ($40/kg whole weight) for greenlip abalone and $84/kg meat weight ($34/kg whole weight) for brownlip abalone. Greenlip abalone prices in 2015 were similar to prices in 2014 ($101/kg meat weight) but are still lower compared to 10 years ago (e.g. $127/kg meat weight in 2005).

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels (Commercial - Not Acceptable; Recreational - Acceptable)

Commercial: 170 t (TACC) (3,440 – 5,270 fishing hours)

Recreational: Not formal

Commercial effort (5,293 hours) exceeded tolerance range due to lower abundance. TACC reduced in 2016 for both management areas in response to the lower abundance.

Current recreational catch levels are not considered to pose any stock issues.

Harvest Strategy (Formal)

The harvest strategy (DoF 2017) uses SCPUE as a proxy for biomass as the key performance indicator, which are assessed against specified reference levels for each management area. A recent review (2015) of the harvest control rule and reference levels indicated that a more conservative approach was required, and management action has subsequently been implemented. The TACCs (whole weight) have been set for the 2016/17 season using the harvest strategy (DoF 2017), for greenlip abalone they are 3 t in Area 1, 48 t in Area 2 and 68 t in Area 3, while for brownlip abalone they are 150 kg in Area 1, 12.5 t in Area 2 and 12.5 t in Area 3.

Compliance

The Department conducts regular inspections of commercial catch at both the point of landing and processing facilities to ensure the commercial industry is adhering to governing legislation. The recreational fishery has a level of enforcement appropriate to the distribution of recreational fishing effort.

Consultation

The Department undertakes consultation directly with the Abalone Industry Association of Western Australia (AIAWA) and 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 facilitated by Recfishwest under a Service Level Agreement, although the Department undertakes direct consultation with the community on specific issues.

Management Initiatives (MSC Assessment)

Consultation also took place with industry on relatively minor operational changes to the *Abalone Management Plan 1992* and these matters are currently being progressed. The commercial greenlip/brownlip abalone fishery is currently undergoing full MSC assessment (https://www.msc.org/track-a-fishery/fisheries-in-the-program/in-assessment/Indian-ocean/Western-Australia-abalone-fishery/Western-Australia-abalone-fishery).

EXTERNAL DRIVERS (*Moderate-High Risk*)

In the last few years there have been a number of changes which impact on fishery governance, and particularly on catch rates. Lease divers and using 2 divers per fishing day are more common, and industry size limits have been varied substantially above the legal minimum lengths. A major impact on fishery governance is expected over the next few years with commercial fishers in Area 3 considering a different industry management model. 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 impacts on diver efficiency. The effect of above-average water temperatures on the abalone stocks since 2011 needs to be investigated further.

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SOUTH COAST NEARSHORE AND ESTUARINE FINFISH RESOURCE STATUS REPORT 2016

K. Smith and G. Baudains

OVERVIEW

In the South Coast Bioregion (SCB), nearshore and estuarine finfish are targeted by beach-based fishers and boat-based fishers operating in shallow water. The main recreational method is line fishing. The main commercial methods are haul, beach seine and gill netting. The main commercial fisheries targeting nearshore and/or estuarine finfish in the SCB are the South Coast Estuarine Managed Fishery (SCEMF) and the South Coast Salmon Managed Fishery (SCSMF). Thirteen estuaries in the SCB are open to commercial fishing.

Fishery landings of nearshore finfish are currently mainly western Australian salmon (*Arripis truttaceus*), southern school whiting (*Sillago bassensis*), Australian herring (*Arripis georgianus*) King George whiting (*Sillaginodes punctata*), silver trevally (*Pseudocaranx georgianus*) and southern garfish (*Hyporhamphus melanochir*). Landings of estuarine finfish are mainly sea mullet (*Mugil cephalus*), estuary cobbler (*Cnidoglanis macrocephalus*) and black bream (*Acanthopagrus butcheri*).

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2015	317 t	23 t (Boat-based only)
Fishing Level	Acceptable	Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Nearshore	Sustainable - Adequate	Annual: Catch, Catch Rate; Periodic: Fishing Mortality, SPR
Estuarine	Inadequate	Annual: Catch, Catch Rate; Periodic: Fishing Mortality, SPR

EBFM Performance Asset	Level	Asset	Level
Bycatch	Low Risk	**Listed Species**	Negligible Risk
Habitat	Negligible Risk	**Ecosystem**	Low Risk (from fishing)
Social	High Amenity Moderate Risk	**Economic**	GVP Level 2 - ($1-5 million) Moderate Risk
Governance	Recovery plan for Wilson Inlet cobbler under development	**External Drivers**	High Risk (Environment)

CATCH AND LANDINGS

In 2015, the total commercial catch of nearshore and estuarine finfish in the SCB was 317 t, comprising 143 t from ocean waters and 174 t from estuaries (South Coast Nearshore and Estuarine Finfish Table 1). The commercial catch was taken by two fisheries: South Coast Estuarine Managed Fishery and the South Coast Salmon Managed Fishery. The boat-based recreational catch (top 10 species only) of nearshore and estuarine finfish in the SCB was estimated to be 23 t in the most recent survey in 2013/14 (Ryan *et al*. 2015). No recent estimate of shore-based catch is available.

SOUTH COAST NEARSHORE AND ESTUARINE FINFISH TABLE 1. *Total catches of finfish by commercial fisheries in nearshore and estuarine waters in South Coast Bioregion in previous five years.*

Species	Scientific name	2011	2012	2013	2014	2015
Western Australian salmon	*Arripis truttaceus*	165.2	75.0	139.4	303.4	119.3
Estuary cobbler	*Cnidoglanis macrocephalus*	65.5	53.1	67.2	56.9	52.7
Black bream	*Acanthopagrus butcheri*	43.9	42.7	42.1	31.2	29.1
Sea mullet	*Mugil cephalus*	29.8	30.6	33.9	27.9	17.6
Australian herring	*Arripis georgianus*	110.7	134.4	250.6	103.9	23.5
King George whiting	*SIllaginodes punctata*	8.0	9.9	11.5	13.3	21.5
Leatherjackets	Monocanthidae	7.5	11.1	11.2	11.7	8.7
Southern garfish	*Hyporamphus melanochir*	11.1	5.4	14.0	6.7	6.8
Tarwhine	*Rhabdosargus sarba*	6.7	3.9	4.6	6.0	7.4
Yelloweye mullet	*Aldrichetta forsteri*	3.9	4.9	3.4	5.2	4.2
Flatheads	Platycephalidae	4.3	3.1	4.9	3.0	5.2
Other finfish		14.2	15.4	15.2	18.8	21.1
Total		**470.8**	**389.6**	**597.9**	**588.0**	**317.1**

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

The status of each stock listed below is assessed using a weight-of-evidence approach that considers all available information about the stock.

Western Australian salmon (Sustainable-Adequate)

Western Australian salmon comprise a single breeding stock that ranges across southern Australia from Western Australia (WA) (typically Kalbarri) to Bass Strait with adult fish in other states migrating to WA prior to spawning (Smallwood *et al*. 2013). The species is caught by commercial and recreational fisheries in WA and South Australia, with minor quantities also taken in Victoria and Tasmania (Stewart *et al*. 2014).

Commercial catches have been at historically low levels since 2011 as a result of weak market demand and low wholesale prices (landings in WA are mainly sold as bait). The 2015 commercial catch was 157 t, 76 % taken by the SCSMF with the remainder taken on the west coast by the South West Coast Salmon Managed Fishery (SWCSMF). Estimated boat-based recreational catches in 2013/14 were 6.8 t (±1.6 t) in 2011/12 and 3.4 t (±0.6 t) but the shore-based sector is believed to take most of the recreational catch of this species.

A level 3 assessment of Western Australian salmon, based on biological data collected in WA during 2012-2015 indicated current fishing mortality (F) was very low and estimates of SPR suggest the current spawning biomass is relatively high (>60% of the virgin (unfished) level). On the basis of this evidence, the western Australian salmon breeding stock is classified as **adequate**.

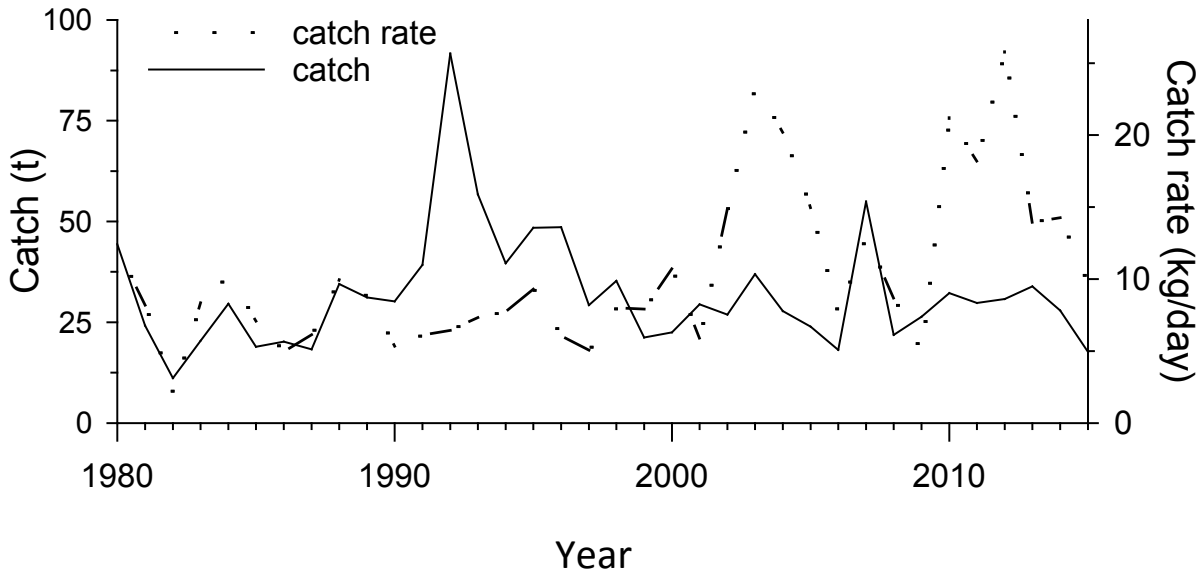
Australian herring (Sustainable-Recovering)

(see West Coast Nearshore and Estuarine Finfish Resource Status Report)

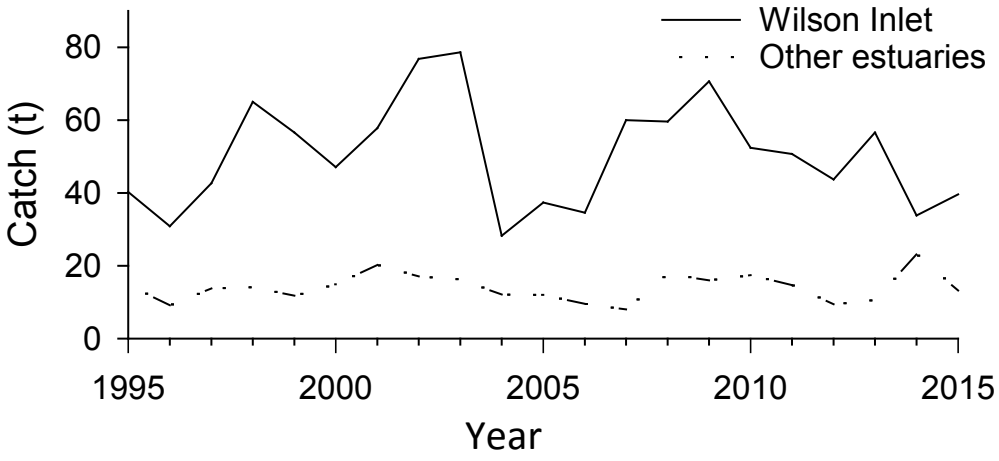
Sea mullet (Sustainable-Adequate)

Sea mullet within each WA Bioregion are currently regarded as discrete stocks. In the SCB, the majority (>90% p.a.) of commercial landings are taken by the SCEFM, mainly in Wilson Inlet and Oyster Harbour although significant quantities are taken in other estuaries in some years. Since the 1970s, total commercial landings in the SCB have been relatively stable, mostly remaining between 20 and 50 t per year (range 11 - 92 t) (South Coast Nearshore and Estuarine Figure 1). The total SCB commercial catch in 2015 was 18 t. Recreational catch is estimated to be **negligible**.

The commercial catch rate trend in Oyster Harbour suggests an increase in SCB stock level since 2000, coinciding with a period of pronounced ocean warming around south-western Australia (South Coast Nearshore and Estuarine Figure 2). On the basis of this evidence, the SCB sea mullet stock is classified as **adequate**.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 1. *Sea mullet i) total commercial catch in the South Coast Bioregion, and ii) annual standardised commercial catch rate in Oyster Harbour, 1980 to 2015.*



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 2. *Total annual commercial catches of estuary cobbler in i) Wilson Inlet and ii) other South Coast Bioregion estuaries, 1995 to 2015.*

Estuarine cobbler (Inadequate - Wilson Inlet)

In WA, cobbler occurs in marine and estuarine waters but is mainly caught by commercial fishers in estuaries. Landings by recreational fishers are believed to be **negligible**. Each estuary hosts a discrete stock of cobbler, which is genetically distinct to other estuarine populations and also distinct to populations in adjacent ocean waters.

Since 2000, 95% of commercial landings of cobbler have been caught in estuaries of the SCB, with the remainder in the WCB. From 2000 to 2015, the total SCB catch ranged from 40 to 98 t (South Coast Nearshore and Estuarine Figure 2). Over this period, 78% of SCB commercial landings were taken in Wilson Inlet, with the remainder in Irwin Inlet (10%), Oyster Harbour (8%) and several other estuaries. The catch was 53 t in 2015, including 40 t from Wilson Inlet.

A level 3 assessment of the Wilson Inlet stock, based on biological data collected during 2010-2014, indicates SPR is currently below the limit reference level of 20%. Annual fishery-independent surveys since 2007 indicate that juvenile recruitment and adult abundance has been declining. The commercial catch and catch rate in this estuary have both followed downward trends since 2009/10, although each was still within the historical range in 2015. On the basis of

this evidence, the Wilson Inlet stock is classified as **inadequate**.

In Irwin Inlet, commercial catches have gradually increased over the last two decades and the catch rate has been relatively high since 2000, suggesting an increase in stock level. In Oyster Harbour, catch has remained stable, but the catch rate has declined slightly since 2000, suggesting a slight decrease in stock level. The catch and catch rate trends are within historical levels, implying that stock levels are **acceptable** in these estuaries. However, it must be noted that the recent Level 3 assessment in Wilson Inlet indicates that catch/catch rate trends may not provide sufficient information to assess stock status for this species. On the basis of the available evidence, these other stocks are classified as **adequate**.

King George whiting (Sustainable-Adequate)

(see West Coast Nearshore and Estuarine Finfish Resource Status Report)

Black bream (Sustainable-Adequate)

Most estuaries and coastal lagoons in south-western WA host a discrete population of black bream which is a true estuarine species. The vast majority (>95% each year) of WA commercial landings occur in the SCB which in 2015 was 29 t coming from Beaufort Inlet (51% of landings), Wilson Inlet (20%), Oyster Harbour (12%), Dempster Inlet (6%), Oldfield Estuary (5%) and five other estuaries. Historically, Stokes Inlet has contributed the greatest proportion of black bream commercial landings of any single South Coast estuary. The 2015 catch (<1 t) in Stokes Inlet was the lowest since the 1970s.

Estimated boat-based recreational catches of black bream in the SCB were 7.1 t (±1.9 t) in 2011/12 and 1.8 t (±0.5 t) in 2013/14 (Ryan *et al*. 2015). The current shore-based recreational catch is unknown, but is believed to be substantially larger than the boat-based catch of this species. A 2002/03 survey of shore- and boat-based fishing in 17 SCB estuaries estimated the total recreational catch was approximately 23 t, including 15 t from Walpole Nornalup Inlet (Smallwood and Sumner 2007). The current stock status in Walpole-Nornalup Inlet cannot be assessed due to lack of recent data.

The increase in annual catch rate in each key commercially-fished estuary suggested a common environmental factor possibly driving strong recruitment by black bream in SCB estuaries in the mid-1990s, leading to higher stock levels.

Environmental factors including rainfall, river flow, temperature, salinity, oxygen and nutrient loads determine the condition and productivity of the estuary, which affects growth and reproductive success in bream. With the exception of Stokes Inlet, the 2015 catch rate in each estuary remains relatively high, suggesting the stock level is still high compared to historic levels. The Stokes Inlet catch rate is low but remains within the historical range. On the basis of this evidence, the black bream stocks in these four estuaries are classified as **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch: 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 and so bycatch species are at **low risk**.

Protected Species: 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. 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. The current risk is considered to be **negligible**.

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 **negligible**.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat: 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. Hence there is a **negligible risk** to benthic habitats.

Ecosystem: 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 very low compared to historic levels. Recreational fishing effort directed towards Australian herring is relatively high. Total removals by fishing currently pose a **low risk**.

SOCIAL AND ECONOMIC OUTCOMES

Social

The nearshore and estuarine recreational fisheries of the WCB provide a high social amenity for the WA community. There is currently a **moderate risk** to these values.

In 2015, there were approximately 27 commercial fishers employed in the South Coast Salmon Fishery and 25 in the South Coast Estuarine Managed Fishery. Additional employment is created by these fisheries in the processing and distribution networks and retail fish sales sectors. Western Australian salmon fisheries 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 beach seine nets by commercial salmon fishers may temporarily impact on beach access by members of the public.

Economic

Estimated annual value (to fishers) for 2015:

South Coast Estuarine Managed Fishery
Level 2: $1 to 5 million (finfish + invertebrates)

South Coast Salmon Managed Fishery
Level 1: <$1 million

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

South Coast Estuarine Managed Fishery: 200 – 500 tonnes (finfish only).

Finfish catch was 177 t in 2015. This fishery has traditionally targeted finfish, but in recent years has harvested significant quantities of blue swimmer crabs (53 t in 2015), which have partly replaced finfish in the overall catch. Thus, the total catch by this fishery in 2015 is considered **adequate**.

Australian Salmon Fisheries (all WA commercial fisheries): 1200 – 2800 tonnes.

Catch was 157 t in 2015. The catch has now been below the range for 9 consecutive years. Recent catches continue to be low relative to historic levels, due to low effort from limited market demand. A review of the catch tolerance range needs to be undertaken.

Harvest Strategy

This resource is harvested using a constant exploitation approach, where the annual catch taken varies in proportion to variations in the stock abundance. Indicator species are used to determine the status of the resource. All indicator species are assessed annually based on catch

and/or catch rate trends, where data is available (noting that recreational fishery data is limited for these stocks). Additionally, higher level assessments are periodically undertaken for some stocks. There is currently no formal harvest strategy developed for the South Coast Salmon Managed Fishery commercial or the South Coast Estuarine Managed Fishery.

Compliance

The Department undertakes regular compliance inspections to ensure fishing is being undertaken in accordance with the governing legislation.

Consultation

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. Consultation with the recreational sector is undertaken via the peak representative body, Recfishwest, and/or the Department's website when documents are released for public comment.

Management Initiatives/Outlook Status

A recovery plan for the Wilson Inlet cobbler stock is being developed in conjunction with industry, WAFIC and Recfishwest.

EXTERNAL DRIVERS (*High Risk*)

The abundance of fish species in SCB estuaries are strongly influenced by climatic and other environmental factors, independent of fishing. For example, high rainfall may contribute to higher catches of black bream. Catchment processes can have major effects on estuary condition and fishery production. Annual variations in coastal currents (particularly the Leeuwin and Capes Currents) influences the spawning, recruitment, distribution and catchability of species such as Australian herring and western Australian salmon. Cool inshore temperatures due to a strong Capes Current appears to have provided a favourable 'corridor' for fish to migrate northwards in 2016.

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 these species 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.

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SOUTH COAST SMALL PELAGIC SCALEFISH RESOURCE STATUS REPORT 2016

J. Norriss and G. Baudains

OVERVIEW

The five species comprising the south coast small pelagic scalefish resource are pilchards (*Sardinops sagax*), yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*), scaly mackerel (*Sardinella lemuruand*) and maray (*Etrumeus teres*). Pilchards and yellowtail scad are the indicator species and dominate the catch, which is taken predominantly by the quota managed, limited entry South Coast Purse Seine Managed Fishery (SCPSMF) using purse seine gear in waters between Cape Leeuwin and the South Australian border. The SCPSMF is also entitled to take sandy sprat (*Hyperlophus vittatus*) and blue sprat (*Spratelloides robustus*), which form part of the South Coast Nearshore and Estuarine Finfish Resource, but catches have been very small and infrequent. The SCPSMF has five management zones, centred on King George Sound, Albany, Bremer Bay, Esperance and a developmental zone near Augusta. The SCPSMF was the largest tonnage fishery in WA during the late 1980s and early 1990s, until a pilchard virus devastated stocks in 1995 and 1998/99. While surveys demonstrated recovery by 2005 the catches have remained below conservative TACs. The SCPSMF underwent pre-assessment for Marine Stewardship Council certification in 2014, but has not progressed to full assessment.

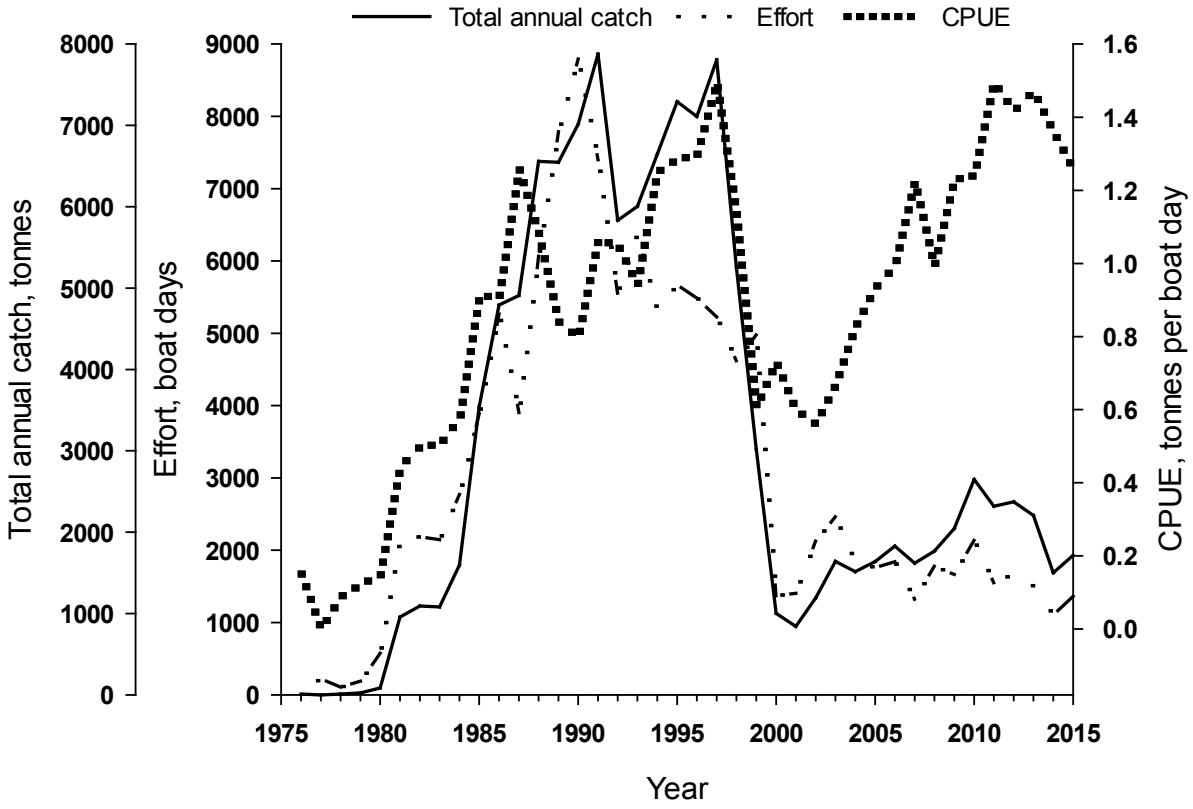
SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2014/15	1,734.5 t	<1 t (2013/14)
Fishing Level	Acceptable (≤5,683 t)	Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
South Coast small pelagic	Sustainable - adequate	Egg surveys integrated with age model in mid 2000s, and subsequent catch and catch rate trends

EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Negligible Risk	**Listed Species**	Medium Risk
Habitat	Negligible Risk	**Ecosystem**	Low Risk
Social	Low Amenity	**Economic**	GVP $1-5 million
	Low Risk		Moderate Risk
Governance	Stable	**External Drivers**	Moderate Risk

CATCH AND LANDINGS

The SCPSMF total catch of 1,734.5 t in the 2014/15 quota year was comprised of 993 t for the Albany region (zones 1 and 2 combined) and 742 t for Bremer and Esperance zone combined. The large majority (99%) was pilchards (1,715 t), a 14% increase from the previous year (South Coast Small Pelagic Figure 1). The remainder of the catch was almost entirely comprised of 16.6 t of yellowtail scad, the highest annual catch for this species since 1998/99. Fishing effort in the 2014/15 quota year was 1,363 boat days by 13 active vessels, an increase of 24% from the previous year.



SOUTH COAST SMALL PELAGIC FIGURE 1. *Time series of total annual catch, effort and catch per unit effort (CPUE) for pilchards in the SCPSMF since 1975/76.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Pilchards (Sustainable-Adequate)

The pilchard is a small, low trophic level pelagic species that feeds by filtering plankton. Longevity is up to 9 years and the maximum size is 200-250 mm SL. Three biological stocks are recognised in the South Coast Bioregion, centred on fishing ports at Albany (zones 1 and 2), Bremer Bay (zone 3) and Esperance (zone 4).

Population modelling, based on spawning biomass estimates (using the daily egg production method), catch-at-age and catch data, show that by the mid-2000s the stock had recovered from a mass mortality event in 1998/99 caused by a herpesvirus (Gaughan *et al*. 2008). The mid-2000s exploitation rate was around 3 per cent (less than 3,000 t from an estimated spawning biomass of approximately 97,000 t), and the total annual catch has never exceeded 3,000 t since then.

The nominal SCPSMF catch rate since 2008/09 has been consistently close to record highs (South Coast Small Pelagic Figure 1). The stock is therefore not considered to be recruitment overfished. Under the current level of fishing pressure the biological stocks of pilchards are considered **adequate**.

Yellowtail scad (Sustainable-Adequate)

Yellowtail scad is a schooling species common in temperate Australian waters. The population structure in WA is unknown. The maximum recorded age in Australia is 14 years although older ages have been recorded elsewhere. Low catches in both the SCPSMF since 1998/99 and the recreational sector suggest a low level of fishing pressure, so the biological stock is considered **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

The SCPSMF is a species-restricted fishery, and the capture of species not listed in the management plan or under FBL conditions is prohibited. Small quantities of bycatch species are sometimes captured incidentally, but this occurs infrequently and the majority are released from the net unharmed.

Interactions with endangered, threated and protected species must be reported to the Department of Fisheries on Catch and Disposal Records for each fishing trip, and on Catch and Effort Statistics returns that must be lodged monthly. The SCPSMF has adopted a protocol to minimise the impacts from the interactions. Low capture rates of dolphins, sea lions and seals that have been released unharmed have been recorded. There have also been interactions with seabirds, particularly shearwaters becoming entangled in nets, with most released alive but mortalities recorded. Industry has led and funded trials to mitigate shearwater entanglements which are ongoing.

HABITAT AND ECOSYSTEM INTERACTIONS

Purse seine nets are pelagic in nature, with no impact on benthic habitats during normal operations. On rare occasions nets may be deployed in shallow waters and come into contact with sensitive habitats such as seagrass beds. The light structure of the net is expected to cause minimal damage to benthic habits when this occurs, and would be kept to a small, localised area. The SCPSMF is therefore considered to be a **negligible risk** to these habitats.

Pilchards are a low trophic level species important for ecosystem structure and function, although their abundance is subject to large natural variation in response to environmental conditions. With catch quotas estimated to be <10% of spawning biomass, and trophic modelling indicating minor impacts on top order predators from the much larger South Australian pilchard fishery (Goldsworthy *et al*. 2013), the ecosystem impact from fishing is considered **low**.

SOCIAL AND ECONOMIC OUTCOMES

Social

Local employment was provided by 13 active vessels as well as local processing factories in Albany, Bremer Bay and Esperance. The only small pelagic species detected in the catch of boat-based recreational fishers by recent surveys was a small take of yellowtail scad.

Economic

A small proportion of the catch is sold for human consumption but the large majority for bait, aquaculture feed or pet food. The estimated gross value of product (GVP) for the SCPSMF in 2014/15 was level 2 ($1-5 million).

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

The SCPSMF total annual catch for all species combined in the 2014/15 quota year was less than half the total allowable catch (TAC, South Coast Small Pelagic Table 1). Catches are therefore at **acceptable** levels.

Harvest Strategy

No formal harvest strategy has been developed for the SCPSMF. Proposed changes to the TAC would be made with regard to total catches and nominal catch rates, and in consultation with stakeholders.

Compliance

Licensees are allocated individual transferable quotas and catches are assessed against quotas by the submission by fishers of trip Catch and Disposal Records to the Department of Fisheries. Compliance is monitored via aerial patrols and both at-sea and on-land inspections.

Consultation

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

Management Initiatives/Outlook Status

The south coast small pelagic scalefish resource will continue to be monitored using catch and catch rates.

SOUTH COAST SMALL PELAGIC TABLE 1. *2014/15 catches and total allowable catches (TAC) for each of the major Management Zones of the South Coast Purse Seine Managed Fishery.*

Management Zone	TAC (t)	2014/15 catch (t)	Active vessels	2014/15 catch as per cent of TAC
Albany (Zones 1 and 2)	2,683	993	8	37.0%
Bremer Bay (Zone 3)	1,500	*	2	-
Esperance (Zone 4)	1,500	*	3	-
Total for Fishery	5,683	1,734	13	30.5%

** Insufficient vessels operated in 2014/15 so cannot be reported.*

EXTERNAL DRIVERS

Licensed operators in the Commonwealth Small Pelagic Fishery are permitted to take pilchards in waters adjacent to the West Australian coast line but none were taken in those waters in 2013/14, the last year reported for that fishery (Moore and Mazur 2015).

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TEMPERATE DEMERSAL GILLNET AND DEMERSAL LONGLINE RESOURCE STATUS REPORT 2016

M. Braccini and J. O'Malley

OVERVIEW

The Temperate Demersal Gillnet and Demersal Longline Fishery (TDGDLF) comprises the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF), which operates between 26° and 33° S, and the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLF), which operates from 33° S to the WA/SA border. Most of the operators employ demersal gillnets to target sharks with scalefish being a byproduct. Demersal longline is also permitted but is not widely used.

Gummy (*Mustelus antarcticus*), dusky (*Carcharhinus obscurus*), whiskery (*Furgaleus macki*), and sandbar (*C. plumbeus*) sharks are the main shark species targeted (~80% of the fisheries' shark catch) and they have been identified as indicators for the status of the temperate shark 'suite' because they represent the range of life history strategies of other shark species caught by these fisheries. For further details see Braccini *et al* (in prep) and SAFS (2016).

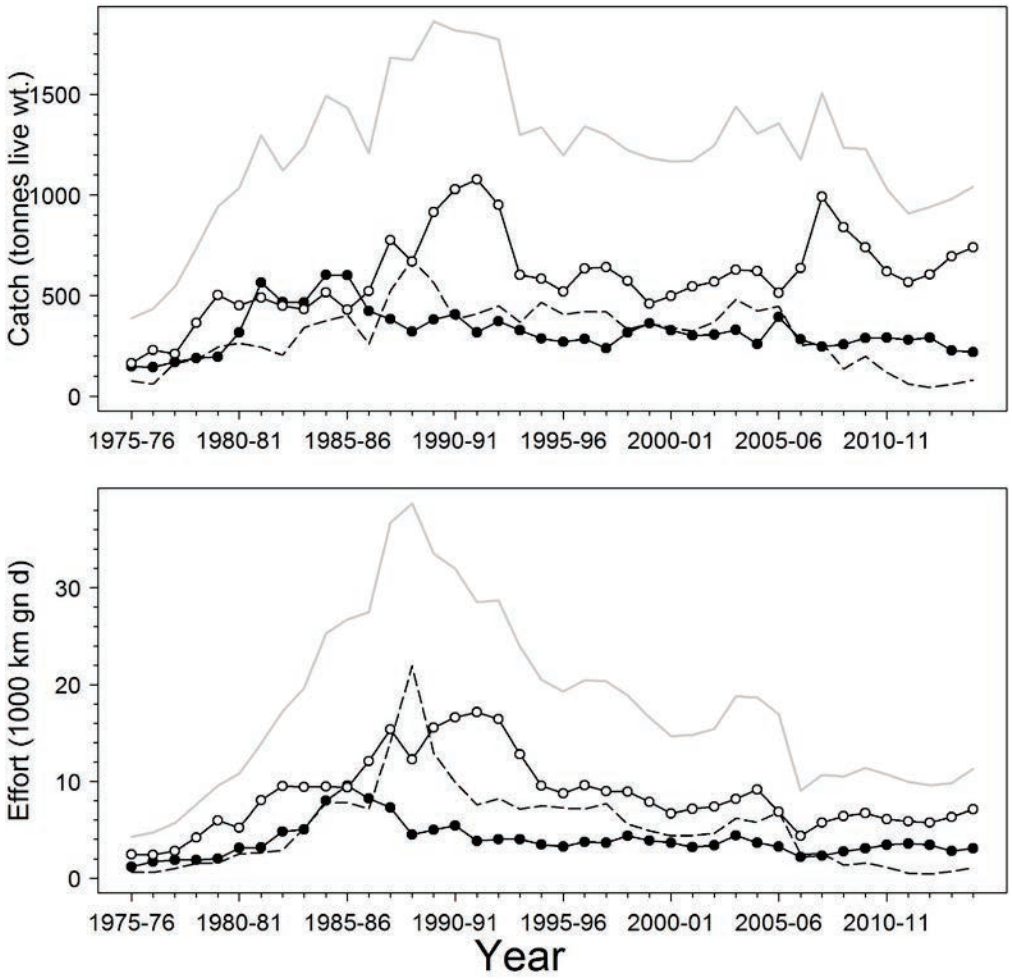
SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2014-15			
Sharks and rays[*]	1040 t	< 5% of commercial catch	
Scalefish[*]	156 t		
Fishing Level	Acceptable	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Sharks South & West	Sustainable - Recovering	Annual: Catch, CPUE; Periodic: Total Biomass	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low Risk	**Listed Species**	Negligible-Low Risk
Habitat	Negligible Risk	**Ecosystem**	Low Risk
Social	Medium Social Amenity and Severe Social Risk	**Economic**	GVP Level 3. ($5-10 million)
Governance	Moderate Risk	**External Drivers**	Moderate Risk

**All reported weights are live weight*

CATCH AND LANDINGS

For the TDGDLF, elasmobranch reported catches and fishing effort peaked during the late 1980s and early 1990s and have stabilised at much lower levels in recent years (Temperate Demersal Figure 1). The catch of sharks in other WA commercial fisheries is **negligible** (< 10 t). Additionally, recreational fishers retain very small numbers of sharks in WA (Ryan *et al*. 2015). Scalefish catches are reported in the West Coast and South Coast Demersal Scalefish Resource Status Report chapters, respectively. For a detailed historic account of shark catch and effort in WA refer to Braccini *et al*. (in prep.).



TEMPERATE DEMERSAL FIGURE 1. *Total elasmobranch catches, and demersal gillnet and longline effort (in km gillnet days, km gn d). Black circles = JASDGDLF Zone 1; white circles = JASDGDLF Zone 2; dashed black line = WCDGDLF; plain grey line = total from the three management zones.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Based on the available evidences, the current status of the whiskery and gummy shark stocks is **adequate** whereas the dusky and sandbar shark stocks are currently **recovering**. It is highly likely that the four stocks are above the point where recruitment would be impaired by the operations of the TDGDLF.

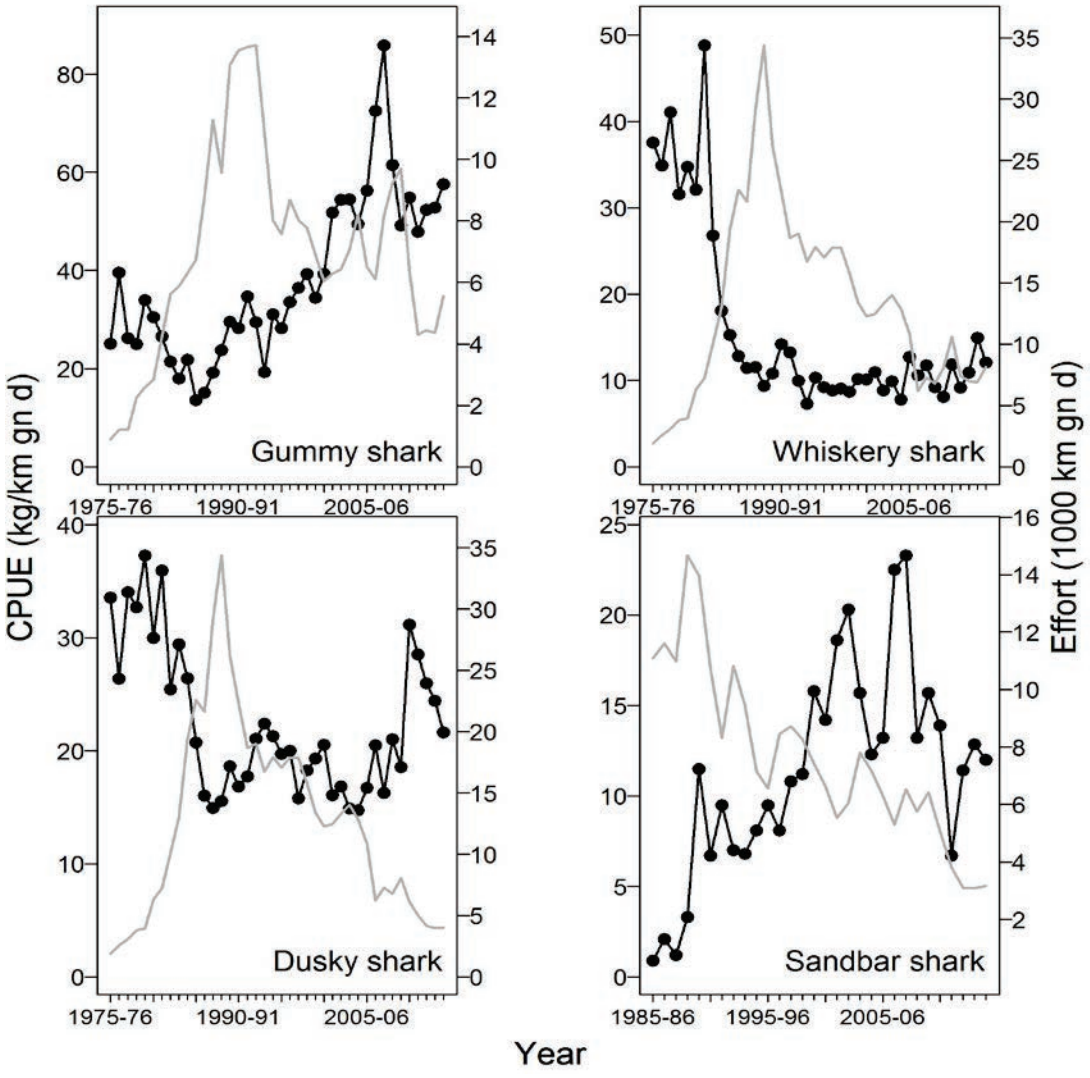
The most recent stock assessment for gummy sharks estimated the 1997-98 biomass at 42% unfished levels, which is above the 40% target. Effective (i.e. the regions of the fisheries that overlap each species' primary distribution) CPUE has increased since the mid 1980s (Temperate Demersal Figure 2). As gummy shark catches are almost exclusively comprised of large juveniles and adults, this trend suggests that breeding biomass has increased following reductions in demersal gillnet fishing effort commencing in 1992.

For dusky shark, catches comprise mostly of neonates and one to two year old fish. Effective effort has significantly declined since the late 1980s (Temperate Demersal Figure 2), recent catches (which include catches of bronze whaler, *C. brachyurus*, which cannot be accurately separated in catch returns data prior to 2006/07) have been reduced to approximately half of the quantity determined to be sustainable in 1994-95 and 1995-96 and comprehensive measures to mitigate cryptic mortality of older dusky sharks that have been introduced since 2006. Hence, current management arrangements are considered suitably to allow gradual recovery of the breeding stock. The recent decline in effective CPUE (Temperate Demersal Figure 2) will be

considered in more detail during development of the new stock assessment models (Braccini *et al*. in prep.).

For whiskery shark, the most recent stock assessment estimated the 2009-10 biomass at 52% unfished levels, which is above the 40% target level. Significant decline in effective CPUE in the early 1980s (Temperate Demersal Figure 2) is likely a result of changes in targeting practices (Simpfendorfer *et al*. 2000). Since the 1990s, the effective CPUE has remained stable, with a moderate increase in recent years. For sandbar shark, effective effort has significantly declined since the late 1980s and the effective CPUE has shown an increasing trend between mid 1980s and mid 2000s and has fluctuated subsequently at relatively high levels trend ever since. Sandbar shark catches in the TDGDLF since 2008/09 have been at levels that would allow a gradual recovery of the breeding stock.

For gummy and whiskery sharks, the current level of fishing pressure is such that the biological stocks are classified as **adequate**. For dusky and sandbar sharks, the above evidence indicates that the current level of fishing pressure should allow the stocks to recover from overfishing. The biological stocks are classified as **recovering**.



TEMPERATE DEMERSAL FIGURE 2. *Effective effort (grey line) and CPUE (black circles) by species.*

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch: The TDGDLF have low levels of discarded bycatch of unsaleable species of sharks, rays and scalefish (McAuley & Simpfendorfer 2003). 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 has reduced. Based on ESD risk assessment of these fisheries, all fishery impacts on stocks of bycatch species impose a **low risk** to their ongoing sustainability.

Protected Species: The TDGDLF have low interactions with listed species (McAuley & Simpfendorfer 2003). For 2014-15, fishers reported catching and releasing 3 dead muttonbirds, 4 dead and 20 alive grey nurse sharks, and 3 dead and 16 alive white sharks and are therefore considered **negligible-low risk**. For a detailed description of species interactions refer to Braccini *et al*. (in prep).

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat: The level of effort in the TDGDLF is such that the gear is deployed infrequently over approximately 40% of the fisheries' areas and under normal circumstances the physical impact of the gear on the benthic habitat 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 these gears annually therefore representing a **negligible risk** to benthic habitats.

Ecosystem: There is no evidence of any systematic change in species diversity, richness or trophic index (Hall & Wise 2011), indicating that the TDGDLF is not having a material impact on food chain or ecosystem structure therefore representing a **low risk** to the ecosystem. For a detailed description of habitat and ecosystem effects refer to Braccini *et al*. (in prep).

SOCIAL AND ECONOMIC OUTCOMES

Social

Fishing returns reported that between 68 and 79 skippers and crew were employed in the JASDGDLF and between 14 and 15 skippers and crew were employed in the WCDGDLF during 2014-15. As sharks are generally not targeted by recreational fishers in Western Australia, their direct social importance to this group is **negligible**. However, at the community level the capture of sharks generates a high level of community interest and debate, creating **medium** social amenity and **severe** social risk.

Economic

Shark meat is mostly sold in the Western Australian fish and chip shop market (WCDGDLF and Zone 1 of the JASDGDLF) or sold to wholesalers in Adelaide and Melbourne (Zone 2 of the JASDGDLF). However, anecdotal evidence suggest that recent tourism expansion in the South West of the State may have resulted in a higher proportion of shark meat having been sold to restaurants and fish retailers around landing ports. The estimated annual value (to fisheries) for 2014-15 is $4.7 and $0.4 million for JASDGDLF and WCDGDLF, respectively (GVP level 3).

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

All key shark species: 725 - 1,095 t (gummy shark: 350 - 450 t; dusky shark: 200 - 300 t; whiskery shark: 175 - 225 t; sandbar shark: < 120 t).
The catch levels of both the commercial and recreational sectors indicate that the fishery performance for both sectors is considered **acceptable**.

For 2014-15, total elasmobranch catches were within target range, similar to previous years and considered acceptable given effort levels. Total gummy, dusky, sandbar and whiskery shark catches were 492 t, 197 t, 46 t, and 147 t, respectively. As gummy shark CPUE appears to have been maintained at a relatively high level since the mid 2000s, this year's catch is still considered acceptable with no concern for the stock. Whiskery catch was maintained below historical allowable levels due to reductions in targeted effort.

Harvest Strategy

While there is currently no formalised harvest strategy developed for the TDGDLF, the operational management objective of the TDGDLF has been 'to maintain the biomass of the fisheries' for the three traditional target stocks (gummy, whiskery and dusky sharks) at or above 40% of their unfished levels'. Management is via input controls in the form of transferable time/gear effort units and restrictions on mesh and hook sizes, net height ('drop') and maximum net length.

Maximum acceptable effort levels for each management zone have been based on their respective 2001/02 (daily) levels (Zones 1 & 3 of the JASDGDLF: 84,075 km gn.hr -1 or 3,503 km gn.d-1; Zone 2 of the JASDGDLF: 144,102 km gn.hr -1 or 7,205 km gn.d-1; WCDGDLF: 67,692 km gn.hr-1 or 2,832 km gn.d-1).

Compliance

TDGDLF vessels are fitted with an Automatic Location Communicator (ALC) that enables the Department to monitor vessels using a Vessel Monitoring System (VMS) and manage compliance with temporal and spatial closures. The Department also undertakes regular vessel inspections to ensure fishing is being undertaken in accordance with the governing legislation.

Consultation

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.

Management Initiatives

In 2015, the TDGDLF was reaccredited under Part 13 and 13A of the Environment Protection and Biodiversity Conservation Act 1999. The Wildlife Trade Operation export approval expires on 24 August 2018 and it carries conditions associated with addressing interactions between the TDGDLF and Australian sea lions (ASL). It was proposed that closures of 25km and 20km to gillnet fishing be implemented around identified ASL colonies in the WCDGDLF and the JASDGDLF respectively to meet these conditions. The State and Commonwealth are still in negotiations. For further governance details refer to Braccini *et al*. (in prep).

EXTERNAL DRIVERS

The TDGDLF key target species span multiple regional boundaries but risks to the stocks are currently **low** due to low catches from other fisheries or catches from tightly-managed fisheries (gummy sharks). Environmental drivers pose **low risk** to shark stocks. The main external risk to the viability of the TDGDLF is the introduction of Commonwealth Marine Reserves and future ASL closures.

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SOUTH COAST DEMERSAL SCALEFISH RESOURCE STATUS REPORT 2016

J. Norriss and S. Walters

OVERVIEW

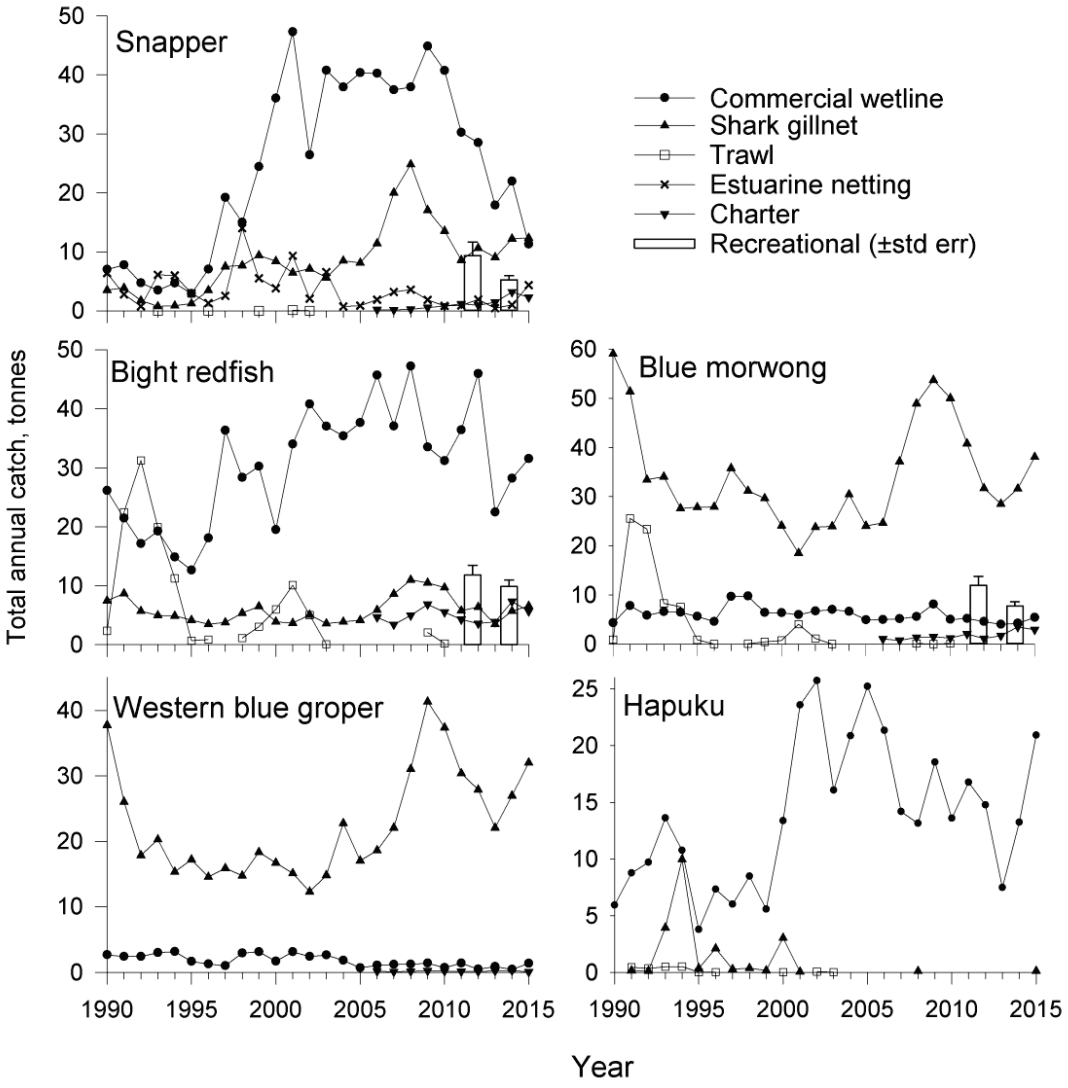
The south coast demersal scalefish resource (SCDSR) includes demersal species taken predominantly in marine waters deeper than 20 metres in the South Coast Bioregion (SCB). Indicator species are snapper (*Chrysophrys auratus*), Bight redfish (*Centroberyx gerrardi*), blue morwong (*Nemadactylus valenciennesi*), western blue groper (*Achoerodus gouldii*) and hapuku (*Polyprion oxygeneios*). The commercial wetline sector takes these species predominantly by hook and line. The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLMF), which uses demersal gillnets to take mostly sharks, also takes demersal scalefish as a legitimate part of their catch, particularly blue morwong and western blue groper (see Temperate Demersal Gillnet and Demersal Longline Fisheries Resource Status Report). Recreational and charter catches are almost exclusively boat-based using hook and line.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	194 t	34 t (2013/14, top 10 species).	
Fishing Level	Acceptable	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Inshore Demersal	Sustainable - Adequate	Annual: Catch, Fishing Mortality, SPR	
Offshore Demersal	Sustainable - Adequate	Annual: Catch, Fishing Mortality	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low Risk	**Listed Species**	Negligible Risk
Habitat	Negligible Risk	**Ecosystem**	Low Risk
Social	Moderate Amenity	**Economic**	GVP $1-5 million
	High Risk		Moderate Risk
Governance	Under Review	**External Drivers**	Moderate Risk

CATCH AND LANDINGS

Commercial catches of SCDSR indicator species have increased over the last two years following low catches around 2013, with the exception of snapper which has seen reduced catches over the last five years (South Coast Demersal Figure 1). Surveys of boat based recreational fishing show the catch by that sector is substantial for snapper, Bight redfish and blue morwong (Ryan *et al*. 2015).



SOUTH COAST DEMERSAL FIGURE 1*: Annual catches by sector for each demersal indicator species in the South Coast Bioregion since 1990.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Demersal species on the south coast are typically long lived (≥24 years) and slow growing, making them inherently vulnerable to overfishing. Snapper in the SCB, and Bight redfish throughout their distribution in southern WA, comprise single genetic stocks. The stock structure of the other three indicator species is less well known.

Inshore Demersal (Sustainable-Adequate)

A weight-of-evidence assessment that incorporated catch-at-age sampling in 2013 and 2014 indicated risk profiles to be medium for snapper, Bight redfish and blue morwong, and low for western blue groper, i.e. the levels of breeding stock for these species were therefore considered **adequate** (Norriss *et al*. 2016).

Snapper and Bight redfish (Sustainable-Adequate)

Age-based estimates of fishing mortality (F) and spawning potential ratio (SPR) show these parameters were unlikely to have breached management intervention threshold levels (1.0 and 0.30, respectively), and only a remote chance of breaching the limit reference points (1.5 and 0.20 respectively). However, any significant increase in catch beyond recent historical levels would constitute an unacceptable risk.

Blue morwong (Sustainable-Adequate)

Age-based estimates of F and SPR for females show an almost zero likelihood of breaching the management intervention threshold levels (1.0 and 0.30, respectively). Males were unlikely to have breached these thresholds and there was only a remote likelihood they breached the limit reference points (1.5 and 0.20 respectively). There is only a slight capacity for increased catches beyond recent historical levels before risk levels become unacceptable.

Western blue groper (Sustainable-Adequate)

Age-based estimates of F (both sexes) and SPR for females shows an almost zero likelihood of breaching management intervention thresholds (1.0 and 0.30 respectively). The male SPR estimate showed that a breach of the threshold was unlikely and a breach of the limit reference point only a remote possibility. There is a small capacity for increased catches beyond recent historical levels before risk levels become unacceptable.

Offshore Demersal (Sustainable-Adequate)

Hapuku

An age-based assessment estimated F to be within target and threshold levels, suggesting harvest rates in 2005 and 2006 were sustainable (Wakefield *et al*. 2010). However, if longevity of south coast hapuku is found to be older than currently recorded and in fact approaches what is known elsewhere, then those harvest rates were likely to be at sustainable limits, indicating a level of uncertainty about the status of the resource.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Line fishing for demersal species using baited hooks is highly selective for demersal scalefish, with only low levels of catches of non-retained species. Interactions with protected species are **negligible**.

HABITAT AND ECOSYSTEM INTERACTIONS

Line fishing using baited hooks has little physical impact on the benthic environment and therefore constitutes a negligible habitat risk. An analysis of a long time series of commercial fishery data showed no reduction in mean trophic level in the finfish catches within the SCB (Hall and Wise 2011).

SOCIAL AND ECONOMIC OUTCOMES

Social

A recent survey of recreational boat based fishing estimated annual fishing effort in the SCB to be 28,277 boat days (Ryan *et al*. 2015). In recent years approximately 50 to 60 commercial wetline vessels have each employed up to about three crew. Several seafood processors in the SCB and in Perth have also provided employment.

Economic

The estimated gross value of product (GVP) for the SCDSR in 2015 was level 2 ($1-5 million). There is currently a **moderate** level of risk to this level of return.

GOVERNANCE SYSTEM

The commercial wetline sector is not subject to specific legislative management arrangements (Notice or Management Plan) although this is currently under review (see below). The recreational sector is managed through a range of input and output controls such as bag and size limits authorised under the Fish Resources Management Act 1994 and Fish Resources Management Regulations 1995.

Allowable Catch Tolerance Levels (Acceptable)

Not developed, but a recent stock assessment recommended catches remain within recent historical limits (Norriss *et al*. 2016).

Harvest Strategy

A formal harvest strategy has not been developed for this resource.

Compliance

Fisheries and Marine Officers conduct both at-sea and on-land inspections.

Consultation

A broad consultation process is currently in progress as part of a review of management arrangements for the SCB wetline sector (see Management Initiatives/Outlook Status below). Consultation with commercial wetline fishers occurs directly on operational issues. For the recreational sector, consultation processes are facilitated by Recfishwest under a Service Level Agreement although the Department undertakes

direct consultation with the community on specific issues.

Management Initiatives (Under Review)

A review of South Coast commercial fish trap, G-net and open-access line, net and squid jig fisheries commenced in December 2013. As part of this review a discussion paper was released for public consultation on the Department's proposed future direction for management of these fisheries (DoF 2015). Following this discussion paper process, the Minister for Fisheries approved the development of a South Coast line, fish trap and squid jig managed fishery and a South Coast nearshore net managed fishery. In February 2016, an Independent Access Panel (IAP) was engaged by the Department to provide recommendations relating to access to the proposed new fisheries. The IAP released a draft report with proposed access criteria recommendations in August 2016 for public consultation. Following consideration of the comments the IAP will review and submit their final report to the Department. The Department will then provide advice (including the IAP's final report) to the Minister for Fisheries for his in-principle decisions regarding access criteria for these fisheries. Following the Minister's decision, the two new management plans will be developed and will be informed by the recent stock assessment of snapper, Bight redfish, blue morwong and western blue groper stocks on the South Coast (Norriss *et al*. 2016).

EXTERNAL DRIVERS

Bight redfish are an important component of the catch of the Great Australia Bight Trawl Sector, a Commonwealth managed fishery permitted to operate across southern Australia as far west as Cape Leeuwin. Their 2014/15 season Bight redfish catch was 218 t, predominantly in waters off South Australia but also from the western Great Australian Bight off the WA coast (Moore and Cutotti 2015). Otolith chemistry has shown that Bight redfish from the waters surrounding Albany and Esperance constitute separate stocks to those of the main South Australian fishing grounds.

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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 ACTIVITIES POTENTIALLY IMPACTING THE BIOREGION

Commercial Fishing

The main water body in the Northern Inland Bioregion, Lake Argyle, is a man-make lake in the East Kimberley that was formed in 1973, following the completion of the Ord River Dam. The lake supports the State's only commercial freshwater fishery, the Lake Argyle Silver Cobbler Fishery (LASCF). In Lake Argyle, silver cobbler (*Neoarius midgleyi*) is an enhanced stock, which has become numerous since the Ord River dam was first filled to capacity in the 1974 wet season. The LASCF uses gillnets to specifically target this species.

Recreational Fishing

Relative to the commercial catch, indications are that the total recreational catch of silver cobbler is small. A small recreational and charter boat fishery for this species exists in Lake Argyle with fishing activities peaking during the dry season (winter months). The 2013/14 iSurvey of boat-based recreational fishing in WA indicated that silver cobbler are targeted mainly by hook and line fishing, with the majority of fish being released after capture. A single charter vessel has been operating in Lake Argyle since 2001, with very few silver cobbler being retained in recent years (only 11 fish in 2012).

Lake Argyle and its associated river system also support recreational fishing for the freshwater component of the barramundi stock and cherabin (freshwater prawns). Limited surveys of recreational fishing in this region have been completed. An integrated recreational survey of boat-based fishers (iSurvey) has recently provided bioregional-wide estimates of catches of all species.

Aquaculture

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.

Tourism

A viable tourism industry operates on Lake Argyle, with boat operators, helicopter and plane flights, fishing, canoeing and bird watching. There is recreational boating usage on the Lake including skiing and swimming.

Other Factors

While the Lake was created to supply water for irrigation and hydroelectric power generation in the Ord River Irrigation Area, it is also a source of water for supplying mining operations, town water supplies and a large number of industrial operations.

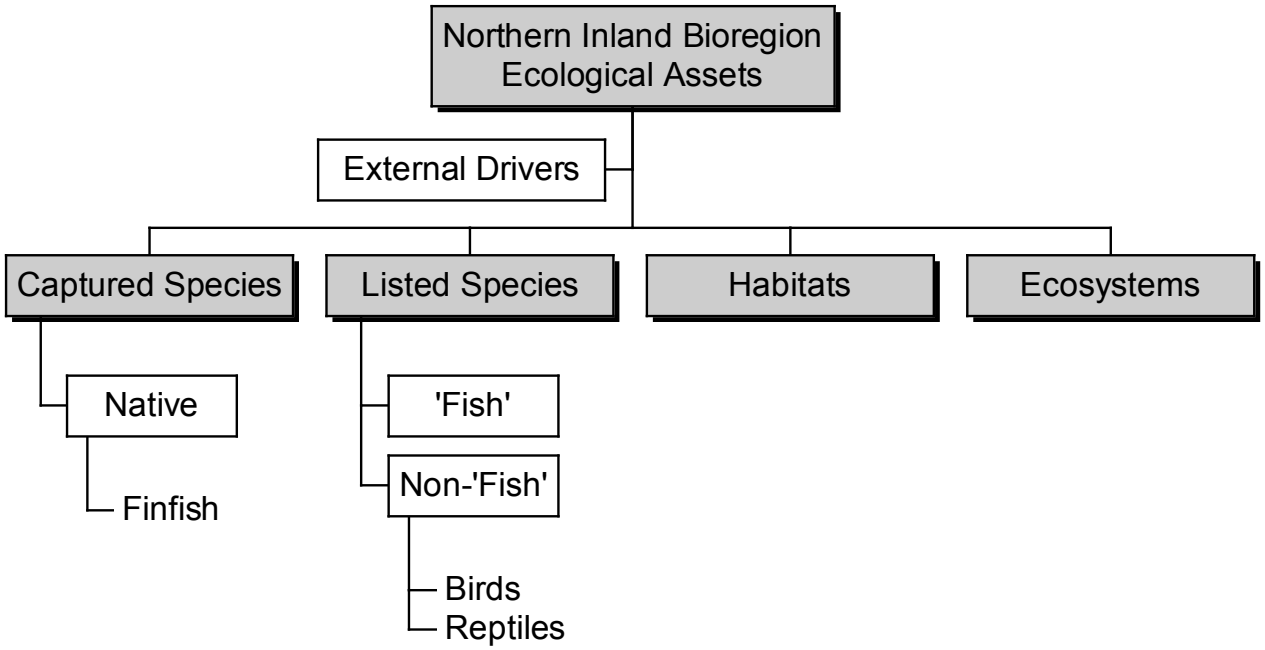
BIOREGIONAL SPECIFIC ECOSYSTEM MANAGEMENT

Within each Bioregion there are a range of management measures that have been implemented to manage the potential impact of activities (See the Ecosystem Management Section for an overview).

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 in the Northern Inland Bioregion associated with this activity.

ECOSYSTEM MONITORING AND STATUS

In order to assess the adequacy of management arrangements aimed at ensuring sustainability of the ecological assets within the Northern Inland 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) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment. (*See How to Use section for more details*). The key ecological assets identified for the Northern Inland Bioregion are identified in Northern Inland Overview Figure 1 and their current risk status reported on in the following sections.



NORTHERN INLAND ECOSYSTEM MANAGEMENT FIGURE 1

Component tree showing the ecological assets identified and separately assessed for the Northern Inland Bioregion.

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 (e.g. floods and droughts) is necessary to fully assess the performance of the ecological resource. The main external drivers identified with potential to affect the Northern Inland Bioregion include climate and introduced pests and diseases.

Climate

External Drivers	Current Risk Status
Climate	MODERATE

The Northern Inland Bioregion is predicted to have relatively minor impacts from climate change,

especially in the coming decade, compared to more southerly locations.

Introduced Pests and Diseases

External Drivers	Current Risk Status
Introduced Pests	NEGLIGIBLE
Introduced diseases	NEGLIGIBLE

There is currently minimal activity in this region that will generate risks from pests or diseases.

Captured Species

Finfish

Captured Species	Aquatic zone	Ecological Risk
Native Finfish	Freshwater	LOW

The LASCF operates throughout Lake Argyle using gillnets to target silver cobbler (*N. midgleyi*). Gillnets have a relatively low habitat impacts, and fishers actively avoid fishing in areas where the nets may become entangled on submerged vegetation. Therefore, the Fishery is considered to be a negligible risk to the habitats of Lake Argyle. As silver cobbler is essentially the only retained species, the main impacts of the fishery on the ecosystem are likely to be due to the removal of individuals of this species. The Fishery removes only a portion of the overall biomass of this species within the lake.

Listed Species

Fish

Listed Species	Aquatic zone	Ecological Risk
Fish	Freshwater	NEGLIGIBLE

The stocks of freshwater fish are not under threat.

Non-Fish

Listed Species	Aquatic zone	Ecological Risk
Birds and Reptiles	Freshwater	LOW

There is an incidental capture of freshwater or Johnston's crocodiles (*Crocodylus johnstoni*) and some tortoises by the LASCF. Where practicable freshwater crocodiles are released alive, however, there is an incidental mortality of some individuals.

Habitats and Ecosystems

Category	Aquatic zone	Current Risk Status
Habitats	Freshwater	NEGLIGIBLE
Ecosystems	Freshwater	NEGLIGIBLE

The Northern Inland Bioregion occurs north of Shark Bay (27o S), from the coast to the South Australian and Northern Territory borders. Within the Bioregion are a series of freshwater rivers and wetlands. Healthy wetlands and rivers have native fringing vegetation and aquatic plants and provide habitat for birds, frogs, reptiles, native fish and macroinvertebrates.

Lake Argyle, with its large capacity, deep water and rapidly fluctuating water levels, provides a range of habitats not available at the adjacent Lake Kununurra or downstream Ord River. Most of the eastern and southern shoreline of Lake Argyle is bare sediment, with highly variable water levels preventing the establishment of plants. There are areas of emergent sedges (*Eleocharis brassii*), as well as submerged aquatic plants such as *Myriophyllum spp*., *Najas tenuifolia* and *Potamogeton sp*. However, distribution is limited to localised patches where large weed mats can form. The western and northern shorelines are generally steeper and consist of rock exposed by wave action.

NORTHERN INLAND LAKE ARGYLE FINFISH RESOURCE STATUS REPORT 2016

S. Newman, G. Mitsopoulos and P. Dobson

OVERVIEW

The Lake Argyle Silver Cobbler Fishery (LASCF) is the only commercial freshwater fishery in Western Australia. This gillnet fishery is located in the artificially created Lake Argyle in the north-eastern Kimberley and specifically targets silver cobbler (*Neoarius midgleyi*), with catches of barramundi (*Lates calcarifer*) not permitted. A small recreational and charter boat fishery also operates in Lake Argyle and surrounding waters for silver cobbler and barramundi with fishing activities peaking during the dry season (winter months).

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.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2016	91 t	NA
Fishing Level	Acceptable	Acceptable

Stock/Resource Performance	Stock Status	Assessment Indicators
Northern Inland	Sustainable - Adequate	Annual: Catch, Catch Rate

EBFM Performance Asset	Level	Asset	Level
Bycatch	Negligible Risk	**Listed Species**	Low Risk
Habitat	Negligible Risk	**Ecosystem**	Negligible Risk
Social	Low Risk	**Economic**	Level 1 (<$1 million)
Governance	Stable	**External Drivers**	Low Risk

CATCH AND LANDINGS

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 and 118 t. In 2015, the catch of silver cobbler was 91 t.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Northern Inland (Sustainable-Adequate)

Data for assessing the status of the silver cobbler stock in Lake Argyle are derived from the catch and effort returns provided by industry. These data are compiled annually and used as the basis for this assessment. Biological data on the species' specialised reproductive behaviour and low fecundity are used to interpret these assessments. There remains uncertainty around the biological parameters (e.g. longevity, growth rate) for silver cobbler.

The level of catch in the fishery in 2015 is marginally below the acceptable catch range. This level of catch is considered acceptable as the

effort in the fishery is relatively low and catch rate is within the historical range. The lower level of catch in the fishery in recent years is likely to have allowed the stock to increase and it is thus considered **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

As a result of the large mesh size used relative to the species present in the lake, there is minimal fish by-catch in this fishery.

Although Lake Argyle is an artificially-created aquatic environment it is now designated as a wetland of international importance under the Ramsar Convention. There is an incidental capture of freshwater or Johnston's crocodiles (*Crocodylus johnstoni*) and some tortoises by the silver cobbler fishery in Lake Argyle. Where practicable, freshwater crocodiles are released alive and based on the reports by fishers, only low levels of crocodile capture occur and this is considered to be of **low risk** to the stock.

HABITAT AND ECOSYSTEM INTERACTIONS

The gillnets used in this fishery have minimal impact on the habitat. This results in a **negligible risk** to the overall ecosystem from the fishery.

SOCIAL AND ECONOMIC OUTCOMES

Social

During 2015, four vessels fished in the LASCF, with an average crew of two people per vessel, indicating that eight people were directly employed in the fishery. Additional employment occurs throughout the fish processing and distribution networks.

Economic

The fishery's score value in 2015 was estimated to be Level 1 (i.e. Risk level – **Low**; Economic value – < $1 million). There is limited social amenity value for the silver cobbler fishery. There is currently a **low** level of risk to these values.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels (Acceptable)

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 catch range is specified as the values within the minimum and maximum catches observed during the reference period. The target catch range is 93 – 180 t. The level of catch in the fishery in 2015 is marginally below the target acceptable catch range, due to relatively low effort. The catch rate is within the historical range and the lower level of catch in the fishery in recent years is likely to have allowed the stock to increase and it is thus considered **adequate**.

Harvest Strategy

The harvest strategy for silver cobbler in the Lake Argyle Silver Cobbler Fishery in the Northern Inland Bioregion of Western Australia is based on a constant commercial catch policy where the annual commercial catches of silver cobbler are allowed to vary within the target catch range.

Compliance

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. These nets must have a minimum mesh size of 159 mm and maximum net drop of 30 meshes.

The management arrangements for the fishery are contained in the *Prohibition on Commercial Fishing (Lake Argyle) Order 2012*. The six Fishing Boat Licences listed are prohibited from taking any fish 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.

Consultation

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

Management Initiatives (Stable)

The next management review for the Fishery is scheduled for 2016/2017. The LASCF underwent MSC pre-assessment in 2014.

EXTERNAL DRIVERS

A number of external factors may impact on silver cobbler biomass. These include the introduced cane toad (*Rhinella marina*) which was first observed in Lake Argyle and may affect prey and predators of silver cobbler.

The population of the freshwater crocodile (*Crocodylus johnsoni*) has increased and is likely to impact silver cobbler biomass in the form of predation and competition for food. The external drivers pose a **low risk** to the stock.

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 ACTIVITIES POTENTIALLY IMPACTING THE BIOREGION

Commercial Fishing

There are currently no commercial fisheries in the Southern Inland Bioregion.

Recreational Fishing

The Southern Inland Bioregion 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

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.

Tourism

The bioregion is a popular tourist destination with known for its national parks and wineries. Recreational fishing in the regions lakes, rivers is also important for both residents and tourists.

BIOREGIONAL SPECIFIC ECOSYSTEM MANAGEMENT

Within each Bioregion there are a range of management measures that have been implemented to manage the potential impact of activities (See the Ecosystem Management Section for an overview). Management measures specific to the South Inland Bioregion are detailed below.

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

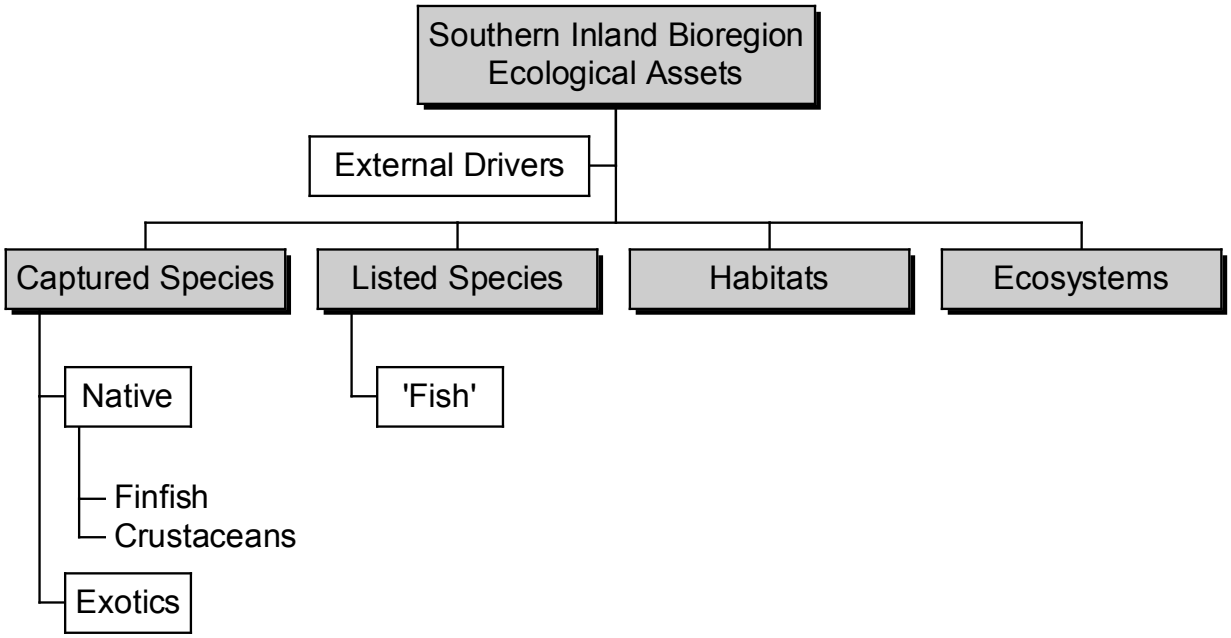
and associated funding sources to mitigate environmental impacts and so better protect native fish species. This is being facilitated by the recent establishment of the Freshwater Ecosystem Working Group which aims to coordinate a whole-of -Government approach to the management of freshwater ecosystems 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 MONITORING AND STATUS

In order to assess the adequacy of management arrangements aimed at ensuring sustainability of the ecological assets within the Southern Inland 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) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment. (See How to Use section for more details). These key ecological assets identified for the Southern Inland Bioregion are identified in Southern Inland Overview Figure 1 and their current risk status reported on in the following sections.



SOUTHERN INLAND ECOSYSTEM MANAGEMENT FIGURE 1

Component tree showing the ecological assets identified and separately assessed for the Southern Inland Bioregion.

External Drivers

External drivers 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 (e.g. floods and droughts) is necessary to fully assess the performance of the ecological resource. The main external drivers identified with potential to affect the Southern Inland Bioregion include climate (i.e. a drying climate) and introduced pests and diseases.

Climate

External Drivers	Current Risk Status
Climate	MODERATE

Climate effects are likely to be generated with reduced rainfall expected for this region.

Introduced Pests and Diseases

External Drivers	Current Risk Status
Introduced Pests	HIGH
Introduced Diseases	LOW

A high number of other exotic fish species have been released into the South West catchments e.g. red fin and cichlids. There is an assessment program underway to determine the extent of this and which of these events can be addressed by eradication.

Captured Species

Native Finfish

Captured Species	Aquatic zone	Ecological Risk
Native Finfish	Freshwater	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).

Native Crustaceans

Captured Species	Aquatic zone	Ecological Risk
Native Crustaceans	Freshwater	HIGH (non-fishing)

The abundance of smooth marron (*C. cainii*) 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

Captured Species	Aquatic zone	Ecological Risk
Exotics (stocked)	Freshwater	MODERATE (non-fishing)

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

Fish **Crustaceans are classified as fish under the FRMA 1994*

Listed species	Ecological Risks
Western minnow	SIGNIFICANT (non-fishing
Hairy marron*	SIGNIFICANT (fishing)
Hairy marron*	SIGNIFICANT (non-fishing

Western minnow (*G. occidentalis*) were successfully bred in captivity by the department.

Poaching of hairy marron (*C. tenuimanus*) from the upper reaches of Margaret River has been observed despite a ban on all marron 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.

Habitats and Ecosystems

Habitat/Ecosystem	Aquatic zone	Current Risk Status
Habitat	Freshwater	HIGH (non-fishing)
Ecosystems	Freshwater	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. In addition there is concern that climate change may lead to a drying climate that could potential alter the habitats and ecosystems in the bioregion.

SOUTH-WEST RECREATIONAL FRESHWATER RESOURCE STATUS REPORT 2016

R. Duffy, F. Trinnie and K. Ryan

OVERVIEW

The Southern Inland Freshwater Fishery (SIFF) Resource incorporates the Marron Fishery and the South West Recreational Freshwater Angling (SWRFA) fishery. Both fisheries are managed with separate recreational licenses and rules around seasons, bag limits, size limits and area closures. Combined, the license fees have a value of approximately $1 million.

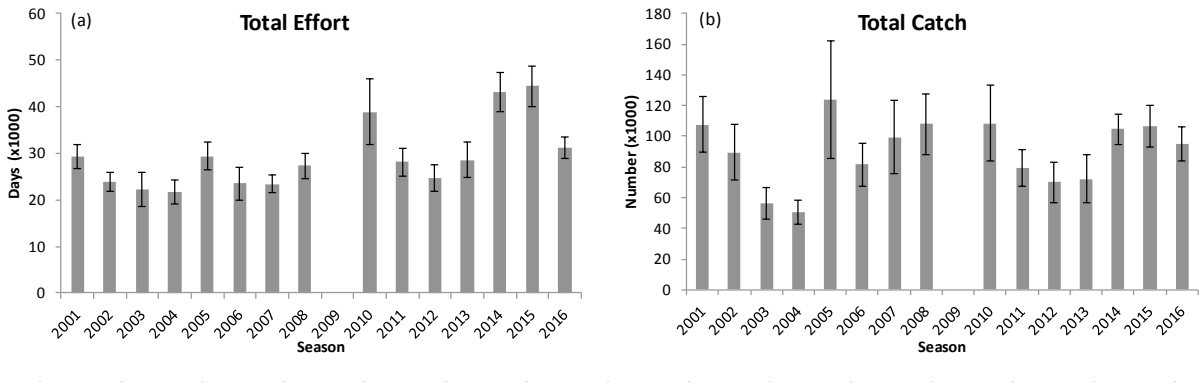
SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	NA	Marron: 56,155 (±5,817 s.e.) Marron SWRFA: 94,972 (± 11,043 s.e.) Fish	
Fishing Level	NA	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**	
Marron	Sustainable - Adequate	Annual: Recreational Catch, Effort, CPUE; Fishery Independent Stock Assessment	
Trout	Sustainable - Adequate	Annual: Number Stocked	
EBFM Performance			
Asset	**Level**	**Asset**	**Level**
Bycatch	Low Risk	**Listed Species**	Severe Risk
Habitat	Medium Risk	**Ecosystem**	Low Risk
Social	High Amenity Medium Risk	**Economic**	NA
Governance	Stable	**External Drivers**	Severe Risk

CATCH AND LANDINGS

Marron (*Cherax cainii*): The total catch for the 2016 season was estimated to be 56,155 (±5,817) marron. This was substantially lower than the catch in 2015 of 70,807 (±5,650 s.e.). The overall catch per unit effort (CPUE) of 3.41 (±0.24 s.e.) in 2016 was not significantly different from the CPUE of 3.44 (±0.20 s.e.) in 2015. Lower catch can be attributed to fewer active fishers in 2016 vs 2015 (5,688 vs 7,161). Serious fires occurred during the 2016 marron season that severely restricted access to a number of marroning sites, explaining the drop in fisher participation.

SWRFA: The estimated number of licensed fishers in 2016 (9,918) was down slightly on 2015 (10,759), however it remained around the long-term average (Recreational Fishery Figure 1a). Fishing effort was lower in 2016 compared to 2015 (31,106 days in 2016 vs. 44, 387 days). The estimated total recreational catch from SWRFA across all species for 2016 was 94,972 (±11,043 s.e.) fish of which 52,794 (±7,873 s.e.) were kept and 42,178 (±6,673 s.e.) were released. This was a decrease from 2015, where the estimated total recreational catch was 106,612 fish (Recreational Fishery Figure 1b).



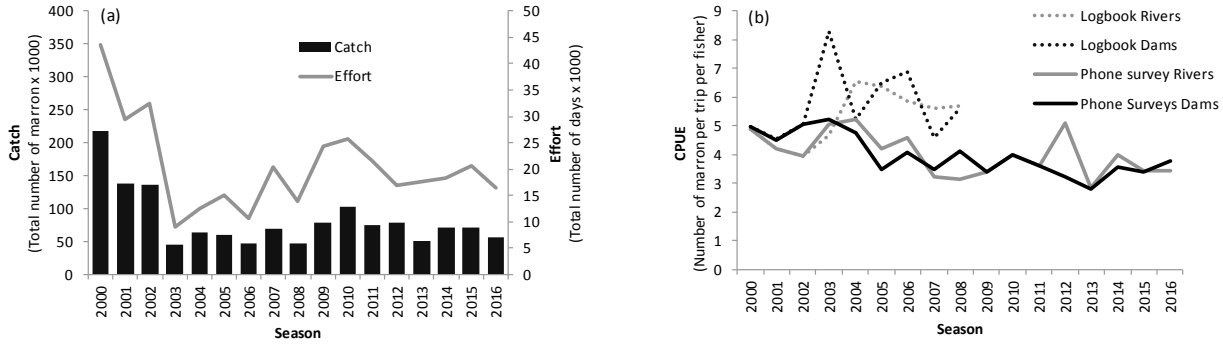
RECREATIONAL FISHERY FIGURE 1. *Estimated total effort in days (a) and total number of fish caught (b) from 2001 to 2016 for the SWRFA fishery.*

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Marron (Sustainable-Adequate)

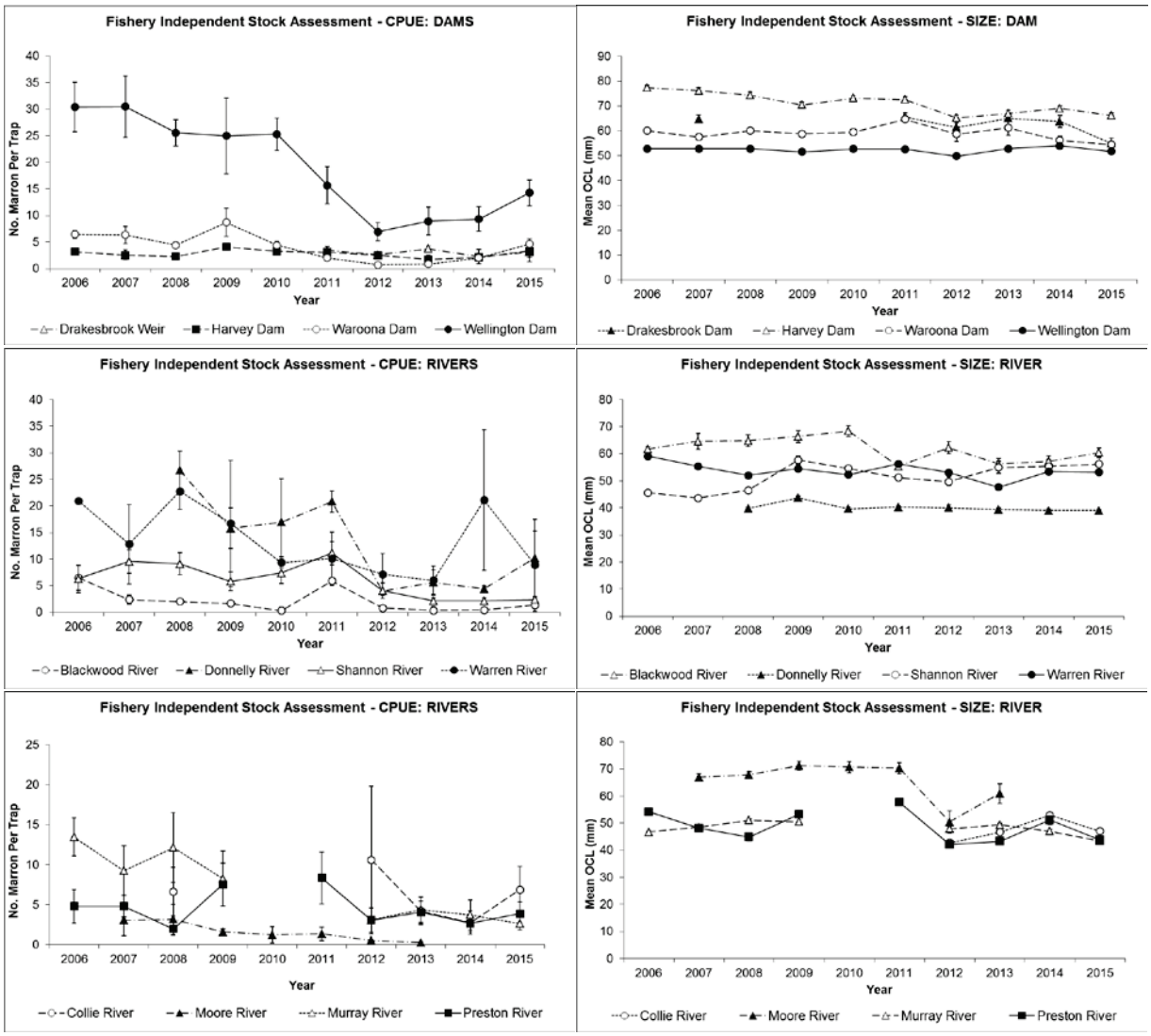
Smooth marron (*Cherax cainii*), are the third largest crayfish in the world and endemic to Western Australia (Beatty *et al*. 2016). The Marron Fishery is composed of many discrete populations (Beatty *et al* 2016) that exhibit biological and life history traits that differ among systems (Beatty *et al* 2011), including fecundity (Beatty *et al* 2016) and growth (Lawrence 2007). Refer to Southern Inland Freshwater Fishery Resource Assessment Report (RAR) for further information.

The total number of licensed fishers in 2016 (14,006) was slightly lower than 2015 (14,357). The number of license holders and the proportion that actually fished for marron in 2016 (5,688 active fishers, 39% of license holders) was lower than 2015 (7,161 active fishers, 48% of license holders). As a result, total effort was also less in 2016 (16,433 days ±949 s.e.) compared to 2015 (20,609 days ±1,182 s.e.) but similar to effort levels since 2011. The number of days fished per fisher was similar between 2016 (2.89 days ±0.17 s.e.) and 2015 (2.88 days ±0.17 s.e.). The estimated total recreational catch in 2016 (56,155 marron ±5,817 s.e.) was lower than 2015 (70,807 marron ±5,650 s.e.), however the overall catch per unit effort (CPUE) in 2016 (3.41 ±0.24 s.e.) was similar to 2015 (3.44 ±0.20 s.e.) (Recreational Fishery Figure 2). Therefore the reduction in catch was due to less people fishing, rather than people undertaking fewer fishing trips, or catching fewer animals. Distribution of fishing effort across particular rivers and dams is largely consistent across years, although some fluctuations occur. (Refer to RAR for further information.)



RECREATIONAL FISHERY FIGURE 2. *Estimated a.) recreational catch (numbers), effort (days), and b.) nominal CPUE of marron from 2000 to 2016 from phone surveys.*

Fishery independent survey data showed relative abundance of marron varied greatly among indicator sites (Recreational Fishery Figure 3). 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, receives more than 70% of all effort in dams (refer to RAR). Overall marron stocks are considered **adequate** due to stable recreational catch and CPUE, although fishery independent survey data suggests they are under pressure from environmental conditions, i.e. CPUE in the Shannon River, a system completely closed to fishing, shows a similar pattern to rivers where fishing occurs. However, there is also some evidence of site specific abundance reductions from fishery independent CPUE data. For more information refer to RAR (in prep.).

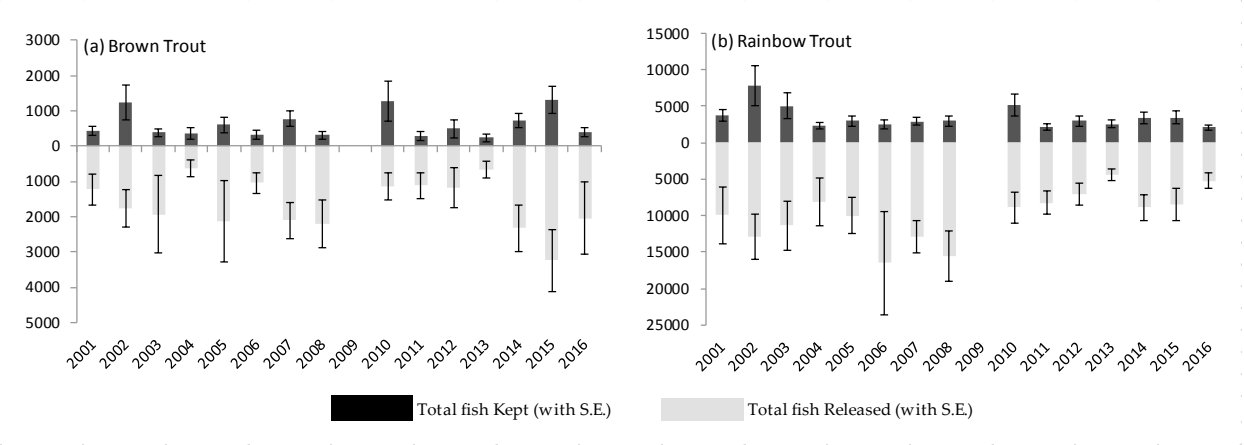


RECREATIONAL FISHERY FIGURE 3. *The relative abundance (CPUE) and size (mm OCL) of marron in four dams and eight rivers as determined by the fishery-independent stock assessment. Note: Missing values occur in years a site was not sampled.*

Trout (Annually Stocked)

Rainbow trout (*Oncorhynchus mykiss*) and Brown trout (*Salmo trutta*) are produced at the Pemberton Freshwater Research Centre Facility and released into rivers and dams of south-west WA. Wild self-sustaining populations are thought to be limited; therefore stock levels are dependent on release rates and are supplemented annually.

The total estimated recreational catch of each species in 2016, was generally lower than 2015, due in part to reduced effort. Overall, catches were within historical levels (Recreational Fishery Figure 4). For information on other freshwater fish species, refer to RAR (in prep.).



RECREATIONAL FISHERY FIGURE 4. *Total kept and released by species (a) Brown trout (b) Rainbow trout for 2001 to 2016 seasons.*

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch: The Marron Fishery also reports captures of 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. The introduced yabby also composes a small part of the fishery and carry some disease risks. There is little to no bycatch in the SWRFA due to the small size of non-target native species. Therefore the impact of the fishery on bycatch is a **low risk**.

Protected Species: Trout stocking occurs only in waterways where protected species are absent, therefore the fishery has no impact on protected species. Anecdotal evidence suggests that Redfin Perch, despite being feral, are still stocked and spread by fishers. Therefore they have the potential to negatively impact protected species through direct predation.

A second species of marron, the critically endangered hairy marron, *Cherax tenuimanus*, occurs only in Margaret River. In late 2002, recreational marron fishing within Margaret River, upstream of Ten Mile Brook Junction was prohibited to remove the impacts of fishing on the remaining hairy marron stocks. Illegal fishing is still recorded in this reach of the Margaret River by the Department, and combined with the small population size is considered a **severe risk**.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat: The major habitat impacts of the Marron Fishery and the SWRFA are litter in surrounding areas, and the trampling of riparian vegetation and subsequent bank erosion. However, they can also provide an environmental benefit through the removal of large numbers of feral redfin perch (*Perca fluviatilis*). Therefore, impact on habitat is considered a **medium risk**.

Ecosystem: The removal of legal-sized marron from freshwater rivers is unlikely to have a significant effect on ecosystem function, as the bulk of the marron biomass is below legal size and 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 ecosystem function.

Stocking of trout has occurred in WA waters for over 100 years. To minimise adverse impacts of trout on native species, they are stocked only in rivers where non-native fish species are also present, and protected species are absent. SWRFA is largely a lure and fly fishery, however there is a small risk to the ecosystem through bait collection, its use, the release of unwanted live bait (mainly for redfin perch), and potential to spread disease and parasites, e.g. Thelohania. Therefore the resource is considered to have a **low risk** to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

The Marron Fishery in particular is iconic, whilst the SWRFA has an enthusiastic base of fishers and a dedicated angling group, the Western Australian Trout and Freshwater Angling Association (WATFAA), therefore the resource has high social amenity. Both fisheries attract tourists to regional areas and a FRDC project is underway looking at the social drivers of the Marron Fishery.

The effect of reduced rainfall on the availability of marron habitat is expected to increase awareness of changes in climate patterns in the South-West. In 2015, the drying of Cardiff Town Pool, on the south branch of the Collie River, resulted in the death of a number of large marron and gained significant media attention. The Department is investigating how these situations can be managed in the future and as such it is identified as having a **medium risk**.

Economic

Licences fees for the SIFF in 2016 had an estimated value of $950,000 (marron licence: $550,000; SWFRA licence: $400,000). The SIFF fisheries are also likely to provide a significant economic boost to regional towns in the South-West. Economic risk is assessed on income from a resource. As this resource does not generate income, a risk score is not applicable.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels (Acceptable)

Marron: In 2006, the Recreational Freshwater Fisheries Stakeholder Subcommittee (RFFSS) proposed that, based on the available science the fishery be managed to a catch range of 96,000-136,000 marron. This level of catch has rarely been achieved with the exception of 2010, a year of extremely low rainfall. Recreational catch is proportionate to effort and fishery independent surveys do not indicate negative impacts of fishing on stocks, therefore catch is considered **acceptable** but will be reviewed.

SWRFA: There are no allowable catch and tolerance levels specified as trout are stocked annually.

Harvest Strategy

There are currently no formal harvest strategies for the marron or SWRFA fishery.

Compliance

Southern Region Fisheries and Marine Officers apply compliance through the delivery of an Operational Plan. Areas of high interest have been identified and patrols are designed to frequent those, and other areas. Patrol and compliance planning focuses on out-of-season illegal fishing, illegal use of fishing gear, and a high profile presence through the marron season. Compliance activities are supported by educational activities.

Consultation

Meetings between the Department of Fisheries, Recfishwest, Freshwater Fisheries Reference Group and freshwater fishers are held annually.

Management Initiatives (Stable)

No significant changes to the management arrangements are planned.

EXTERNAL DRIVERS (*Severe Risk*)

Rainfall in the south-west of Western Australia has declined by 10-15% since 1975 according to CSIRO models and it predicts an additional 7% decrease in rainfall by 2030 (CSIRO 2009). The decline has been most noticeable in autumn and early winter rains. The impact of reduced rainfall has included a greater than 80% reduction of runoff into dams. This has negative implications for rivers and lakes in the south-west and the associated fish and crustacean assemblages. The major impact of these changes will be through a reduction in habitat availability, with negative implications for fish and crustacean abundance. Reduced river flows inhibit movement, and combined with increasing salinity, could negatively impact populations of all freshwater species. In addition, the drying climate may lead to more frequent and higher intensity bushfires that can impact the fisheries through restricting fisher access, and associated impacts of fire and fire management methods on stream fauna.

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STATEWIDE BIOREGION

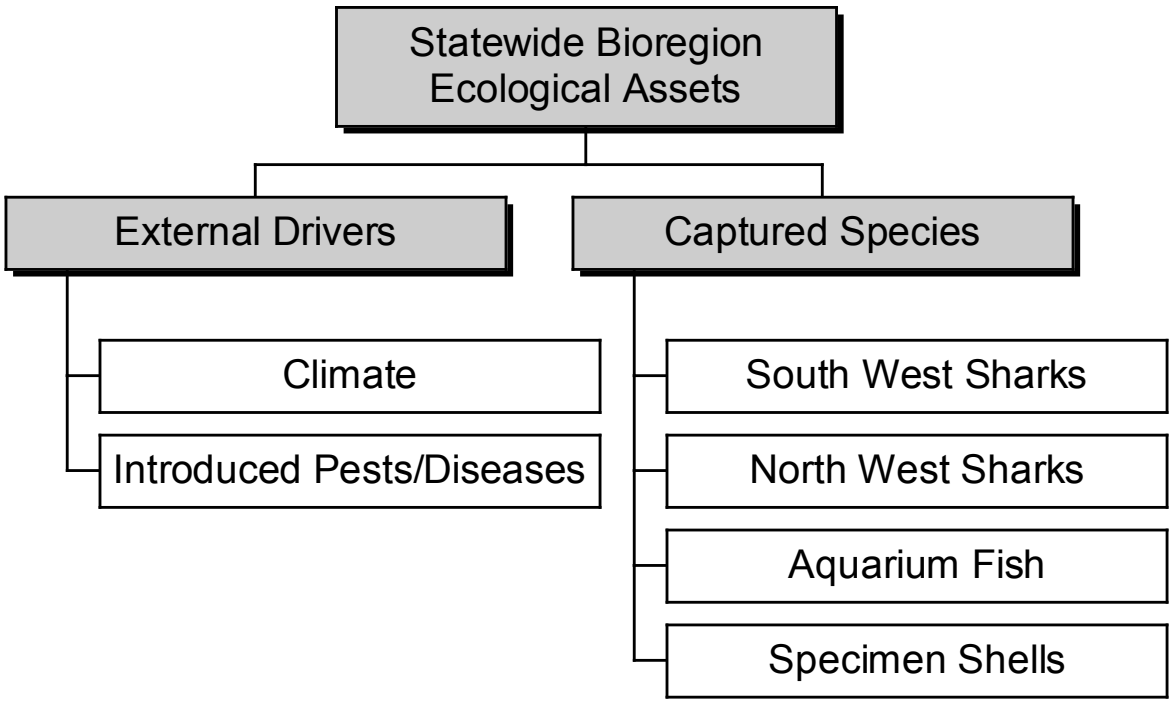
ECOSYSTEM BASED FISHERIES MANAGEMENT

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 Ecosystem sections provide an overview and cumulative assessment of the current risks to those ecological assets that function at a Statewide level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These level risks are now used by the Department as a key input into the Department's Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions for Statewide issues.



STATEWIDE ECOSYSTEM MANAGEMENT FIGURE 1
Component tree showing the Statewide ecological assets and external drivers identified and separately assessed.

External Drivers

External Drivers	Current Risk Status
Introduced Pests	HIGH
Introduced Disease	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.

Captured Species

Captured Species	Aquatic zone	Ecological Risk
Sharks	South and lower west	MODERATE
	Mid West – North	MODERATE

The stock levels of most sharks in the south and lower west regions are now either at acceptable levels or are deemed to be recovery at acceptable rates following management intervention.

The stocks levels of some sharks in the mid west and north 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.

Captured Species	Aquatic zone	Ecological Risk
Aquarium Fish	Marine	MODERATE

The level of capture is low and the management restrictions are such that that these species are not at risk.

Captured Species	Aquatic zone	Ecological Risk
Specimen Shells	Marine	MODERATE

The level of capture is low and the management restrictions are such that that these species are not at risk.

STATEWIDE MARINE AQUARIUM FISH AND HERMIT CRAB RESOURCES STATUS REPORT 2016

S. Newman, B. Molony, C. Bruce, C. Syers and P. Kalinowski

OVERVIEW

The Marine Aquarium Fish Managed Fishery (MAFMF) is able to operate in all State waters (between the Northern Territory border and South Australian border). The fishery is typically more active in waters between Esperance and Broome with higher levels of effort around the Capes region, Perth, Geraldton, Exmouth and Dampier. The MAFMF resource potentially includes more than 950 species of marine aquarium fishes under the Marine Aquarium Fish Management Plan 1995. 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.

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. The HCF is currently permitted to fish Western Australian waters north of Exmouth Gulf (22°30'S).

There are no documented recreational fisheries.

Both the MAFMF and HCF underwent pre-assessment for Marine Stewardship Council certification in 2014, but have not progressed to full assessment.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2016	Fish (n) - 20,993; Syngnathid (n) – 257; Invertebrates (n) - 52,386; Hard coral (kg) - 4,461.92; Soft coral (kg) - 6,881.00; Living rock & Living sand (kg) - 15,749.00; Sponges (n) - 3,533; Algae/Seagrasses (l) - 310.00; Hermit crabs (n) - 93,654	NA
Fishing Level	MAFMF: Acceptable HCF:Acceptable	NA

Stock/Resource Performance	Stock Status	Assessment Indicators
Statewide MAFMF & HCF	Sustainable - Adequate	Annual: Small numbers of individual species taken annually.

EBFM Performance			
Asset	Level	Asset	Level
Bycatch	Negligible Risk	**Listed Species**	Low Risk
Habitat	Negligible Risk	**Ecosystem**	Negligible Risk
Social	Low Risk	**Economic**	Level 2 ($1-5 million)
Governance	Stable	**External Drivers**	Negligible Risk

CATCH AND LANDINGS

A total of 13 licences were active in the MAFMF (8) and the HCF (5) in 2015. The total catch in the MAFMF and the HCF in 2015 was 171,133 fishes, 27.1 t of coral & sand and 310 L of marine plants. This is similar to the catches over the past several years. MAFMF fish catches were dominated by glassfish (*Ambassis vachelli*, n = 5,245), black-axil chromis (*Chromis atripectoralis*, n =2,400), spotted blenny (*Istiblennius meleagris*, n = 1,680) and scribbled angelfish (*Chaetodontoplus duboulayi*, n = 1,668), with an additional 160 fish taxon also reported. In addition, more than 180 invertebrate taxa were also landed in the MAFMF dominated by crabs, gastropods and soft coral.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Statewide MAFMF & HCF (Sustainable-Adequate)

Due to the large number of species captured in the MAFMF and the relatively low numbers per species, traditional stock assessments are not undertaken. Catches at the lowest taxonomic level are annually monitored based on fisher returns. A new risk assessment was undertaken with industry and other marine management groups in 2014/15 which determined that the risk these fisheries are imposing on the stocks is **low**.

This is a result of all specimens being collected for the live market. Therefore, fishers are restricted in 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.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

There is no bycatch in either fishery as both fisheries target specific taxon by hand. The potential for ETP interactions is limited due to low fishing effort and small areas accessed on each trip. The MAFMF has a small take of sygnathids under a WTO from the Commonwealth. However, there is a prohibition on the take of leafy sea dragons (*Phycodurus eques*).

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat and ecosystem impacts are considered **negligible**. This is due to the small scale of the fisheries and the hand collection methods. While the fisheries can potentially operate over large areas catches are relatively low due to the special handling requirements of live fish. Fishing operations are also heavily weather-dependent due to the small vessels used (MAFMF) and beach access (HCF). This results in a **negligible risk** to the overall ecosystem from the fishery.

SOCIAL AND ECONOMIC OUTCOMES

Social

Thirteen licences were active in 2015. Collections are undertaken on SCUBA from small vessels typically in small teams of 2 – 3 people.

Economic

The value per individual aquarium fish and hermit crab licence is relatively high. The value of these fisheries is difficult to estimate as operators can sell direct to the public, sell to wholesalers or have vertically integrated businesses including export. It is likely the combined value of both fisheries exceeds several million dollars. There is currently a **low** level of risk to these values.

GOVERNANCE SYSTEM

The current effort level in these fisheries is low and relatively constant from year to year. The impact of the fisheries 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 **adequate**.

There is a specific performance measure for syngnathids in the MAFMF, with a limit of 2,000 individuals per year. In 2015, a total of 257 syngnathids were landed, well below the limit.

Harvest Strategy

Draft harvest strategies were developed for both fisheries in 2014 as part pf the MSC pre-assessment process. An updated risk assessment was completed on 2014/15 for the MAFMF.

Compliance

Statutory returns are required to be submitted by the 16th of the following month. The low risks to the sustainability of the stocks imposed by these fisheries results in a **low risk** and low level of compliance.

Consultation

Consultation with licensees occurs directly on operational issues and through industry Annual General Meetings convened by the West Australian Fishing Industry Council (WAFIC) under a Service Level Agreement with the Department.

Management Initiatives/Outlook Status

Major management reviews were undertaken in 2015 and 2016, in addition to an updated risk assessment. There are no management initiatives currently planned in the next few years.

EXTERNAL DRIVERS

Fishers are typically limited by sea and weather conditions, and access to beaches. Consumer demand and unit prices also influence the target species and numbers landed. The external drivers pose a **low risk** to these fisheries.

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APPENDICES

APPENDIX 1 – PUBLICATIONS

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APPENDIX 2

The following tables contain data reported for commercial catches, estimated recreational and charter catches, aquaculture production, reported bycatch of protected and listed species from commercial fisheries and fish prices reported from land based processors. The reporting period is dependent on the most recent data available.

Table of catches from commercial fishers' statutory returns for 2014/15

This table contains the landed[1] and estimated live weight[2] of species recorded in the compulsory catch and fishing effort returns provided by commercial fishers each month. These data include the catch taken as by-product as well as the targeted catch.

These catch data may differ slightly from some of the catch estimates presented for specific fisheries as the latter may include additional data from other sources, such as research log books and processors. The figures may also differ slightly from previously reported figures, as additional data may have been received by the Department of Fisheries. The table represents the latest year for which a complete set of data is available.

While scientific names have been included wherever possible, it should be noted that many fish recorded under a common name cannot be identified as belonging to a particular single species and therefore must be reported as being part of a commercial grouping of several species. For example, the common name 'Redfish' may be used for several species of the genus Centroberyx.

Data for species with live weight catches of less than 500 kg have been combined into the general or 'other' category within each class. Data for the Marine Aquarium fish Fishery, Specimen Shell Fishery and Hermit Crab Fishery are presented in the next table. Data for the Indian Ocean Territories Fishery have not been included.

	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH				
Carcharhinidae				
	Bronze Whaler	*Carcharhinus brachyurus*	31	48
	Dusky Whaler	*Carcharhinus obscurus*	94	149
	Sandbar Shark	*Carcharhinus plumbeus*	29	46
	Spinner Shark	*Carcharhinus brevipinna*	24	39
	Tiger Shark	*Galeocerdo cuvier*	3	4
Lamnidae				
	Shortfin Mako	*Isurus oxyrinchus*	1	2
Orectolobidae				
	Wobbegong	*Orectolobidae*	18	29
Pristiophoridae				
	Common Sawshark	*Pristiphorus cirratus*	3	8
Rajidae				
	Skates	*Rajidae*	4	10
Sphyrnidae				
	Hammerhead Sharks	*Sphyrnidae*	38	61
Triakidae				
	Gummy Shark	*Mustelus antarcticus*	310	492
	Pencil Shark	*Hypogaleus hyugaensis*	0	1
	School Shark	*Galeorhinus galeus*	1	1
	Whiskery Shark	*Furgaleus macki*	98	147

	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH(Continued)				
	Sharks, Other		5	9
	Shovelnose/Fiddler Rays	*Rhinobatidae & Rhynchobatidae*	0	1
Acanthuridae/Zanclidae				
	Surgeonfishes	*Acanthuridae/Zanclidae*	4	4
Ariidae				
	Catfishes	*Ariidae*	8	8
Berycidae				
	Bight Redfish	*Centroberyx gerrardi*	48	49
	Redfish	*Centroberyx spp.*	10	10
	Yelloweye Redfish	*Centroberyx australis*	2	2
Clupeidae				
	Australian Sardine (Pilchard)	*Sardinops sagax*	1763	1763
	Perth Herring	*Nematalosa vlaminghi*	4	4
	Sandy Sprat (Whitebait)	*Hyperlophus vittatus*	97	97
	Scaly Mackerel	*Sardinella lemuru*	1073	1073
Hemiramphidae				
	Southern Garfish	*Hyporhamphus melanochir*	9	9
Platycephalidae				
	Flatheads	*Platycephalidae*	20	20
Plotosidae				
	Estuary Cobbler	*Cnidoglanis macrocephalus*	38	53
Latidae				
	Barramundi	*Lates calcarifer*	26	46
Polyprionidae				
	Bass Groper	*Polyprion americanus*	1	1
	Hapuku	*Polyprion oxygeneios*	20	20
Epinephelidae				
	Banded Grouper	*Epinephelus amblycephalus*	10	10
	Barcheek Coral Trout	*Plectropomus maculatus*	16	16
	Birdwire Rockcod	*Epinephelus merra*	1	1
	Blackspotted Rockcod	*Epinephelus malabaricus*	15	15
	Breaksea Cod	*Epinephelides armatus*	5	5
	Chinaman Rockcod	*Epinephelus rivulatus*	1	1
	Common Coral Trout	*Plectropomus leopardus*	2	2
	Duskytail Grouper	*Epinephelus bleekeri*	14	14
	Eightbar Grouper	*Hyporthodus octofasciatus*	12	12
	Flowery Rockcod	*Epinephelus fuscoguttatus*	57	57
	Goldspotted Rockcod	*Epinephelus coioides*	31	31
	Rankin Cod	*Epinephelus multinotatus*	112	112
	Tomato Rockcod	*Cephalopholis sonnerati*	1	1
	Cods	*Epinephelus/Cephalopholis*	54	54
Glaucosomatidae				
	Northern Pearl Perch	*Glaucosoma buergeri*	24	24
	West Australian Dhufish	*Glaucosoma hebraicum*	59	61
Priacanthidae				
	Bigeyes	*Priacanthidae*	38	38

	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH(Continued)				
Terapontidae				
	Trumpeters	*Terapontidae*	3	3
	Yellowtail Grunter	*Amniataba caudavittata*		
Sillaginidae				
	King George Whiting	*Sillaginodes punctatus*	25	25
	Whitings	*Sillaginidae*	73	73
	Yellowfin Whiting	*Sillago schomburgkii*	104	104
Pomatomidae				
	Tailor	*Pomatomus saltatrix*	21	21
Rachycentridae				
	Cobia	*Rachycentron canadum*	11	11
Carangidae				
	Amberjack	*Seriola dumerili*	22	22
	Black Pomfret	*Parastromateus niger*	2	2
	Golden Trevally	*Gnathanodon speciosus*	4	4
	Queenfish	*Scomberoides commersonnianus*		
	Samsonfish	*Seriola hippos*	36	37
	Silver Trevally	*Pseudocaranx spp.*	6	6
	Trevallies	*Carangidae*	122	122
	Yellowtail Kingfish	*Seriola lalandi*	1	1
	Yellowtail Scad	*Trachurus novaezelandiae*	21	21
Arripidae	Australian Herring	*Arripis georgianus*	66	66
	Western Australian Salmon	*Arripis truttaceus*	191	191
Lutjanidae				
	Brownstripe Snapper	*Lutjanus vitta*	70	70
	Chinamanfish	*Symphorus nematophorus*	7	7
	Crimson Snapper	*Lutjanus erythropterus*	165	165
	Darktail Snapper	*Lutjanus lemniscatus*	14	14
	Flagfish/Spanish Flag	*Lutjanus vitta/quinquelineatus/carponotatus/lutjan*	35	35
	Goldband Snapper	*Pristipomoides multidens*	813	813
	Mangrove Jack	*Lutjanus argentimaculatus*	10	10
	Moses' Snapper	*Lutjanus russelli*	33	33
	Red Emperor	*Lutjanus sebae*	261	261
	Rosy Snapper	*Pristipomoides filamentosus*	3	3
	Ruby Snapper	*Etelis carbunculus*	21	21
	Saddletail Snapper	*Lutjanus malabaricus*	179	179
	Sharptooth Snapper	*Pristipomoides typus*	2	2
	Stripey Snapper	*Lutjanus carponotatus*	1	1
	Tropical Snappers	*Lutjanidae*	2	2
Nemipteridae				
	Monocle Bream	*Scolopsis spp.*	4	4
	Threadfin Breams	*Nemipteridae*	87	87
Lobotidae				
	Tripletail	*Lobotes surinamensis*		

	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH(Continued)				
Haemulidae				
	Javelin Fish	*Pomadasys spp.*	9	9
	Painted Sweetlips	*Diagramma labiosum*	32	32
Haemulidae				
	Sweetlips	*Haemulidae*	37	37
Lethrinidae				
	Bluespotted Emperor	*Lethrinus punctulatus*	221	221
	Drab Emperor	*Lethrinus ravus*	4	4
	Emperors	*Lethrinidae*	0	0
	Grass Emperor	*Lethrinus laticaudis*	4	4
	Longnose Emperor	*Lethrinus olivaceus*	14	14
	Mozambique Seabream	*Wattsia mossambica*	10	10
	Redspot Emperor	*Lethrinus lentjan*	20	20
	Redthroat Emperor	*Lethrinus miniatus*	64	64
	Robinson's Seabream	*Gymnocranius grandoculis*	24	24
	Spangled Emperor	*Lethrinus nebulosus*	69	69
	Yellowtail Emperor	*Lethrinus atkinsoni*	1	1
Sparidae				
	Black Bream	*Acanthopagrus butcheri*	32	32
	Frypan Bream	*Argyrops spinifer*	27	27
	Snapper (Pink Snapper)	*Chrysophrys auratus*	354	357
	Tarwhine	*Rhabdosargus sarba*	7	7
	Western Yellowfin Bream	*Acanthopagrus morrisoni*	20	20
Sciaenidae				
	Black Jewfish	*Protonibea diacanthus*	1	2
	Mulloway	*Argyrosomus japonicus*	27	28
Mullidae				
	Red Mullet	*Mullidae*	20	20
Kyphosidae				
	Sweep	*Scorpis aequipinnis*		
Pentacerotidae				
	Boarfishes	*Pentacerotidae*	5	6
Oplegnathidae				
	Knifejaw	*Oplegnathus woodwardi*	1	1
Cheilodactylidae				
	Blue Morwong	*Nemadactylus valenciennesi*	43	46
Mugilidae				
	Mullets	*Mugilidae*		
	Sea Mullet	*Mugil cephalus*	204	204
	Yelloweye Mullet	*Aldrichetta forsteri*	20	20
Sphyraenidae				
	Pikes	*Sphyraenidae*	3	3
	Snook	*Sphyraena novaehollandiae*	3	3
Polynemidae				
	King Threadfin	*Polydactulus macrochir*	13	22
	Threadfin	*Polynemidae*	1	1

	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
FISH(Continued)				
Labridae				
	Baldchin Groper	*Choerodon rubescens*	10	10
Labridae				
	Blue Groper	*Achoerodus gouldii*	37	43
	Bluespotted Tuskfish	*Choerodon cauteroma*	2	2
	Parrotfishes	*Scarinae*	3	3
	Pigfishes	*Bodianus spp.*	1	1
	Tuskfishes	*Choerodon spp.*	3	3
	Wrasses	*Labrinae*	1	1
Scombridae				
	Bonito	*Sarda australis*	11	11
	Grey Mackerel	*Scomberomorus semifasciatus*	3	3
	Mackerels, Other	*Scombridae*	0	0
	Spanish Mackerel	*Scomberomorus commerson*	216	299
	Spotted Mackerel	*Scomberomorus munroi*	1	1
	Tuna, Other	*Scombridae*	1	1
Centrolophidae				
	Blue-Eye Trevalla	*Hyperoglyphe antarctica*	5	5
Bothidae				
	Flounders	*Bothidae*	10	10
Monacanthidae				
	Leather Jacket	*Monacanthidae*	11	18
	Fish, other		132	151
	TOTAL FISH		8386	8946
CRABS				
	Crystal Crab	*Chaceon albus*	155	155
	Champagne Crab	*Hypothalassia acerba*	2	2
	Giant Crab	*Pseudocarcinus gigas*	10	10
	Blue Swimmer Crab	*Portunus armatus*	519	519
	Mud Crab	*Scylla spp.*	18	18
	TOTAL CRABS		704	704
PRAWNS				
	Banana Prawn	*Penaeus merguiensis*	446	446
	Brown Tiger Prawn	*Penaeus esculentus*	662	662
	Coral Prawn	*Metapenaeopsis spp.*	92	92
	Endeavour Prawn	*Metapenaeus endeavouri*	199	199
	Western King Prawn	*Penaeus latisulcatus*	1569	1569
	Prawns, Other	*Penaeidae*	11	11
	TOTAL PRAWNS		2979	2979
LOBSTERS				
	Southern Rock Lobster	*Jasus edwardsii*	44	44

	Common Name	Scientific Name	Landed Weight (tonnes)	Live Weight (tonnes)
LOBSTERS (continued)				
	Western Rock Lobster	*Panulirus cygnus*	6083	6083
	Bugs/ Slipper lobster	*Scyllaridae*	14	14
	TOTAL LOBSTERS		6141	6141
MOLLUSCS				
	Squid	*Sepioteuthis spp./Loligo spp.*	36	36
	Octopus	*Octopus (cf.) tetricus*	169	219
	Cuttlefish	*Sepiidae*	50	50
	Saucer scallop	*Amusium balloti*	88	438
	Brownlip Abalone	*Haliotis conicopora*	12	31
	Greenlip Abalone	*Haliotis laevigata*	62	165
	Roe's Abalone	*Haliotis roei*	52	52
	TOTAL MOLLUSCS		469	991
	OTHER INVERTEBRATES		12	37
GRAND TOTAL			**18222**	**18807**

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 .

Table of catches from marine aquarium fish, specimen shell and hermit crab commercial fishers' statutory returns for 2014/15

Common Name	Quantity (numbers)	Weight (kg)	Volume (litres)
MARINE AQUARIUM FISH FISHERY			
Fish	17,854		
Syngnathidae (not included in Fish)	232		
Invertebrates (not including Corals)	40,587		
Hard Coral		3,256.50	
Soft Coral[1]		5,447 .00	
Living Rock & Living Sand		14,008.00	
Sponges	1,990		
Algae/Seagrasses			317
SPECIMEN SHELL FISHERY			
Specimen Shells - Mollusca	18,391		
HERMIT CRAB FISHERY			
Land Hermit Crabs only - *Coenobita variabilis*	80,654		

[1] The 'Soft coral' category for the Marine Aquarium Fish Fishery includes 4,400 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.

[2] Due to confidentiality provisions the reported catch of 'Live Feed' cannot be shown for the Marine Aquarium Fish Fishery in the Collection Fisheries Appendix Table 1.

Table of catches from boat-based recreational fishers and charter returns for 2013/14

This table contains the estimated number[1] and weight[2] of species retained in the state-wide survey of boat-based recreational fishers and charter returns for 2013/14 (May 2013–April 2014). These estimates include catch from targeted and non-targeted recreational fishing. Estimates are reported at species level where adequate sample size and precision were obtained. Species were then grouped to general or 'other' categories within each class and where > 2,500 (by number) are included in this table. Uncertainty around estimates from the state-wide survey is not included in this table (refer to Ryan et al. (2015) for this information). Estimates of shore-based recreational catches are not included in this table. The table represents the latest year for which a complete set of data is available.

Family	Common Name	Scientific Name	Est Kept Catch (number)	Est Kept Catch (tonnes)	Charter Kept Catch (number)	Charter Est Kept Catch (tonnes)
FISH						
Carcharhinidae	Bronze Whaler	*Carcharhinus brachyurus*	657	N/A	3	N/A
	Dusky Whaler	*Carcharhinus obscurus*	211	N/A	0	N/A
Triakidae	Gummy Shark	*Mustelus antarcticus*	834	N/A	23	N/A
Arripidae	Australian Herring	*Arripis georgianus*	132,155	16	86	Neg
	Western Australian Salmon	*Arripis truttaceus*	2,317	6	8	Neg
Berycidae	Bight Redfish	*Centroberyx gerrardi*	9,891	11	3,154	4
	Swallowtail	*Centroberyx lineatus*	1,749	< 1	1,054	< 1
Carangidae	Amberjack	*Seriola dumerili*	id	id	97	< 1
	Giant Trevally	*Caranx ignobilis*	688	3	48	< 0.5
	Golden Trevally	*Gnathanodon speciosus*	1,994	5	105	< 1
	Queenfish	*Scomberoides commersonnianus*	581	N/A	253	N/A
	Samsonfish	*Seriola hippos*	2,737	16	606	5
	Silver Trevally	*Pseudocaranx* spp.	34,948	17	1,746	2
	Yellowtail Kingfish	*Seriola lalandi*	1,144	3	51	< 0.5
	Trevally – Other	Carangidae – undifferentiated	3,157	N/A	476	N/A
Cheilodactylidae	Blue Morwong	*Nemadactylus valenciennesi*	3,906	11	619	2
Glaucosomatidae	Northern Pearl Perch	*Glaucosoma buergeri*	641	1	636	1
	West Australian Dhufish	*Glaucosoma hebraicum*	18,907	84	2,258	13
Haemulidae	Painted Sweetlips	*Diagramma labiosum*	3,083	7	268	< 1
Hemiramphidae	Southern Garfish	*Hyporhamphus melanochir*	2,809	< 0.5	0	N/A
	Garfish – Other	Hemiramphidae – undifferentiated	3,224	N/A	8	N/A
Labridae	Baldchin Groper	*Choerodon rubescens*	11,968	27	3,303	10
	Blackspot Tuskfish	*Choerodon schoenleinii*	3,615	10	121	< 0.5
	Blue Tuskfish	*Choerodon cyanodus*	1,975	6	0	N/A
	Brownspotted Wrasse	*Notolabrus parilus*	2,616	< 1	17	N/A
	Foxfish	*Bodianus frenchii*	1,437	1	680	< 1
	Western King Wrasse	*Coris auricularis*	9,075	3	96	Neg
	Wrasse – Other	Labridae – undifferentiated	2,170	N/A	377	N/A
Latidae	Barramundi	*Lates calcarifer*	1,676	7	1,077	4
Lethrinidae	Bluespotted Emperor	*Lethrinus punctulatus*	1,233	< 1	447	< 0.5
	Grass Emperor	*Lethrinus laticaudis*	21,060	29	2,391	3

Family	Common Name	Scientific Name	Est Kept Catch (number)	Est Kept Catch (tonnes)	Charter Kept Catch (number)	Charter Est Kept Catch (tonnes)
	Redthroat Emperor	*Lethrinus miniatus*	6,055	5	2,824	3
	Robinson's Seabream	*Gymnocranius grandoculis*	1,495	3	1,093	3
	Spangled Emperor	*Lethrinus nebulosus*	12,364	24	3,620	8
	Emperor – Other	Lethrinidae – undifferentiated	715	N/A	2,584	N/A
Lutjanidae	Chinamanfish	*Symphorus nematophorus*	828	4	567	3
	Crimson Snapper	*Lutjanus erythropterus*	1,646	3	1,360	2
	Goldband Snapper	*Pristipomoides multidens*	3,499	7	2,097	9
	Golden Snapper	*Lutjanus johnii*	1,384	2	2,524	4
	Mangrove Jack	*Lutjanus argentimaculatus*	4,361	3	1,522	1
	Moses' Snapper	*Lutjanus russellii*	1,114	< 1	417	N/A
	Red Emperor	*Lutjanus sebae*	5,290	19	2,229	8
	Rosy Snapper	*Pristipomoides filamentosus*	id	id	1,429	3
	Ruby Snapper	*Etelis carbunculus*	id	id	274	2
	Saddletail Snapper	*Lutjanus malabaricus*	1,294	2	1,790	4
	Sharptooth Snapper	*Pristipomoides typus*	id	id	620	1
	Stripey Snapper	*Lutjanus carponotatus*	7,437	4	667	< 1
Mugilidae	Sea Mullet	*Mugil cephalus*	id	id	1,308	Neg
	Mullet – Other	Mugilidae – undifferentiated	4,656	N/A	178	N/A
Nemipteridae	Western Butterfish	*Pentapodus vitta*	6,209	1	8	N/A
Platycephalidae	Flathead – Other	Platycephalidae – undifferentiated	5,193	N/A	211	N/A
Polynemidae	Blue Threadfin	*Eleutheronema tetradactylum*	2,006	3	822	2
	King Threadfin	*Polydactulus macrochir*	id	id	16	N/A
Pomatomidae	Tailor	*Pomatomus saltatrix*	8,370	6	33	Neg
Rachycentridae	Cobia	*Rachycentron canadum*	905	7	406	3
Scaridae	Parrotfish	Scaridae – undifferentiated	3,827	N/A	26	N/A
Sciaenidae	Black Jewfish	*Protonibea diacanthus*	562	2	163	< 1
	Mulloway	*Argyrosomus japonicus*	1,620	7	214	< 1
Scombridae	Bonitos	*Sarda australis*	1,513	N/A	6	N/A
	Longtail Tuna	*Thunnus tonggol*	509	3	149	< 1
	Mackerel Tuna	*Euthynnus affinis*	1,526	4	80	< 0.5
	School Mackerel	*Scomberomorus queenslandicus*	2,906	6	183	< 0.5
	Shark Mackerel	*Grammatorcynus bicarinatus*	304	N/A	31	N/A
	Southern Bluefin Tuna	*Thunnus maccoyii*	460	2	8	Neg
	Spanish Mackerel	*Scomberomorus commerson*	9,067	74	2,236	21
	Spotted Mackerel	*Scomberomorus munroi*	499	3	59	< 0.5
	Yellowfin Tuna	*Thunnus albacares*	1,151	8	223	2
	Mackerel/Tuna – Other	Scombridae – undifferentiated	2,914	N/A	286	N/A
Scorpididae	Sea Sweep	*Scorpis aequipinnis*	2,270	3	900	1
Serranidae	Barcheek Coral Trout	*Plectropomus maculatus*	4,111	11	1,018	3
	Breaksea Cod	*Epinephelides armatus*	16,449	15	3,044	4
	Common Coral Trout	*Plectropomus leopardus*	1,371	4	720	2
	Goldspotted Rockcod	*Epinephelus coioides*	4,096	11	553	3
	Rankin Cod	*Epinephelus multinotatus*	4,173	16	2,970	12

Family	Common Name	Scientific Name	Est Kept Catch (number)	Est Kept Catch (tonnes)	Charter Kept Catch (number)	Charter Est Kept Catch (tonnes)
	Rockcod – Other	Serranidae – undifferentiated	13,874	N/A	1,690	N/A
Sillaginidae	King George Whiting	*Sillaginodes punctatus*	74,329	17	662	< 0.5
	School Whiting	*Sillago bassensis, vittata & schombirgkii*	276,229	26	2	N/A
	Whiting – Other	Sillaginidae – undifferentiated	1,992	N/A	922	N/A
Sparidae	Black Bream	*Acanthopagrus butcheri*	11,653	3	6	Neg
	Snapper (Pink Snapper)	*Chrysophrys auratus*	25,200	59	11,443	26
	Tarwhine	*Rhabdosargus sarba*	1,978	< 1	27	Neg
	Western Yellowfin Bream	*Acanthopagrus morrisoni*	1,089	< 1	0	N/A
Sphyraenidae	Snook	*Sphyraena novaehollandiae*	5,065	2	2	Neg
	Pike/Barracuda – Other	Sphyraenidae – undifferentiated	5,910	N/A	11	N/A
CRAB						
	Blue Swimmer Crab	*Portunus armatus*	285,202	72	35	N/A
	Mud Crab	*Scylla* spp.	11,172	N/A	1,063	N/A
MOLLUSCS						
	Cuttlefish	Sepiidae	1,477	N/A	28	N/A
	Octopus	Octopodidae - undifferentiated	2,767	N/A	48	N/A
	Squid	Order Teuthoidea - undifferentiated	73,197	N/A	430	N/A

1. *Kept catch (number)*: refers to the estimated number of retained fish in the state-wide survey of boat-based recreational fishing, or reported number of retained fish in the Tour Operator Returns (Charter Logbooks). “id” indicates insufficient data where relative standard error > 40% (i.e. standard error > 40% of estimate) and < 30 diarists recorded catches of the species.
2. *Kept catch (tonnes)*: refers to the kept catch (number) converted to a weight from estimates of average weight based on state-wide biological surveys or the Tour Operator Returns. Weight estimates are round off to the nearest tonnage. N/A indicates estimate of average weight is unavailable. “Neg” indicates negligible catch (< 0.1 tonnes).
3. Common names are from the CAAB – Codes for Australian Biota database.
4. More information can be obtained from Ryan *et al.* (2015).[36]

36 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. 208 pp.

Table of growout production for the Western Australian aquaculture industry in 2014/15

This table contains the data collected on quarterly production returns received from all Western Australian aquaculture licence holders.

Some species produced in Western Australian aquaculture have been grouped together and reported under 'Other' as they are produced by less than three contributing licences, so making the data confidential. Species in this category produced in the last ten years include artemia, abalone, black bream, Mahi mahi, live rock, mulloway, Murray cod, pink snapper, prawns, rotifers, western rock oysters and yellowtail kingfish.

Common name	Productive licences	Quantity	Units*	Average price/ kg or individual	Value
Barramundi	5	779	Tonnes	$11.06	$8,615,958
Marron	181	51	Tonnes	$30.46	$1,562,908
Mussels	5	147	Tonnes	$4.32	$632,839
Yabbies	8	17	Tonnes	$25.87	$432,042
Silver Perch	11	15	Tonnes	$21.13	$312,943
Goldfish & Koi carp	7	92,671	No.	n/a	$206,898
Ornamental Invertebrates	7	17,276	No.	n/a	$188,834
Ornamental Fish	5	17,825	No.	n/a	$84,463
Rainbow Trout	4	6	Tonnes	$8.97	$50,733
Other Species**	< 3	38	Tonnes	n/a	$1,235,373
Algae	< 3	**			**
Total (not including algae or pearls)					**$13,322,991**

* 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.

Table of Fish Prices for 2014/15

This table contains the average price per kilogram paid for each marine species caught in Western Australia in 2014/15. The prices are based on prices reported by WA land based processors; the average prices reported are weighted and are based on whole weight. The prices have been adjusted to reflect the beach price paid. Beach price is the price paid per kilogram to commercial fishers for their catch when they first land and excludes any marketing, transport or handling costs.

Family	Common Name	Scientific Name	Price per Kilogram
FISH			
Carcharhinidae	Bronze Whaler	*Carcharhinus brachyurus*	$2.20
	Blacktip Whaler	*Carcharhinus tilstoni/Carcharhinus limbatus/Carcharhinus spp.*	$1.26
	Bull Shark	*Carcharhinus leucas*	$0.75
	Dusky Whaler	*Carcharhinus obscurus*	$4.02
	Sandbar Shark	*Carcharhinus plumbeus*	$2.83
	Spinner Shark	*Carcharhinus brevipinna*	$1.14
	Tiger Shark	*Galeocerdo cuvier*	$0.65
Hexanchidae	Sevengill Shark	*Heptranchias spp.*	$1.00
Lamnidae	Shortfin Mako	*Isurus oxyrinchus*	$0.53
Orectolobidae	Wobbegong Shark	*Orectolobidae*	$1.64
Pristiophoridae	Common Sawshark	*Pristiphorus cirratus*	$0.60
Rajidae	Skates	*Rajidae*	$4.66
Sphyrnidae	Hammerhead Shark	*Sphyrnidae*	$0.94
Squalidae/Centrophoridae/Etmopteridae	Dogfishes, Gulper Sharks & Lantern Sharks	*Squalidae/Centrophoridae/Etmopteridae*	$2.00
Squatinidae	Angel Shark	*Squatina spp.*	$0.90
Triakidae	Gummy Shark	*Mustelus antarcticus*	$4.28
	Pencil Shark	*Hypogaleus hyugaensis*	$1.23
	School Shark	*Galeorhinus galeus*	$2.00
	Whiskery Shark	*Furgaleus macki*	$3.77
	Shark Fins		$15.07
	Shark, Other		$2.35
	Rays & Skates		$2.00
	Shovelnose/Fiddler Rays	*Rhinobatidae & Rhynchobatidae*	$0.38
Acanthuridae/Zanclidae	Surgeonfishes	*Acanthuridae/Zanclidae*	$2.00
Ariidae	Catfishes	*Ariidae*	$2.24
	Silver Cobbler	*Neoarius midgleyi*	$4.68
Arripidae	Australian Herring	*Arripis georgianus*	$2.46
	Western Australian Salmon	*Arripis truttaceus*	$0.49
Belonidae	Long Tom	*Belonidae*	$2.00
Berycidae	Bight Redfish	*Centroberyx gerrardi*	$6.47
	Redfish	*Centroberyx spp.*	$7.52
	Swallowtail	*Centroberyx lineatus*	$3.02

Family	Common Name	Scientific Name	Price per Kilogram
	Yelloweye Redfish	*Centroberyx australis*	$4.30
Bothidae	Flounder	*Bothidae*	$14.43
Carangidae	Amberjack	*Seriola dumerili*	$2.26
	Black Pomfret	*Parastromateus niger*	$7.99
	Common Dart	*Trachinotus botla*	$2.50
	Golden Trevally	*Gnathanodon speciosus*	$3.38
	Queenfish	*Scomberoides commersonnianus*	$5.10
	Samson Fish	*Seriola hippos*	$2.48
	Silver Trevally	*Pseudocaranx spp.*	$2.41
	Trevallies	*Carangidae*	$3.16
	Turrum (Goldspot Trevally)	*Carangoides fulvoguttatus*	$1.07
	Yellowtail Kingfish	*Seriola lalandi*	$3.94
	Yellowtail Scad	*Trachurus novaezelandiae*	$0.53
Centrolophidae	Blue-Eye Trevalla	*Hyperoglyphe antarctica*	$5.22
Cheilodactylidae	Blue Morwong	*Nemadactylus valenciennesi*	$3.76
	Morwong	*Cheilodactylidae*	$2.58
Clupeidae	Australian Sardine (Pilchard)	*Sardinops sagax*	$0.86
	Blue Sprat	*Spratelloides robustus*	$4.25
	Maray	*Etrumeus teres*	$0.95
	Perth Herring	*Nematalosa vlaminghi*	$2.98
	Sandy Sprat (Whitebait)	*Hyperlophus vittatus*	$4.15
	Scaly Mackerel	*Sardinella lemuru*	$0.94
Coryphaenidae	Mahi Mahi	*Coryphaena hippurus*	$5.90
Engraulidae	Australian Anchovy	*Engraulis australis*	$0.64
Elopidae	Hawaiian Giant Herring	*Elops hawaiensis*	$2.00
Epinephedae	Banded Grouper	*Epinephelus amblycephalus*	$2.00
	Barramundi Cod	*Cromileptes altivelis*	$2.00
	Birdwire Rockcod	*Epinephelus merra*	$5.36
	Blackspotted Rockcod	*Epinephelus malabaricus*	$7.65
	Breaksea Cod	*Epinephelides armatus*	$7.86
	Chinaman Rockcod	*Epinephelus rivulatus*	$5.36
	Cods	*Epinephelus/Cephalopholis*	$6.57
	Comet Grouper	*Epinephelus morrhua*	$5.36
	Coral Rockcod	*Cephalopholis miniata*	$5.36
	Duskytail Grouper	*Epinephelus bleekeri*	$7.29
	Eightbar Grouper	*Hyporthodus octofasciatus*	$8.15
	Flowery Rockcod	*Epinephelus fuscoguttatus*	$6.19
	Goldspotted Rockcod	*Epinephelus coioides*	$6.88
	Harlequin Fish	*Othos dentex*	$2.00
	Radiant Rockcod	*Epinephelus radiatus*	$6.59
	Rankin Cod	*Epinephelus multinotatus*	$8.43
	Tomato Rockcod	*Cephalopholis sonnerati*	$7.14
	Yellowedge Coronation Trout	*Variola louti*	$16.23
	Yellowspotted Rockcod	*Epinephelus areolatus*	$2.00

Family	Common Name	Scientific Name	Price per Kilogram
Gempylidae	Barracouta	*Thyrsites atun*	$2.50
Gempylidae	Gemfish	*Rexea solandri*	$2.18
Gerreidae	Common Silverbiddy	*Gerres subfasciatus*	$3.28
Glaucosomatidae	Northern Pearl Perch	*Glaucosoma buergeri*	$7.09
	West Australian Dhufish	*Glaucosoma hebraicum*	$14.60
Haemulidae	Barcheek Coral Trout	*Plectropomus maculatus*	$15.09
	Common Coral Trout	*Plectropomus leopardus*	$2.00
	Coral Trouts	*Plectropomus spp./Variola spp.*	$15.09
	Javelin Fish	*Pomadasys spp.*	$2.15
	Painted Sweetlips	*Diagramma labiosum*	$4.75
	Sweetlips	*Haemulidae*	$4.79
Hemiramphidae	Southern Garfish	*Hyporhamphus melanochir*	$7.37
Kyphosidae	Banded Sweep	*Scorpis georgianus*	$1.14
	Buffalo Bream	*Kyphosidae*	$2.00
	Moonlighter	*Tilodon sexfasciatum*	$2.00
	Sea Sweep	*Scorpis aequipinnis*	$7.87
Labridae	Baldchin Groper	*Choerodon rubescens*	$10.90
	Blue Groper	*Achoerodus gouldii*	$5.28
	Bluespotted Tuskfish	*Choerodon cauteroma*	$7.02
	Parrotfishes	*Scarinae*	$5.68
	Pigfish	*Bodianus spp.*	$7.21
	Tuskfishes	*Choerodon spp.*	$6.89
	Wrasses	*Labrinae*	$4.75
Latidae	Barramundi	*Lates calcarifer*	$7.54
Lethrinidae	Bluespotted Emperor	*Lethrinus punctulatus*	$4.37
	Drab Emperor	*Lethrinus ravus*	$4.43
	Emperors	*Lethrinidae*	$5.38
	Grass Emperor	*Lethrinus laticaudis*	$7.33
	Longnose Emperor	*Lethrinus olivaceus*	$5.93
	Mozambique Seabream	*Wattsia mossambica*	$5.92
	Redspot Emperor	*Lethrinus lentjan*	$4.87
	Redthroat Emperor	*Lethrinus miniatus*	$7.49
	Robinson's Seabream	*Gymnocranius grandoculis*	$4.39
	Sea Bream	*Gymnocranius spp.*	$6.38
	Spangled Emperor	*Lethrinus nebulosus*	$5.41
	Spotcheek Emperor	*Lethrinus rubrioperculatus*	$4.42
	Yellowtail Emperor	*Lethrinus atkinsoni*	$7.50
Lobotidae	Tripletail	*Lobotes surinamensis*	$2.00
Lutjanidae	Brownstripe Snapper	*Lutjanus vitta*	$3.61
	Chinaman Fish	*Symphorus nematophorus*	$5.38
	Crimson Snapper	*Lutjanus erythropterus*	$5.18
	Darktail Snapper	*Lutjanus lemniscatus*	$5.54
	Five Line Snapper	*Lutjanus quinquelineatus*	$3.58
	Flagfish/Spanish Flag	*Lutjanus*	$3.61

Family	Common Name	Scientific Name	Price per Kilogram
		vitta/quinquelineatus/carponotatus/lutjan	
	Flame Snapper	*Etelis coruscans*	$6.64
	Goldband Snapper	*Pristipomoides multidens*	$8.81
	Golden Snapper	*Lutjanus johnii*	$7.29
	Indonesian Snapper	*Lutjanus bitaeniatus*	$4.76
	Jobfish	*Pristipomoides spp.*	$9.30
	Mangrove Jack	*Lutjanus argentimaculatus*	$5.40
	Moses Snapper	*Lutjanus russelli*	$5.07
	Red Emperor	*Lutjanus sebae*	$11.62
	Rosy Snapper	*Pristipomoides filamentosus*	$7.94
	Ruby Snapper	*Etelis carbunculus*	$6.64
	Saddletail Snapper	*Lutjanus malabaricus*	$5.36
	Sharptooth Snapper	*Pristipomoides typus*	$6.58
	Stripey Snapper	*Lutjanus carponotatus*	$3.58
	Tang's Snapper	*Lipocheilus carnolabrum*	$7.58
	Tropical Snappers	*Lutjanidae*	$3.95
Monacanthidae	Leather Jacket	*Monacanthidae*	$3.98
Mugilidae	Mullets	*Mugilidae*	$1.74
	Sea Mullet	*Mugil cephalus*	$2.41
	Yellow-Eye Mullet	*Aldrichetta forsteri*	$1.27
Mullidae	Red Mullet	*Mullidae*	$2.64
Nemipteridae	Blue Mackerel	*Scomber australasicus*	$2.50
	Monocle Bream	*Scolopsis spp.*	$1.75
	Threadfin Breams	*Nemipteridae*	$3.62
Ophidiidae	Ling, Pink Or Rock Ling	*Genypterus tigerinus*	$1.70
Oplegnathidae	Knifejaw	*Oplegnathus woodwardi*	$1.73
Pentacerotidae	Boarfish	*Pentacerotidae*	$4.14
Platycephalidae	Flatheads	*Platycephalidae*	$6.77
	Rock Flathead	*Platycephalus laevigatus*	$9.04
Plotosidae	Estuary Cobbler	*Cnidoglanis macrocephalus*	$4.83
Polynemidae	King Threadfin	*Polydactulus macrochir*	$7.14
	Threadfin	*Polynemidae*	$7.14
Polyprionidae	Bass Groper	*Polyprion americanus*	$8.42
	Hapuku	*Polyprion oxygeneios*	$7.43
Pomatomidae	Tailor	*Pomatomus saltatrix*	$5.45
Priacanthidae	Bigeyes	*Priacanthidae*	$1.37
Psettodidae	Australian Halibut	*Psettodes erumei*	$4.22
Rachycentridae	Cobia	*Rachycentron canadum*	$3.21
Scatophagidae	Butterfish (Striped Scat)	*Selenotoca multifasciata*	$2.00
Sciaenidae	Black Jewfish	*Protonibea diacanthus*	$3.20
	Mulloway	*Argyrosomus japonicus*	$4.77
Scombridae	Bigeye Tuna	*Thunnus obesus*	$10.52
	Bonito	*Sarda australis*	$6.61
	Grey Mackerel	*Scomberomorus semifasciatus*	$7.56

Family	Common Name	Scientific Name	Price per Kilogram
	Longtail Tuna	*Thunnus tonggol*	$2.86
	Mackerel Tuna	*Euthynnus affinis*	$2.52
	Mackerel, Other	*Scombridae*	$1.95
	Shark Mackerel	*Grammatorcynus bicarinatus*	$2.71
	Skipjack Tuna	*Katsuwonus pelamis*	$2.69
	Spanish Mackerel (Narrow-barred)	*Scomberomorus commerson*	$8.21
	Spotted Mackerel	*Scomberomorus munroi*	$4.35
	Tuna, Other	*Scombridae*	$3.31
	Wahoo	*Acanthocybium solandri*	$4.73
	Yellowfin Tuna	*Thunnus albacares*	$10.56
Scorpaenidae	Scorpionfishes	*Scorpaenidae*	$5.51
Siganidae	Goldlined Rabbitfish	*Siganus lineatus*	$2.00
	Rabbitfish	*Siganus spp.*	$2.00
Sillaginidae	Goldenline Whiting	*Sillago analis*	$1.37
	King George Whiting	*Sillaginodes punctatus*	$13.23
	Whitings	*Sillaginidae*	$4.11
	Yellowfin Whiting	*Sillago schomburgkii*	$7.09
Sparidae	Black Bream	*Acanthopagrus butcheri*	$8.28
	Frypan Bream	*Argyrops spinifer*	$4.80
	Snapper (Pink Snapper)	*Chrysophrys auratus*	$7.63
	Tarwhine	*Rhabdosargus sarba*	$5.62
	Western Yellowfin Bream	*Acanthopagrus latus*	$4.46
	Yellowback Bream	*Dentex tumifrons*	$7.31
Sphyraenidae	Pikes	*Sphyraenidae*	$3.03
	Snook	*Sphyraena novaehollandiae*	$3.54
Terapontidae	Trumpeters	*Terapontidae*	$1.70
Triglidae	Gurnard	*Triglidae*	$2.06
Zeidae	John Dory	*Zeus faber*	$8.64
	General Fish		$4.11
CRABS			
	Blue swimmer Crab	*Portunus armatus*	$5.36
	Champagne Crab	*Hypothalassia acerba*	$8.50
	Crystal Crab	*Chaceon albus*	$21.11
	Giant Crab	*Pseudocarcinus gigas*	$46.50
	Giant Mud crab	*Scylla serrata*	$30.97
	Orange Mud Crab	*Scylla olivacea*	$30.97
PRAWNS			
	Banana Prawn	*Penaeus merguiensis*	$11.42
	Black Tiger Prawn	*Penaeus monodon*	$18.00
	Brown Tiger Prawn	*Penaeus esculentus*	$14.25
	Coral Prawn	*Metapenaeopsis spp.*	$3.53
	Endeavour Prawn	*Metapenaeus endeavouri*	$9.48

Family	Common Name	Scientific Name	Price per Kilogram
	Prawns, Other	*Penaeidae*	$2.00
	Western King Prawn	*Penaeus latisulcatus*	$13.11
LOBSTERS			
	Bugs/ Slipper lobster	*Scyllaridae*	$11.40
	Southern Rock Lobster	*Jasus edwardsii*	$60.00
	Western Rock Lobster	*Panulirus cygnus*	$63.00
MOLLUSCS			
	Brownlip Abalone	*Haliotis conicopora*	$33.54
	Cuttlefish	*Sepiidae*	$3.38
	Greenlip Abalone	*Haliotis laevigata*	$40.09
	Octopus	*Octopus (cf.) tetricus*	$8.13
	Roe's Abalone	*Haliotis roei*	$23.69
	Saucer scallop	*Amusium balloti*	$7.10
	Squid	*Sepioteuthis spp./Loligo spp.*	$13.18
ECHINODERMS			
	Sea Cucumbers	*Holothuroidea*	$3.00

APPENDIX 3

Table of reported bycatch of protected and listed species from commercial fisheries for 2015

This table contains the numbers of accidental captures of protected and listed animals by commercial fishers, as reported in statutory fishing returns and Catch Disposal Records, during calendar year 2015[1]. To the extent possible, other types of recorded interactions with protected and listed species[2] have been excluded. For the purpose of this report, protected and listed species (or taxa) are defined as those listed as: Totally Protected Fish[3] under the WA Fish Resources Management Act 1994 (FRMA); Specially Protected Fauna under the WA Wildlife Conservation Act 1950 (WCA) and Threatened species and cetaceans for which it is an offence to harm under the Australian Environment Protection and Biodiversity Conservation Act 1999 (EPBC). These data do not include interactions with species that may be afforded other forms of general protection or conditions under these (or other) Acts, international agreements or conventions[4]. As other reports may include records that do not meet these definitions, these data may differ from other accounts.

			Release Condition		
Class	**Common Name**	**Scientific Name**	**ALIVE (number)**	**DEAD (number)**	**UNKNOWN (number)**
Birds	Shearwater (unspecified)		178	18	-
Fishes	Sawfish (unspecified)	Family Pristidae	11	3	-
	Green sawfish	*Pristis zijsron*	28	13	-
	Narrow sawfish	*Anoxypristis cuspidata*	9	7	-
	White shark	*Carcharodon carcharias*	9	2	-
	Grey nurse shark	*Carcharias taurus*	12	3	-
	Seahorses, seadragons & pipefish	Family Syngnathidae	28	45	-
Reptiles	Crocodile (unspecified)	*Crocodylus* spp.	8	2	-
	Freshwater crocodile	*Crocodylus johnstoni*	6	4	-
	Freshwater turtle (unspecified)		9	10	-
	Sea snake (unspecified)		2174	255	-
	Turtle (unspecified)		37	-	-
	Green turtle	*Chelonia mydas*	12	-	-
	Loggerhead turtle	*Caretta caretta*	8	-	-
	Olive Ridley turtle	*Lepidochelys olivacea*	1	-	-
Mammals	Bottlenose dolphin	*Tursiops spp.*	2	16	-
	Australian sea lion	*Neophoca cinerea*	2	-	-
	Total all species		**2534**	**378**	**-**

1. *Reports by other sources (eg. members of public and Departments of Fisheries and Parks and Wildlife officers) of whale entanglements in fishing gear, dead seabirds that have washed ashore, etc. are usually not attributable to particular fishers, fisheries, dates or locations. Although these interactions are reported in Annual Reports to Parliament and elsewhere, they are inconsistent with the more-detailed information in statutory fishing records presented here and therefore not included.*
2. *e.g. shark sightings by abalone divers, dugong interactions with trap fisheries, etc.*
3. *Except those listed as Totally Protected Fish in reference to their sex, size, weight, reproductive cycle, area from which they are taken or specific period of time.*
4. *For example, unless listed under Schedule 5 of the WCA, these include: listed migratory species under the EPBC Act and international agreements: the Convention on the Conservation of Migratory Species of Wild Animals 1979 (CMS; Bonn Convention); 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; 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; the Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds, 2007; the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); for which special conditions may also apply.*