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Status reports of the fisheries and aquatic resources of Western Australia 2016/17. State of the fisheries

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GOVERNMENT OF
WESTERN AUSTRALIA

Department of
**Primary Industries and
Regional Development**

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GENERAL OVERVIEW

The *Status Reports of the Fisheries and Aquatic Resources of Western Australia* (*SRFAR*) provide an annual update on the state of the fish stocks and other aquatic resources of Western Australia (WA). These reports outline the most recent assessments of the cumulative risk status for each of the aquatic resources (assets) within WA's six Bioregions using an Ecosystem Based Fisheries Management (EBFM) approach.

The 2016/17 financial year saw a continuation of the outstanding results achieved in fisheries management to ensure the continued sustainability of the State's aquatic resources. It was also a year in which the Department worked closely with key stakeholders to prepare for the future legislative and administrative frameworks within which the agency will provide future services to the State of Western Australia.

The contributions of the many stakeholders that work with the Department to achieve sustainable fisheries, valuable industries and healthy ecosystems remain an invaluable part of the ongoing successful management of fisheries in Western Australia.

This year, 95 per cent of our fisheries were assessed as not at risk from fishing with the remaining fisheries impacted largely by environmental factors and subject to recovery programs.

Four fisheries (West Coast Demersal Scalefish Fishery (WCDSF); the Shark Bay Crab Fishery, the Shark Bay Scallop Fishery and the Cockburn Sound Crab Fishery) had breeding stocks considered to be recovering at acceptable rates. The WCDSF targets relatively long lived species so its recovery is expected to take a number of years to complete. The initial strong management actions taken in Shark Bay combined with the conservative Total Allowable Commercial Catches (TACCs) imposed since the resumption of commercial fishing are enabling the recovery of both the scallop and crab stocks from the impact of the heat wave event six years ago.

The fishery for scallops in the Abrolhos Islands has been closed since the 2011 marine heat wave but is finally beginning to show the first signs of recovery. Only two fisheries (or 5% of those assessed) have stocks that are considered inadequate as a result of exploitation (garfish in the West Coast Nearshore Fishery and cobbler within Wilson Inlet in the South Coast Nearshore Fishery).

A major milestone was reached during 2016/17 with the passage through Parliament of the *Aquatic Resources Management Bill 2015*. The *Aquatic Resources Management Act 2016* (ARMA) is a once-in-a-generation change that provides a modern, innovative framework that will provide a sound basis for effective, efficient and integrated fisheries and aquatic resource management for decades to come. It is based on the principles of ecologically sustainable development, and will provide the legal framework for improved governance.

A key feature of the ARMA is that it is based around the aquatic resource – rather than the traditional approach based on a fishery or fishing activity. This enables an integrated approach to providing secure fishing access rights for all sectors, with resource sustainability at its core. The ARMA allows for existing management arrangements and resource access rights to remain effective for the State's commercial fishing and pearling industries, until each is separately migrated to the new legislative framework.

The Department is working with stakeholders towards achieving a structured implementation of ARMA, but it is important to understand that the transition to management arrangements facilitated under the ARMA will be evolutionary. For most commercial and recreational fishers, there will be no immediate significant change when the ARMA commences.

The deep-sea crab fishery and abalone fishery were certified by MSC in 2016 as sustainable seafood suppliers. These fisheries join other MSC-certified fisheries in Western Australia including west coast rock lobster, Shark Bay prawn, Exmouth Gulf prawn and the Peel-Harvey sea mullet and blue swimmer crab fisheries.

In recognition of the considerable progress of aquaculture initiatives and investment in Western Australia the status of aquaculture in Western Australia will now be reported in a companion volume.

EDITOR'S INTRODUCTION

This is the first *Status Reports of the Fisheries and Aquatic Resources of Western Australia* to be released by the newly created Department of Primary Industries and Regional Development. I would like to thank the many staff who have contributed to the production of this report over what has been a challenging year. The outcomes have been particularly satisfying given that the report is still transitioning to be web-based at the same time that the former Department of Fisheries is transforming.

As part of the ongoing 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 2016/17* is continuing to adopt 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 continue to be shortened to remove information that was largely repeated among editions. It is planned that all key resources will have a comprehensive Resource Assessment Report (RAR) 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 state government's 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 fishing activities. Taking this resource and 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.

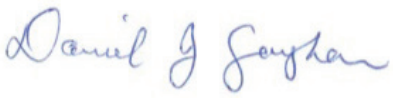
The ongoing involvement by our commercial, recreational and aquaculture stakeholders in specific research projects and monitoring programs remains highly appreciated. Logbook data, voluntary participation in recreational fishing surveys, provision of biological samples, and access to vessels and information are integral to aquatic resource management in this state. 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 2016/17* 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, the government initiative to have a number of WA commercial fisheries undergo certification by the Marine Stewardship Council (MSC) has resulted in some changes in the terminology 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.

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



Dr DAN GAUGHAN
Executive Director, Science and Resource Assessment

November 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* 2016/17 to Parliament) and the ecological resource level reports.

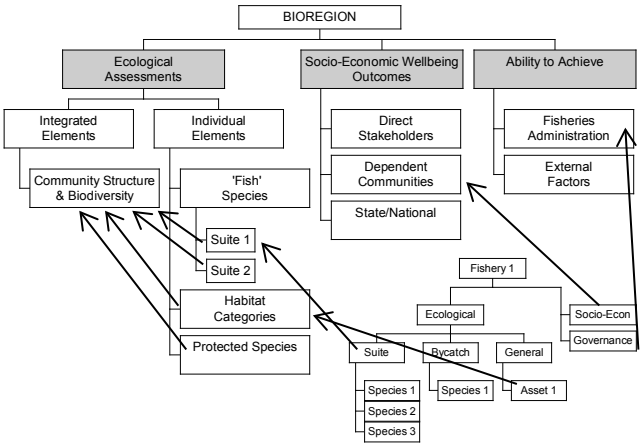
The terms and headings are a combination of the reporting structures first outlined in the National Ecologically Sustainable Development (ESD) reporting structure (Fletcher *et al.* 2002)[1], plus the Ecosystem Based Fisheries Management (EBFM) framework (Fletcher *et al.* 2010, 2012)[2] and the Resource Assessment Framework (DoF, 2011)[3]. The terminology used in reports has now been updated to be consistent with the MSC criteria, and where possible, that used within the Status of Key Australian Fish Stocks reports[4].

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 aquatic resource management 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 and biodiversity within an ecosystem can, at a minimum, be effectively assessed as the 'integrated' sum of the status of the 'individual' ecological elements.

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 aquatic resource management related activities across the Department (see Fletcher *et al,* 2010, 2012 for full details).

1 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.

2 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. Using a regional level, risk-based framework to cost effectively implement Ecosystem Based Fisheries Management (EBFM). In: Kruse *et al*. (eds). Global Progress on Ecosystem-Based Fisheries Management. pp. 129-146. Alaska Sea Grant College Program. doi: 10.4027/gpebfm.2012.07.

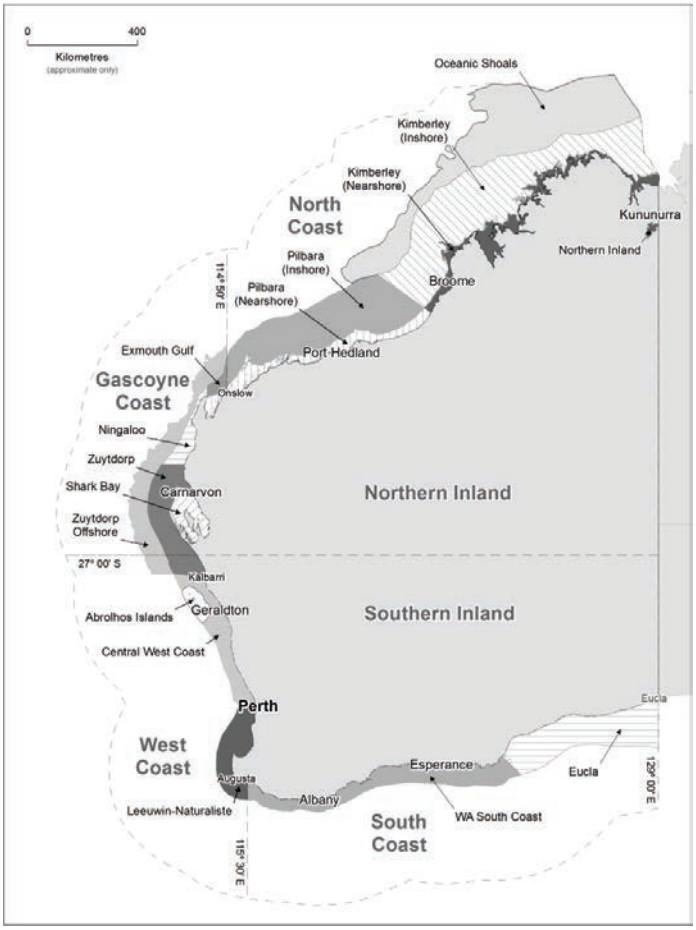
3 Department of Fisheries. 2011. Resource Assessment Framework for Finfish Resources in Western Australia. Fisheries Occasional Publication. No. 85.

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

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. Important cultural values and resources, whether exploited or not, will also be highlighted. 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[1]' (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.

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

RISK ASSESSMENT

The Department's primary objective is to manage the sustainability of the community's aquatic 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)[1].

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). Uncertainties are therefore explicitly incorporated into the assessment to enable the assessment 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 2015/16 or the calendar year 2016, whichever is more appropriate.

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 2017.

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 and 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 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 (third) survey was undertaken from 1 September 2015 to 31 August 2016.

Estimates of the recreational catch and effort range at state-wide and bioregional levels from the third survey presented in Ryan *et al*. (2017[2]) 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 (fourth) series of surveys started in mid-2017. 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.

1 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.

2 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.

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 assists in determining the overall risk level and if further research is required (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 (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 by the 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', 'moderate', '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.

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

Governance Systems

Harvest Strategy

A Harvest Strategy Policy (DoF, 2015) for the aquatic resources of WA provides the framework for developing harvest strategies for each resource. 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, 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. Examination of tolerances will 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, the majority of the state's most valuable fisheries have achieved MSC certification. 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.

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 (KPI) section of the Department of Fisheries Annual Report to the Parliament 2016/17.

The proportion of fish stocks identified as not being at risk or vulnerable through exploitation.

Annual stock assessments of the fisheries that are subject to management are undertaken by the Department's Science and Resource Assessment Division. 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 (full details of which are in the companion Status Reports on the Western Australia's Fisheries and Aquatic Resources 2016/17). Performance is measured as the proportion of fisheries (which have sufficient data) for which the breeding stocks of each of the major target or indicator species are being maintained at levels that ensure catches could be sustained at desirable levels given effort levels and normal environmental conditions; or they are recovering from a depleted state at an appropriate rate following management intervention. The Department's 2016/17 Budget Papers state that the target is for the proportion of fish stocks not at risk from fishing is ninety-seven percent (97%).

For the 2016/17 performance review, 40 fisheries have been reviewed, which includes two recreational only fisheries. For the 40 fisheries reviewed, the 'Stock Status and Catch Ranges for Major Fisheries' in the Outcomes section of the Annual Report records that breeding stock assessments are available for the major species taken in 39 (97%) of these fisheries. The one fishery where there are insufficient data to make an assessment on the target species to make a critical assessment was due to the fishery having not operated for more than six years.

Within the group of 39 assessed fisheries, 32 were considered to have adequate breeding stock levels and a further four fisheries (West Coast Demersal Scalefish Fishery (WCDSF); the Shark Bay Crab Fishery, the Shark Bay Scallop Fishery and the Cockburn Sound Crab Fishery) had breeding stocks considered to be recovering at acceptable rates (collectively 92% of fisheries). The WCDSF targets relatively long lived species so its recovery is expected to take a number of years to complete. The initial strong management actions taken in Shark Bay combined with the conservative Total Allowable Commercial Catches (TACCs) imposed since the resumption of commercial fishing are enabling the recovery of both the scallop and crab stocks from the impact of the heat wave event six years ago.

Of the remaining 8% of fisheries, the fishery for scallops in the Abrolhos Islands has been closed since the 2011 marine heat wave but is finally beginning to show the first signs of recovery. Therefore, only two fisheries (or 5% of those assessed) have stocks that are considered inadequate as a result of exploitation (garfish in the West Coast Nearshore fishery and cobbler within Wilson Inlet in the South Coast Nearshore fishery) with additional actions now progressing to deal with these issues (Overview Table 1). Consequently, 95% of stocks are considered to not be at risk or vulnerable through exploitation, which is very close to the target level.

OVERVIEW TABLE 1:

The proportion (%) of fisheries in which breeding stocks of the major target species are both assessed and considered not to be at risk due to fishing. Note, prior to 2016/17 the KPI and the target listed in the budget papers referred to the proportion of fish stocks at risk.

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
	Percentage of fish stocks considered not at risk by fishing (%)	Target value as per budget (%)
2016/17	95	97

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. The Department's 2016/17 Budget Papers state that the target is ninety-five percent (95%).

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 group.

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) still affected by unusual environmental conditions to the extent that the fisheries were again closed. These stocks continue to be closely monitored and are starting to both show signs of recovery which highlights the

benefits of strong management actions taken by the Department.

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

Ten of the eleven 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). In the Gascoyne demersal fishery Pink snapper catch rates fell below the threshold level and a review of the stock status will be completed in the coming year.

In the 18 effort-controlled fisheries, eleven were within or acceptably above (1) or below (five) their target catch ranges. For effort controlled fisheries, the current catch level of southern garfish required suitable adjustments to management which have already been initiated.

In summary, 27 of the 29 commercial fisheries assessed (93%) 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
2016/17	93	95

The proportion of recreational fisheries where catches or effort levels are acceptable.

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.

The Department has determined an annual tolerance catch and effort range for each of the major recreational fisheries. This indicator target has been set at 80% and has been measured since 2013/14.

For the purposes of this indicator, 17 fisheries or stocks have been identified as having a 'material' recreational catch share. Over time, the indicator may need to expand to include reference to fisheries or stocks for which there are other 'material' sectoral shares (e.g. customary fishing).

Of the 17 recreational fisheries, only five currently have explicit catch ranges developed and another eight have implicit ranges that can be used to assess acceptability. Of these 13 fisheries, the data from the most recent available surveys had catch estimate levels that were all within an acceptable catch range. Consequently, the percentage of recreational fisheries with acceptable catch levels was 100%, which exceeds the target level of 85% (Overview Table 3). The results of the 2016 state-wide boat survey will soon be available which will be used to update the assessments for a number of recreational fisheries.

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	2013/2014	2014/2015	2015/2016	2016/2017
Percentage of fisheries with acceptable catch/effort	77	85	100	100
Target value as per budget	80	80	80	85

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 continue 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 Primary Industries and Regional Development 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.

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, has 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 targeted marine pest surveillance in high value assets such as the Swan River system and Cockburn Sound. Details of the introduced species and pests detected in 2016/17 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

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.

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/. No new notifiable diseases were recorded in Western Australian wild stocks in 2016/17.

Aquatic disease is a critical issue for aquaculture operations, requiring considerable vigilance through regulated testing regimes and translocation restrictions. This is covered in more detail in the accompanying annual report on aquaculture.

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 Western Australia" (SOEWA) issued from time to time by the state Environmental Protection Authority (IW19 Number and location of significant fishkills). The total number of significant fish kills and fish kills investigated in Western Australia since the last SOEWA report is shown in Overview Table 6.

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; MSC – Certified by Marine Stewardship Council.

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] 2015/16 or 2016	Catch (or effort or catch rate) level acceptable and explanation if needed
WEST COAST BIOREGION					
West coast rock lobster (MSC)	Size-structured Population Model (Level 5)	Sustainable: Adequate	Commercial: 6000 (TACC) Recreational: 422 t (TARC)	Commercial: 6087 (t) Recreational: 272-400 t (1) 346-481 t (2)	Acceptable (1) based on historical data (2) based on updated average weight data for metropolitan region. A full review of methods used for estimating recreational catch underway.
Roe's abalone	Catch Rates & Direct Survey (Level 4)	Sustainable: Adequate (open areas)	Commercial: 87 t (Q) (530 – 640 days) Recreational: 18 – 22 t Perth Metro Area	Commercial: 49 t (383 days) Recreational: 26 - 30 t Perth Metro Area; 14 t Other	Acceptable Low overall commercial catch due to in season TACC reduction in area 7 (metro) plus economic and accessibility issues. Recreational catch above target partly due to larger size of abalone taken.
Octopus	Catch Rates (Level 2)	Sustainable: Adequate	Commercial 200 – 500 t Recreational: Not Developed	Commercial: 252t Recreational: 2t (boat only)	Acceptable The commercial catch range was reviewed in 2016 to reflect increased knowledge of sustainable harvest levels. Commercial fishery is in a planned expansion phase.

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] 2015/16 or 2016	Catch (or effort or catch rate) level acceptable and explanation if needed
WEST COAST BIOREGION Continued					
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 fishery remained closed due to ongoing effects of the 2010/11 marine heat-wave and continued above-average water temperatures. With cooler temperatures in 2016, stock levels in part of the Abrolhos Islands have improved.
Cockburn Sound crab	Direct Survey (Level 4)	Sustainable: Recovering	Commercial: Under Revision Recreational: Under Revision	Commercial: 0 t Recreational: 0t	NA With low egg and juvenile indices, the fishery has been closed since April 2014. While the egg production index has increased above the threshold in 2016 (Sep-Dec) the resulting level of recruitment is not yet known.
Peel-Harvey West Coast Crab (MSC)	Commercial Catch Rates (Level 2)	Sustainable: Adequate	Commercial: 45-105 t Recreational: Not formal	Commercial: 57 t Recreational (boat only, 95% CI) 2013/14: West Coast 50-66 t, Peel-Harvey 38-56 t	Acceptable Catch and catch rates were within allowable range. The large proportion of undersize crabs in 2015/16 was possibly due to cooler than average water temperatures and sporadic high rainfall events.
West Coast Nearshore and Estuarine finfish (MSC part)	Yes (Level 2)	Adequate: Mullet/ Whiting Actions taken: Herring Inadequate: Southern garfish	Commercial: 46-166 Peel-Harvey: 46-166t Herring: Under Review Recreational: Not Developed	Commercial (Peel-Harvey): 128 t Herring (Statewide): 72 t Recreational: 69-87 t (boat only)	Acceptable Status of herring stock to be reviewed in 2017 using level 3 assessment. New management arrangements for garfish are being developed.

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] 2015/16 or 2016	Catch (or effort or catch rate) level acceptable and explanation if needed
WEST COAST BIOREGION Continued					
West coast beach bait and south west beach seine	Catch (Level 1)	Sustainable: Adequate	Commercial: 60 – 275 (whitebait only) Recreational: Not applicable	Commercial: (whitebait): 34t	Not Acceptable Available evidence suggests gradual decline in whitebait stock level over past decade in line with environmental shifts requiring a review of the acceptable catch range.
West coast purse seine	Catch (Level 1)	Sustainable: Adequate	Commercial: 0 – 3,000 (Q) Recreational: Not applicable	Commercial: 1,177 t (all species)	Acceptable Total catch for all zones within recent historical catch range.
West coast demersal scalefish	Annual: Catch (Level 1) Periodic: Level 3	Sustainable: Recovering	Commercial: < 450 t Recreational < 250 t	Commercial: 256 t Recreational: 139-166 t(boat only) 56 t (charter)	Acceptable Catches by the commercial and recreational sectors were both within recovery and allocation benchmarks. Updated Level 3 assessment to be completed in 2017.
GASCOYNE COAST BIOREGION					
Shark Bay prawn (MSC)	Direct Survey/Catch Rate (Level 4)	Sustainable: Adequate	Commercial: 1,350-2,150 t Recreational: Not Applicable	Commercial: 1524 t	Acceptable Western king and brown tiger prawn annual landings were within their respective acceptable ranges.
Exmouth Gulf prawn (MSC)	Direct Survey/Catch rate (Level 4)	Sustainable: Adequate	Commercial: 771 – 1,276 Recreational: Not Applicable	Commercial: 822 t	Acceptable Landings of brown tiger and endeavor prawns were within their acceptable range, western king prawns were below their acceptable range but spawning stock above the threshold.

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] 2015/16 or 2016	Catch (or effort or catch rate) level acceptable and explanation if needed
GASCOYNE COAST BIOREGION Continued					
Shark Bay scallop	Catch Rates and Direct Survey (Level 4)	Sustainable: Recovering	Commercial: Trial Quota 830t Recreational: NA	Commercial: 816 t	Acceptable Trial quota for Denham Sound and northern Shark Bay stocks. Most recent survey identified further improved recruitment for both stocks.
Shark Bay Crabs	Catch Rates & Direct Survey (Level 4)	Sustainable: Recovering	Commercial: 450 t (Q) Recreational: NA	Commercial: 372 t	Acceptable Non-achievement of the TACC was due to unused quota. Most recent surveys have found a continued improvement in legal biomass.
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: 178 t	Acceptable Total catch remained below the acceptable range due to a further reduction in effort (lowest on record). Increase in catch of sea mullet and tailor, catch of yellowfin bream again above the 10-year average.
West Coast Deep sea crab (MSC)	Catch Rate (Level 2)	Sustainable: Adequate	Commercial: 154 t (Q); 61 k-101.5 k potlifts Recreational: NA	Commercial: 153.3 t (82 k potlifts)	Acceptable The TAC was achieved with effort remaining within its target range. The standardised catch rate of retained legal, undersize and berried crabs are all within their respective target ranges.
Gascoyne Demersal Scalefish	Annual: Catch and Catch Rates (Level 2) Periodic: Level 3 or Level 5	Sustainable: Adequate	Commercial: Snapper277 (Q) Other demersals – 227 (Q) Recreational: Not formal	Commercial: Snapper 150 t Other demersals 120 t Recreational: 88-110 t (boat only)	Snapper - Not Acceptable Other demersals - Acceptable Snapper catch rate has fallen below the threshold level prompting a review of the assessment. Goldband fishing mortality is lower than target level.

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] 2015/16 or 2016	Catch (or effort or catch rate) level acceptable and explanation if needed
GASCOYNE COAST BIOREGION Continued					
Inner Shark Bay Demersal (Snapper)	Periodic:	Sustainable: Adequate	Commercial: 8 t Recreational: 12 t EG, 12 t DS, 3.8 t FE	Commercial: 2 t Recreational: 4-5 t EG, 6-7 t DS, 1-2 t FE (boat only)	Acceptable The Eastern Gulf (EG), Denham Sound (DS) and Freycinet Estuary (FE) breeding stocks are all above their target abundance levels.
NORTH COAST BIOREGION					
Onslow prawn	Catch (Level 1)	Sustainable: Adequate	Commercial: 60 – 180 t Recreational: NA	Negligible	NA Minimal fishing occurred in 2016.
Nickol Bay prawn	Catch (Level 1)	Sustainable: Adequate	Commercial: 90 – 300 t Recreational: NA	17 t	Acceptable The catch prediction based on summer rainfall was low (30 t) which led to the low effort applied.
Broome prawn	Catch (Level 1)	Sustainable: Adequate	Commercial: 55 – 260 t Recreational: NA	Negligible	NA Minimal fishing occurred in 2016.
Kimberley prawn	Catch (Level 1)	Sustainable: Adequate	Commercial: 240 – 500 t Recreational: NA	Commercial: 155 t	Acceptable With landings of banana prawns below the catch prediction, the total catch was low due to drop in fishing effort in the second part of the season.
North Coast Nearshore and Estuarine	Catch Rates (Level 2)	Sustainable: Adequate	Commercial: 33–45 t (barramundi) Recreational: Not formal	Commercial: 51 t (barramundi) 75 t (total) Recreational: 11-19 t (boat)	Acceptable The catch of barramundi is similar to 2016 and the catch rate remains at a high level.

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] 2015/16 or 2016	Catch (or effort or catch rate) level acceptable and explanation if needed
NORTH COAST BIOREGION Continued					
Northern demersal scalefish	Annual: Catch and Catch Rates (Level 2) Periodic: Integrated Model (Level 5)	Sustainable: Adequate	Commercial: Under revision Recreational: Not Formal	Commercial: 1,173t (total) Recreational: 48-64 t (boat only)	NA Catches of goldband snapper and red emperor both within their longer-term ranges. Current recreational catch not considered a risk to stocks.
Pilbara fish trawl	Catch and Catch Rates/ Fishing Mortality/ Integrated Model (Level 2, 3 & 5)	Sustainable: Adequate	Commercial: Under revision Recreational: NA	Commercial: 1529 t Recreational: Covered in NDSF	NA Full assessment is in progress and the catch range is under review.
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 495 t (trap) 126 t (line) Recreational: Covered in NDSF	Acceptable The total catch of the trap fishery in 2016 was within the catch range. The line catch was marginally above the catch range which is under review for this sector.
Mackerel	Catch (Level 1)	Sustainable: Adequate	Commercial: 246 – 410 t(Q, Spanish Mackerel) Recreational: Not formal	Commercial: 276 t Recreational: 22-37 t (boat only)	Acceptable The commercial catch within the tolerance range since the management plan was introduced. Current recreational catch levels are not considered to pose any stock issues.
Northern shark	No Assessment	NA	< 20 (sandbar)	0	NA No fishing effort since 2008/09.
Pearl oyster	Catch rate predictions, standardised CPUE (Level 3)	Sustainable: Adequate	Commercial 612,550 oysters (Q) (14,071 – 20,551 hours) Recreational: NA	Commercial: 541,260 oysters (19,699 dive hours)	Acceptable Quota not achieved as vessels switched to seeding operations. Catch rates for season low but still within tolerance range. Abundance predicted to significantly increase in 2017.

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] 2015/16 or 2016	Catch (or effort or catch rate) level acceptable and explanation if needed
NORTH COAST BIOREGION Continued					
Sea cucumber	Catch Rate (Level 2)	Sustainable: Adequate	Commercial: Sandfish (Kimberley) 0 – 100 t Sandfish (Pilbara) 0 – 80 t Redfish 0 – 150t Recreational: NA	Commercial: Sandfish (K): 21 t Sandfish (P): 70 t Redfish: 2 t	Acceptable Catch ranges revised in 2016 as part of the new harvest strategy. Catch rates for sandfish and redfish above the target reference levels. New stock of sandfish accessed in Pilbara. Main redfish stocks not targeted this year due to planned rotational harvest schedule by industry.
SOUTH COAST BIOREGION					
South Coast crustacean	Standardised Catch Rate (Level 2)	Sustainable: Adequate	Commercial: 50 – 80 (southern rock lobster) Recreational" NA	Commercial: 38 t	Acceptable Commercial catch was below tolerance range but the catch rate in the targeted region. Catch and catch rates of deep sea crabs currently being assessed.
Abalone (greenlip/ brownlip)	Standardised Catch Rate plus Fishing Mortality (Level 3)	Sustainable: Adequate	Commercial: 145 t (Q) (3440 - 5270 hours) Recreational: Not formal	Commercial: 121 t (4411 hours) Recreational: 8 t	Acceptable Commercial effort within tolerance range following TACC reductions. Non-achievement of TAC due to a commercial Industry decisions. Recreational catch not considered a risk to these stocks.
South Coast Nearshore and Estuarine finfish	Catch Rates (Level 2)	Inadequate (cobbler in Wilson Inlet) Others: Adequate	Commercial: Under review Recreational: Not formal	Commercial: 103 t (salmon) 260 t (other) Recreational: 19-27 t (boat only)	NA Inadequate cobbler stock in Wilson Inlet is being addressed. Commercial catch of salmon relative low due to low effort from limited market demand.

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] 2015/16 or 2016	Catch (or effort or catch rate) level acceptable and explanation if needed
SOUTH COAST BIOREGION Continued					
Albany/King George Sound purse seine	Catch (Level 1)	Sustainable: Adequate	Commercial: 2683 t (Q) Recreational: NA	1515 t	Acceptable Catch and effort higher than in 2014/15 but within recent range.
Bremer Bay and Esperance purse seine	Catch (Level 1)	Sustainable: Adequate	Commercial: 3000 t(Q) Combined Recreational: NA	Commercial: 632 t	Acceptable Catch and effort were lower than 2014/15 for both Bremer Bay and Esperance and within recent ranges
Temperate Demersal Shark Fishery	CPUE (relative to previous assessment) (Level 4)	Gummy and whiskery: Sustainable: Adequate Dusky and sandbar: Recovering	Commercial: shark 725 – 1,095 t	Commercial: 823 t (key shark species only)	Acceptable Total commercial catch of key shark species within allowable tolerance range.
South Coast Demersal Scalefish	Demersal finfish: Level 3 Age Structure SPR	Demersal finfish: Sustainable: Adequate.	Demersal Finfish: under Development Recreational: Not formal	Commercial: 180 t. (Comprises 88 t wetline, 82 t TDGDLMF, and 10 t estuarine netting) Charter: 7 t Recreational: 31-38 t (boat only)	N/A Formal management for this fishery is now under development.
NORTHERN INLAND BIOREGION					
Lake Argyle catfish	Catch (Level 1)	Sustainable: Adequate	Commercial: 93 – 180 t Recreational: NA	103 t.	Acceptable The level of catch is within the allowable range for the fishery.

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] 2015/16 or 2016	Catch (or effort or catch rate) level acceptable and explanation if needed
SOUTHERN INLAND BIOREGION					
Marron	Catch &Fishery Independent CPUE (Level 1 & 4)	Sustainable: Adequate	Commercial: NA Recreational: 50 – 100 k	52,669 marron (± 4,801 se)	Acceptable Total catch was within the historic catch range recorded since 2003.

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 a vessel but 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

Common Name	Scientific Name	Type of Organism	Pest status	Year first detected	Bioregion			
					North Coast	Gascoyne Coast	West Coast	South Coast
	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 fish kills in Western Australia and the total number of fish kill investigated by the Fish Health Laboratory since the last SOEWA 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

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, typically flowing at speeds 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.

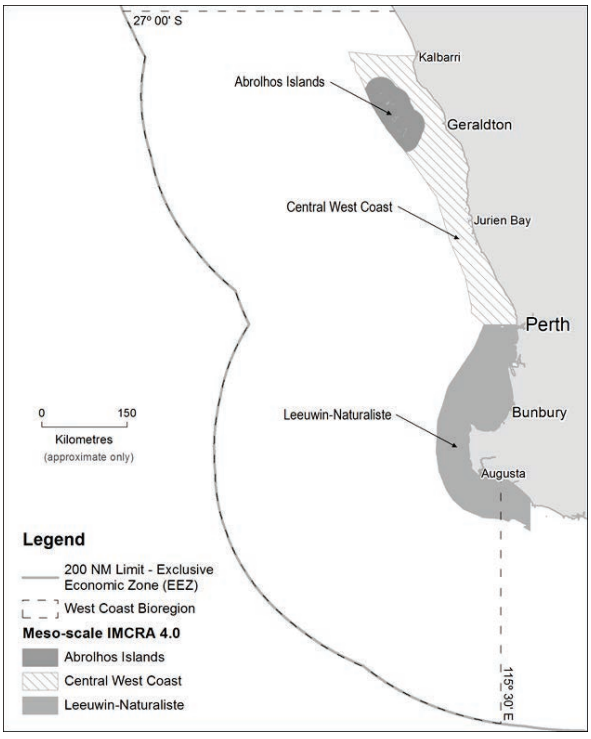
The most significant impact of the clear, warm, low-nutrient waters of the Leeuwin Current is on the growth and distribution of the temperate seagrasses. These form extensive meadows in protected coastal waters of the West Coast Bioregion, generally in depths of less than 20 m (but up to 30 m), and act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

Climate Change

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

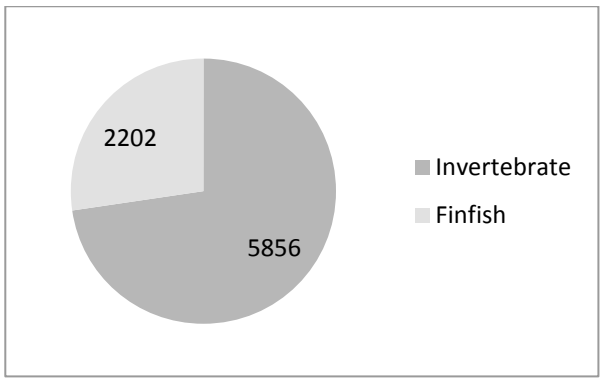
- Increasing frequency of El Niño/Southern Oscillation (ENSO) events;
- More years with a weaker Leeuwin Current;
- Increase in water temperature off the west coast of WA, particularly the lower west coast;
- Increase in salinity, which includes some large annual fluctuations;
- Change in the frequency 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 West 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. Changes in the distribution of key species are monitored in a national citizen-science program (www.redmap.org.au) in which the Department is a collaborator.

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, West Australian 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.

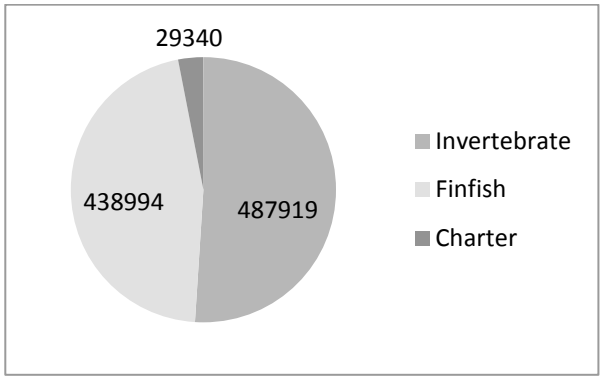


WEST COAST OVERVIEW FIGURE 2

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 (both shore- and boat-based), 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 2015/16, 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. Further, the Department has established a Mid-West Aquaculture Development Zone which aims to provide a platform to stimulate aquaculture investment and development in the bioregion.

Tourism

The State capital, Perth, is the principal gateway for 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 2,000 people, indirectly support 3,000 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 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

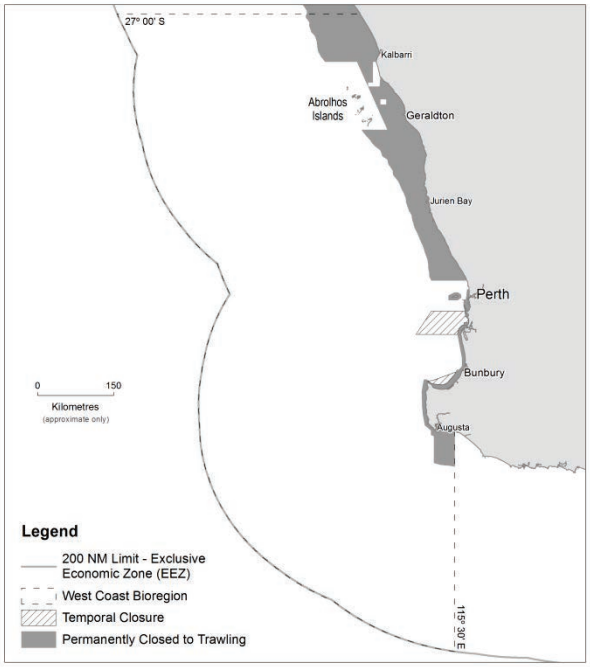
Within each Bioregion there are a range of management measures that have been implemented to manage the potential impact of activities. Management measures specific to the West Coast Bioregion include:

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 31^0 and 33^0 South from 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 (West Coast 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), HMAS Swan (Geographe Bay) and Lena (Off Bunbury). 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.



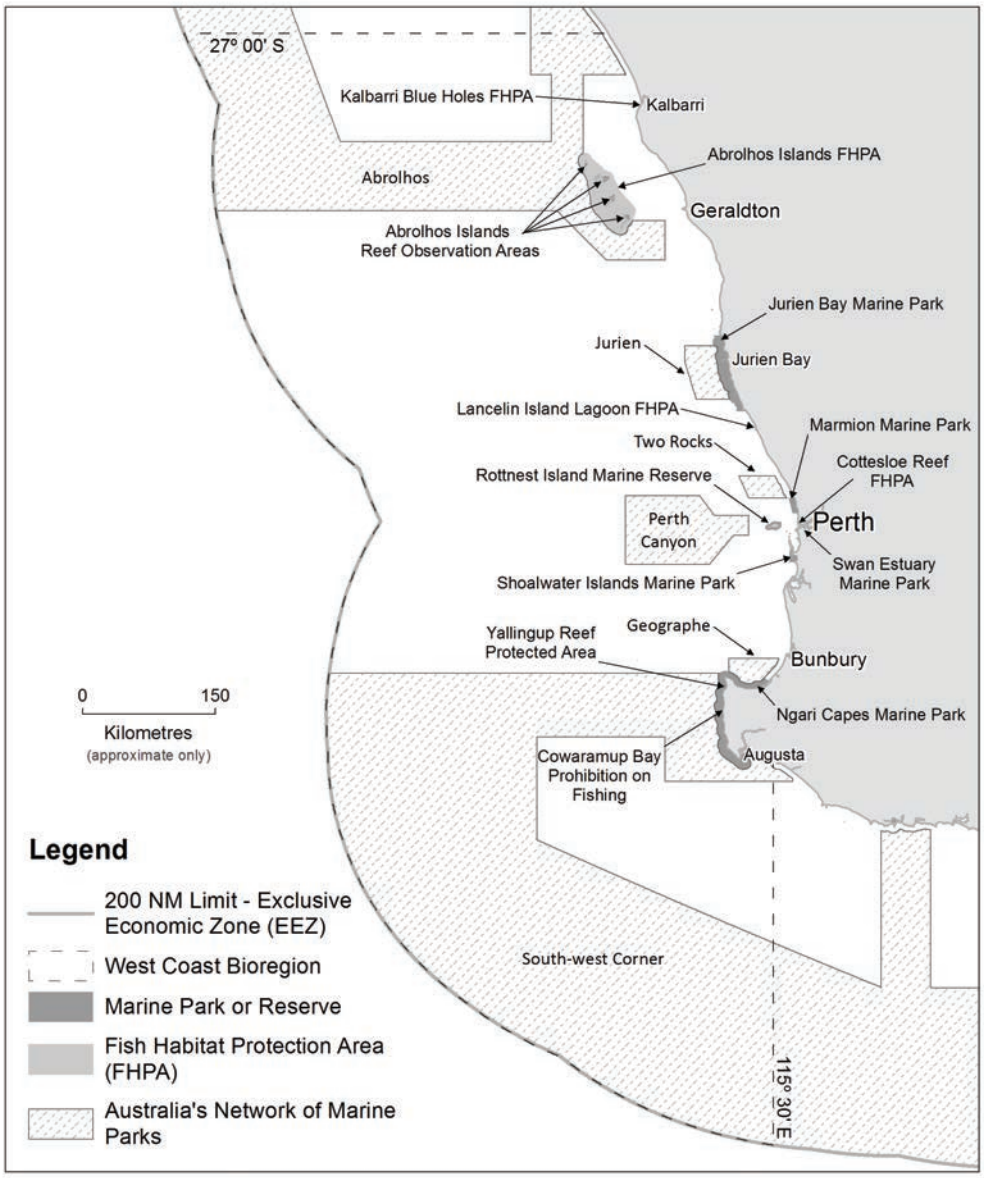
WEST COAST OVERVIEW FIGURE 4

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 (see next Figure).

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

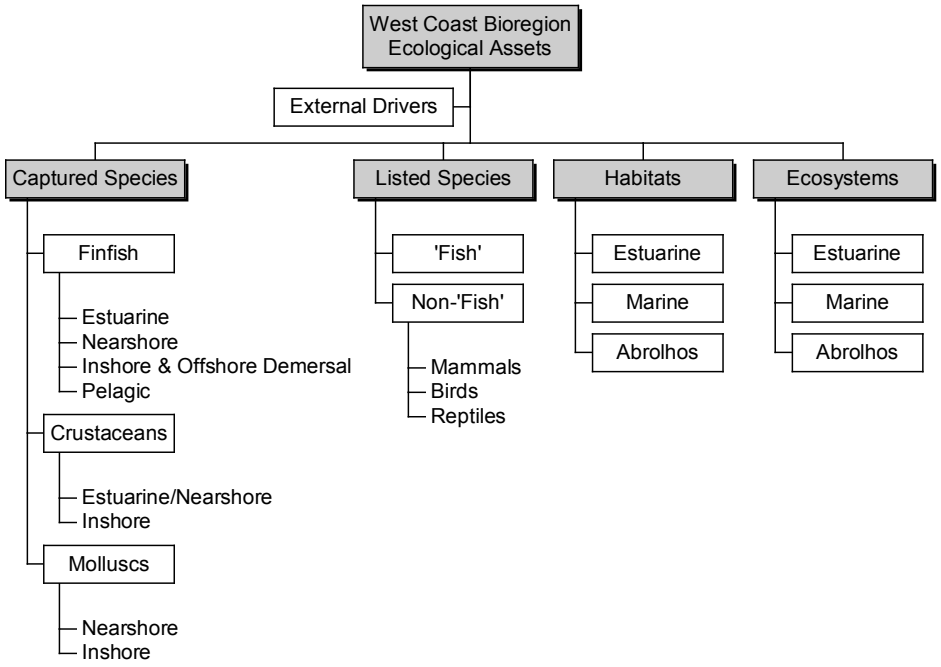


WEST COAST OVERVIEW FIGURE 5

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. 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.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 6

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

External Drivers

External drivers include factors impacting at the bioregional-level that are likely to affect the ecosystem as a 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. 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.

Climate

External Drivers	Current Risk Status
Climate	HIGH (long term)

The south west of Western Australia is predicted to be heavily influenced by the impacts of climate change (e.g. increasing sea temperatures, declines in rainfall). Some climate change information has been taken into account in the rock lobster stock assessment process and the effect of the marine heat wave in 2010/11 on fisheries has been assessed 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.

Captured Species

FINFISH

Estuarine

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

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

Nearshore

Captured Species	Aquatic zone	Ecological Risk
Finfish	Nearshore	SIGNIFICANT

Concerns for status of a range of nearshore species including Australian herring and southern garfish, have resulted in additional activities being undertaken to further monitor and assess stock status and estimate recreational 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 inshore demersal indicator species (West Australian 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 assessments of indicator stocks this resource is 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, with most emphasis focussed on samsonfish by recreational anglers.

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 are recovering and breeding stock levels are improving. However, the fishery remains closed to fishing in 2016/17 with a review of the stock status being conducted in 2017.

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 Peel-Harvey crab fishery achieved MSC certification for the commercial and recreational sectors.

The stock levels of western rock lobster and prawns are both currently at appropriate levels. The strong management that was applied to the rock lobster fishery has ensured that the lobster spawning stock is currently at record high levels.

Molluscs

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 for 5 years before re-opening in 2017.

Listed species

A variety of endangered, threatened and protected[1] (ETP) species can be found within the West Coast Bioregion, including cetaceans, pinnipeds, 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 estuary) and baldchin groper (Abrolhos Islands FHPA between 1 November and 31 January) cannot be landed by commercial or recreational fishers in the particular areas and periods.

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 of the late 1980s.

Regulated modifications to 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 km^2 of shallow coastal waters and grow predominantly on sand from 1 – 35 m depth, but also on deep rock to over 50 m deep. Seagrasses provide habitat for many fish and crustacean species, stabilise coastal sediments and prevent coastal erosion. In addition seagrasses are also important for primary production, CO_2 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 finfish 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 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, reduced rainfall) 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.

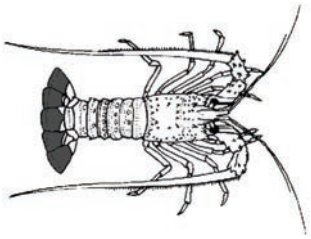
The Abrolhos Islands is noted for its high species diversity, which is attributed to the relatively equal mix of temperate and tropical species. Due to the uniqueness of the Abrolhos Islands Ecosystem in the West Coast Bioregion, it is assessed separately to the bioregion as a whole.

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 recorded 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 the community structure of finfish within and outside of non-fishing areas.

1 Abdo 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 2017



S. de Lestang, M. Rossbach and N. Blay

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. Lobsters are taken throughout their range by both the commercial and recreational sector and each sector operates to formal IFM allocations.

The WCRLMF 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 WCRLMF 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). The WCRLMF 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 2017 it was the first fishery globally to be certified by MSC for the fourth time (see de Lestang *et al*., 2016 for further details: www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_9.pdf).

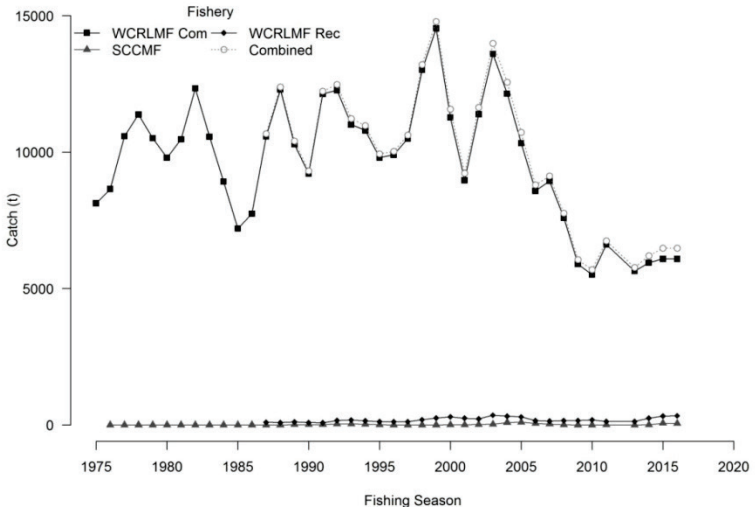
The commercial fishing season now begins on the 15 January each year and runs 12 months. The recreational fishery extends from 15 October each year until 30 June the following year. Licenced recreational fishers are allowed to take lobsters using a maximum of two baited pots or by hand collection when diving to collect legal sized lobsters up to the bag or boat limit.

SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational	
Total Catch 2016	6095 t	272-400 t (346-481 t based on updated average weight)	
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 Level 5 ($424 mill)- High Risk
Governance	Review of Harvest Strategy	External Drivers	High Risk (climate)

CATCH AND LANDINGS

The total landings of western rock lobster in 2016 from the WCRLMF were 6,508t. The commercial catch was 6095 t compared to a total allowable commercial catch of 6090 t (Total Allowable Commercial Catch [TACC] of 6000 plus drip loss). The commercial catch included an additional 8 t as part of a trial to provide lobster to the domestic market. The recreational catch was estimated to be between 272 and 481 t (depending on the average weight assumed) compared to the Total Allowable Recreational Catch (TARC) of 422 t (Western Rock Lobster Figure 1).



WESTERN ROCK LOBSTER FIGURE 1.

Total landings by fishery including the South Coast fishery (SCCMF) (and combined) for western rock lobster.

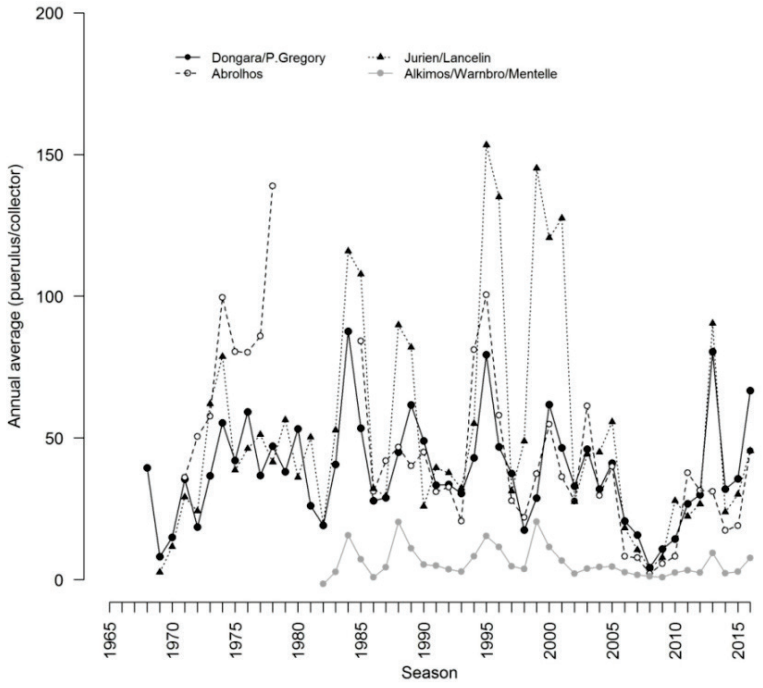
INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Western rock lobster - (Sustainable-Adequate)

Commercial and recreational catch rates have been maintained near their record-high levels. 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 WCRLMF is at record-high levels since the mid-1970s. The breeding stock is therefore considered **sustainable-adequate**.

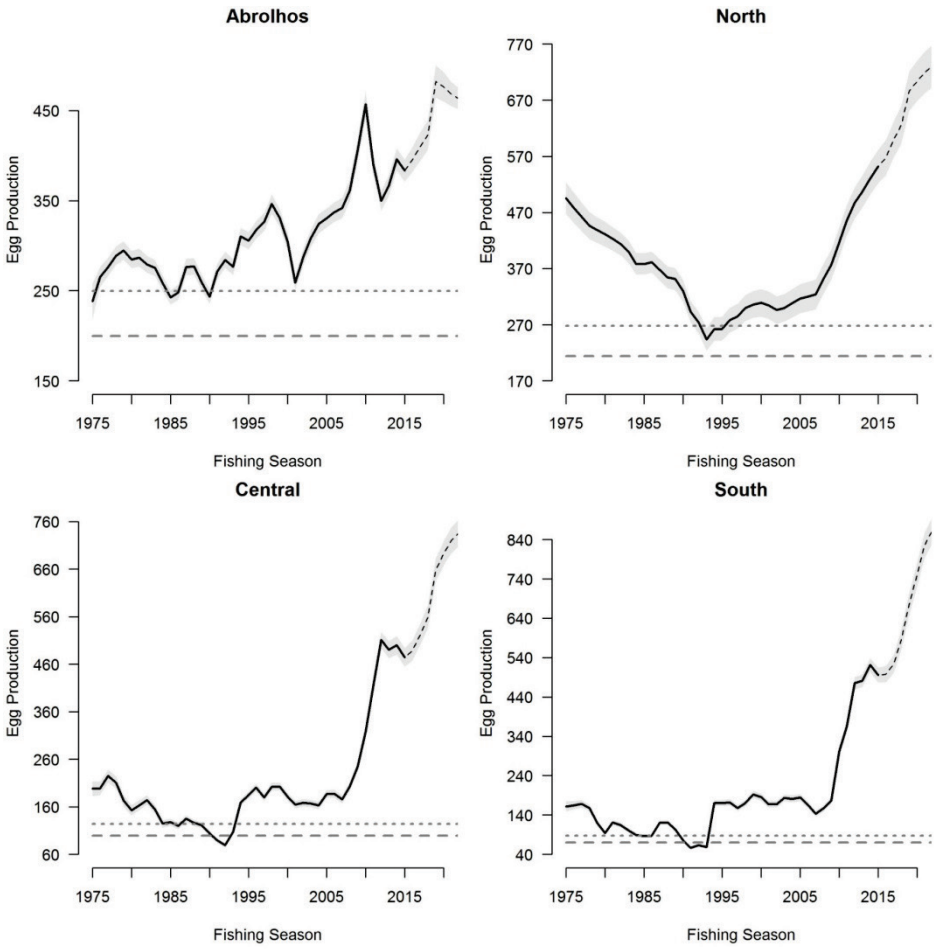
Fishery-independent recruitment (puerulus) monitoring indicates that the puerulus settlement improved in all areas during 2016/17 (Western Rock Lobster Figure 2).

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 legal and spawning biomass and catch rates and reduced harvest rates (see de Lestang *et al*., 2016 section 9.3.14 and Western Rock Lobster Figure 3).



WESTERN ROCK LOBSTER FIGURE 2.

Levels of puerulus settlement in four regions of the WCRLMF from 1968.



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 6400 t. 75% CI is denoted in grey. Horizontal lines represent the threshold (upper grey dotted) and limit (lower grey dashed) reference points for breeding stock levels in each breeding stock management area.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

The main bycatch species landed in the WCRLMF are octopus, champagne crabs (CC) and baldchin grouper (BG). Octopus contribute most to total bycatch landings with 12.4 t in 2016 and only incidental landings of the other species being recorded (1.4 and 1.9 t for CC and BG, respectively). See Octopus and Deep Sea Crab reports for further information.

The WCRLMF may interact with a number of protected species with substantial improvements having been achieved during the past decade (see Bellchambers *et al*. (2017) 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 Bellchambers *et al*. (2017) section 4). This has resulted in a significant (80%) reduction in reported whale entanglements. There were four entanglements reported in 2016.

Turtles can also get caught in the float rigs of lobster pots. In 2016 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 Bellchambers *et al*. (2017) section 6.2).

SOCIAL AND ECONOMIC OUTCOMES

Social

The WCRLMF is important for regional employment with 226 commercial vessels operating in 2016 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 55,000 recreational fishers holding rock lobster licences in 2016. At current high stock levels there is **low risk** to this valuable social amenity.

Economic

The estimated average price across all processors and all zones of the WCRLMF received by commercial fishers for the western rock lobster in 2016 was $69.65/kg. This was essentially the same as that paid in 2015 (the $69.52/kg). The similar beach price with the same TACC resulted in the overall value of the WCRLMF remaining similar at $424 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 6095 t was very close to the TACC of 6090 t (including 1.5% for water loss and 8 t of domestic quota) and therefore the catch level was **acceptable**. The average of the estimate of recreational catch based on the higher average weight (413 t) was close to the TARC of 422 t for the 2015/16 season and was therefore also considered **acceptable**. The harvest control rules surrounding recreational catch are based on a five-year moving average (FYMA). Further work on the exact method by which to calculate and compare the FYMA to the TARC is currently being conducted.

Harvest Strategy

A common Harvest Strategy and Control Rules 2014-2019 (HSCR) (DoF, 2014) are used to set catch limits for both commercial and recreational sectors on an annual basis. The HSCR have a primary sustainability objective to maintain egg production at sustainable levels and a secondary economic objective to target maximising the profitability of the WCRLMF 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 TARC.

Modelled future projections of the WCRLMF and MEY analysis indicates that a small (5 – 10%) increase in TAC will move the WCRLMF towards MEY and maintain healthy levels of egg production.

Compliance

The majority of enforcement effort is applied to ensure that fishers' catches are within their quota entitlement. There is also at-sea compliance to check that rock lobster gear is compliant with ASL and whale mitigation devices.

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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

Consultation with the commercial industry and Recfishwest on the review of the HSCR has begun. This process will aim to incorporate some of the outcomes from a recent FRDC project (Rogers *et al*. 2017) which examined the current TACC setting methodology. A TACC sub-committee of the Western Rock Lobster Council has recently been convened and this group will have direct input into the development of the new HSCR.

EXTERNAL DRIVERS

The variations in WRL 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 (water 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, WRL 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 WCRLMF 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 WRL.

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WEST COAST ROE'S ABALONE RESOURCE STATUS REPORT 2017

L. Strain, J. Brown and S. Walters

OVERVIEW

The Roe's abalone (*Haliotis roei*) resource is accessed by both commercial and recreational sectors, and 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 2017

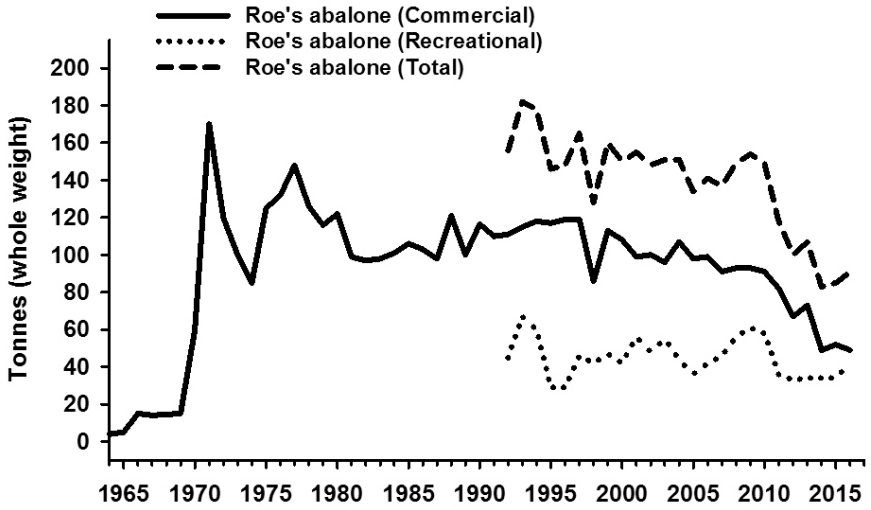
Fishery Performance	Commercial	Recreational
Total Catch 2016	49 t	26–30 t Perth Metro Area; 14 t Other
Fishing Level	Acceptable	Acceptable
Stock/Resource Performance	Stock Status	Assessment Indicators
Roe's abalone	Sustainable - Adequate (open areas)	Annual: Catch, Catch Rates, Surveys

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 - $1.17 mill High Risk
Governance	TAC prediction model (Area 7 / Zone 1) MSC full assessment complete	External Drivers	High - Extreme Risk

CATCH AND LANDINGS

In 2016 the total commercial catch was 49 t whole weight, a 4% decrease from 2015 (51 t) and only 56% of the 87 t whole weight TACC set at the beginning of the season (Roe's Abalone Figure 1). The commercial catch was less than the TACC in Area 1 (0% caught), Area 2 (90% caught), Area 5 (37% caught) and Area 6 (12% 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). In Area 7 (Perth metropolitan fishery) only 23.5 t whole weight was caught due to a voluntary in-season TACC reduction from 32 t to 24 t. This was done to bring the TACC in line with the stock prediction and allocation models for the Perth Metropolitan Roe's Abalone Fishery (DoF 2017).

The total recreational catch of Roe's abalone in 2016 was 42.2 t whole weight, which represents about 46% of the total Roe's abalone catch (Roe's Abalone Figure 1). The recreational catch includes 26–30 t (28.2 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.



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 open areas)

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 2016. 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 2016 was 16.2 t whole weight of the 18 t TACC. The standardised catch per unit effort (SCPUE) has been gradually declining since 2010 until an increase in 2016, and is still above the threshold reference level.

Area 5 (Albany): The catch in 2016 was 7.5 t whole weight of the 20 t TACC. The SCPUE has been slightly lower than the historical trend in the last four years but has increased in the last two years and is still above the threshold reference level.

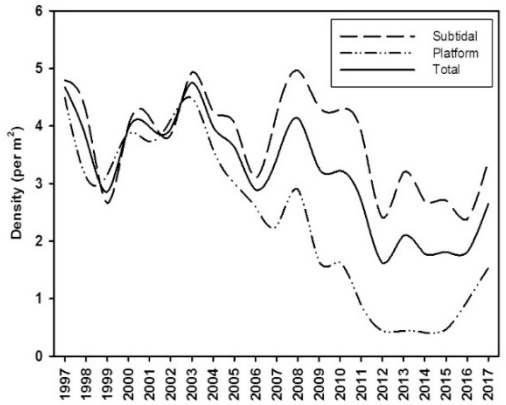
Area 6 (Capes): The catch in 2016 was 1.5 t whole weight of the 12 t TACC. The SCPUE in 2016 was above the threshold reference level and within the historical range, but due to the prevailing weather conditions resulting in low catch there is a degree of uncertainty around the SCPUE estimate.

Area 8 (Kalbarri): Closed since the 2011/12 season due to catastrophic mortality following the 2011 marine heatwave. With no evidence of natural recovery, a trial-scale restocking project was undertaken over several years but it has yet to be determined if restocking would be successful in the longer term (Strain *et al.* in press).

Perth Metropolitan Roe's Abalone Fishery (Area 7 / Zone 1): The commercial catch in 2016 was 23.5 t of the 32 t TACC, due to an in-season voluntary reduction in the TACC from 32 t to 24 t. The SCPUE in Area 7 has declined since 2005 until a slight increase in the last two years. The SCPUE is above the threshold reference level and the TACC was set using the stock prediction model. The recreational catch estimate was 26 – 30 t (28.2 t) whole weight and has been managed to the 20 t (± 2 t) TARC for the last 6 years. The higher recreational catch was due to two anomalous factors: (1) a 10% increase in average weight of animals caught, (2) changes to the effort distribution as more people fished in areas outside of the historical high usage zones. These factors are not accounted for until the data are collated at the end of season but will be incorporated into next year's in-season catch prediction model.

Fishery-independent surveys indicate that the density of harvest-sized (commercial) Roe's abalone in both the subtidal and platform habitats, and across both fished and unfished areas experienced substantial declines between 2002 and 2012 (Roe's Abalone Figure 2a and b). The density of harvest-sized animals on the reef platform has increased in the last two years from the record-low levels during 2012-2015, while the density on the subtidal habitat is at the highest level since 2011. (Roe's Abalone Figure 2a). Importantly, this recent increase in density is present in both unfished and fished stocks, suggesting that favourable environmental conditions for growth may have returned (Roe's Abalone Figure 2b). Age 1+ (17 – 32 mm) animals have also shown an increase in density over the last two years, after the juvenile recruitment density declined by 80% between 2010 and 2013 (post marine heatwave), with 2015 being the lowest year on record (Roe's Abalone Figure 2c).

a)



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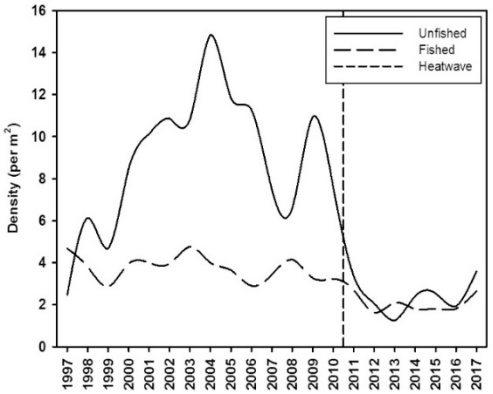

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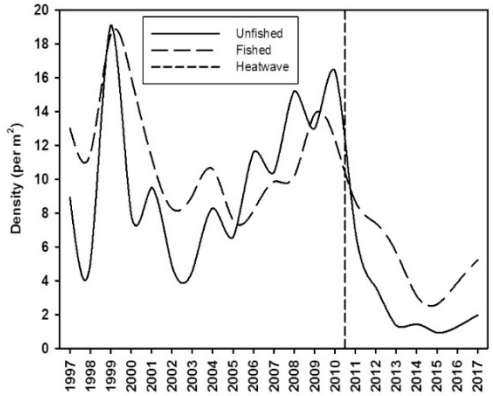

ROE'S ABALONE FIGURE 2.

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 Age 1+ abalone (17 – 32 mm) in the fished and unfished areas.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

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. **Negligible** risk.

HABITAT AND ECOSYSTEM INTERACTIONS

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. **Negligible** risk.

SOCIAL AND ECONOMIC OUTCOMES

Social

There are 22 vessels commercially fishing for Roe's abalone, employing approximately 45 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 members of the community that appreciate the abalone as a delicacy, and 18,002 licences were issued that would have allowed fishers to participate in the recreational abalone fishery. **High** risk.

Economic

Estimated annual value (to fishers) for 2016 was $1.17 million, based on the estimated average price for Roe's abalone of $23.81/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. **High** risk.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

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

Recreational – Acceptable: 18–22 t (TARC) Perth metropolitan fishery only (Zone 1).

Low overall commercial catch was due to an in-season voluntary TACC reduction in Area 7 (Perth metropolitan fishery), plus economic and accessibility issues in Areas 1, 2, 5 and 6. The fishing effort (383 days) was also below the expected range. Area 8 is still closed due to the catastrophic mortality following a marine heatwave. Recreational catch was above the catch target partly due to larger size of abalone taken.

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 with a temperature factor (DoF 2017). The predicted recruitment is used to set the Total Allowable Catch (TAC), with the habitat biomass and sectoral 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. 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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives (MSC Assessment)

Management arrangements for the Western Zone (Zone 1) of the recreational abalone fishery are currently under review.

The commercial Roe's abalone fishery has undergone full MSC assessment and achieved certification (https://fisheries.msc.org/en/fisheries/western-australia-abalone-fishery/@@view).

EXTERNAL DRIVERS

During the summer of 2010/11, the West Coast experienced a marine heatwave such that in the area north of Kalbarri (Area 8) mortalities on Roe's abalone were estimated at 99.9%, and a complete closure of the commercial and recreational fisheries was implemented. The heatwave also affected the Perth metropolitan stock but to a lesser extent.

Annual weather conditions during the time of fishing have a significant effect on catch rates and total catch of recreational fishers.

The small size of Roe's abalone results in its direct competition with hatchery-produced abalone and therefore, there has been a decline in beach price and overall economic value during the last decade.

High-Extreme risk.

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WEST COAST BLUE SWIMMER CRAB RESOURCE STATUS REPORT 2017

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

Overview

Blue swimmer crabs (*Portunus armatus*) are found in waters less than 50 m depth along the entire Western Australian coast. 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), Area 2 (Peel-Harvey Estuary) and Area 3 (Hardy Inlet) 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 and gill nets. 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. Recreational crab fisheries are centred largely on the estuaries and coastal embayments from Geographe Bay to the Swan River and Cockburn Sound. Recreational fishers use either baited drop nets, scoop nets or diving. Management arrangements for the commercial and recreational fisheries include minimum size, protection of breeding females and seasonal closures with effort controls in place for the commercial fishery (Johnston *et al*. 2015a).

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

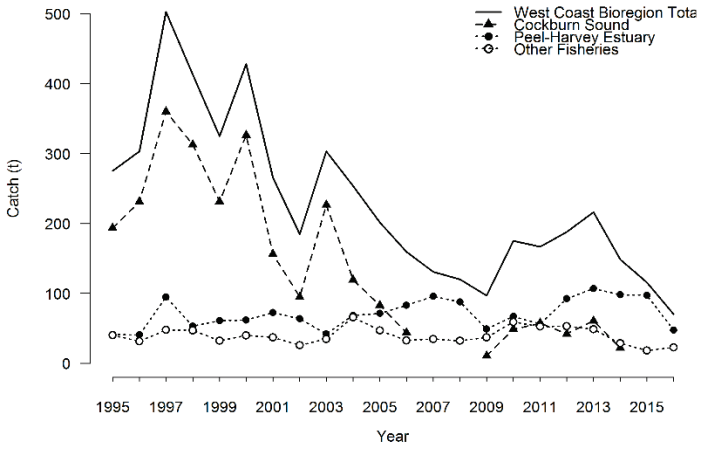
SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational	
Total Catch 2016	70 t	36–50 t (2015/16 boat-based only)	
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	Recovering	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 1 -<$1m 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 2016 was the lowest in over 20 years at 70 t. This represents a 39% decrease on the 116 t taken in 2015 primarily due to the continued closure of Cockburn Sound, cessation of fishing in Area 2 of the Mandurah to Bunbury Developing Crab Fishery, and reduced catch and effort in the Peel-Harvey Estuary (West Coast Blue Swimmer Crab Figure 1).



WEST COAST BLUE SWIMMER CRAB FIGURE 1

West Coast bioregion commercial catch history for the blue swimmer crab in Western Australia since 1995. Other fisheries include Warnbro Sound, Mandurah to Bunbury (Area 1 and 2), Swan River and Hardy Inlet.

Recreational Sector

The estimated boat-based recreational catch of blue swimmer crab in the West Coast represented 92% of the statewide boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range for blue swimmer crab in the West Coast was steady in 2015/16 (95% CI 36–50 tonnes) compared with 2013/14 (50–68), but lower than 2011/12 (75–97) (Ryan *et al.* 2017).

A previous (2008) 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). A recent study on recreationally important fisheries Swan-Canning Estuary, Leschenault Estuary and Geographe Bay investigated breeding stock and recruitment levels and recreational fishing data from a recreational angler logbook program (Harris *et al*., 2017).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Cockburn Sound (Recovering)

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 abundance 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.

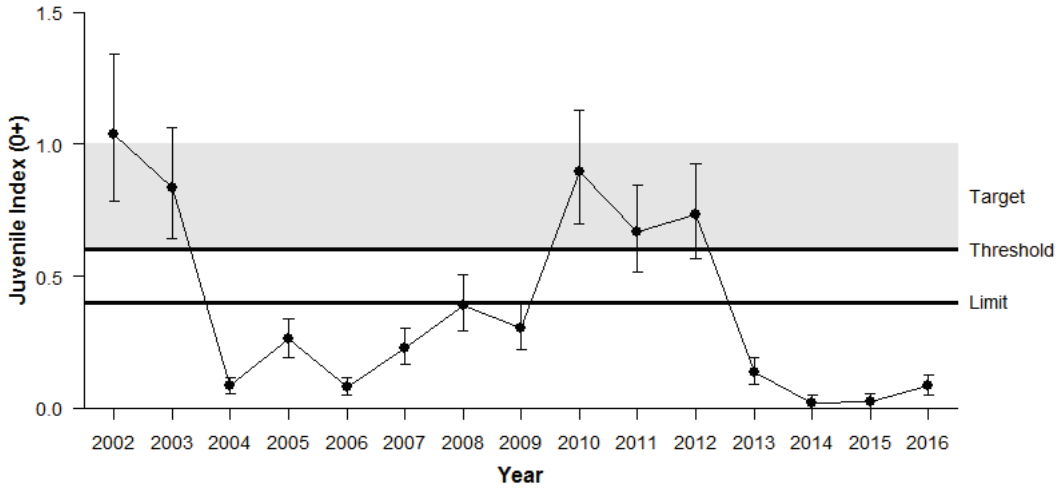
Juvenile index: The juvenile index for 2015 of 0.02 juveniles/100m^2 trawled was still below the limit of 0.4 juveniles/100m^2 trawled. The juvenile index for 2016 was a slight improvement but continues to be below the limit at 0.08 juveniles/100m^2 trawled (West Coast Blue Swimmer Crab Figure 2).

Egg Production index: The egg production index of 11.98 for 2016 was a significant increase from 2014 (4.0) and 2015 (2.8) and was at the harvest strategy threshold level of 12. Despite this increase in egg production, the 2017 juvenile recruitment index remained at a low level.

As commercial monitoring catch rates undertaken aboard a leased commercial vessel during the closure also improved during 2016, the status of the stock has been changed from Environmentally Limited to **Recovering** for the 2017/18 season.

As the 2015 egg production index and 2016 juvenile index were below their respective limit levels, the fishery remained closed for the 2016/17 season**.**

Potential reasons for the stock decline 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 believed to be substantially attributable to environmental changes, rather than fishing.



WEST COAST BLUE SWIMMER CRAB FIGURE 2

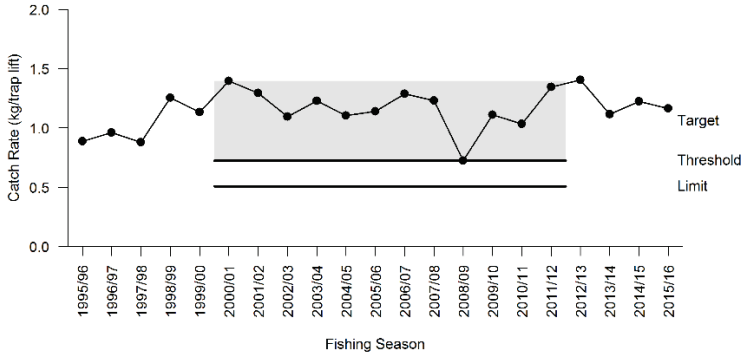
Annual standardised index of juvenile (0+) blue swimmer crabs in Cockburn Sound calculated using data from juvenile research trawls conducted in April, May and June of each year. The index units are numbers of juveniles/100m^2 trawled. The associated reference points (target, threshold and limit) for 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 2015/16 fishing season was 58 t from 56,746 trap lifts which is a 40% reduction in catch and a 19% decrease in effort compared to the 2014/15 season.

Since the 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 2015/16 in the Peel-Harvey Estuary was 1 kg/trap lift.

The standardised catch rate of 1.2 kg/traplift for the 2015/16 fishing season was well above the harvest strategy threshold of 0.7 kg/traplift, indicating the stock is currently being fished at sustainable levels (West Coast Blue Swimmer Crab Figure 3). A weight-of-evidence approach is used for the stock assessment where information from fishery-independent surveys, commercial monitoring and environmental data are also taken into account to assess stock status. On the basis of this evidence, the crab stock in the Peel Harvey is classified as **Sustainable.**

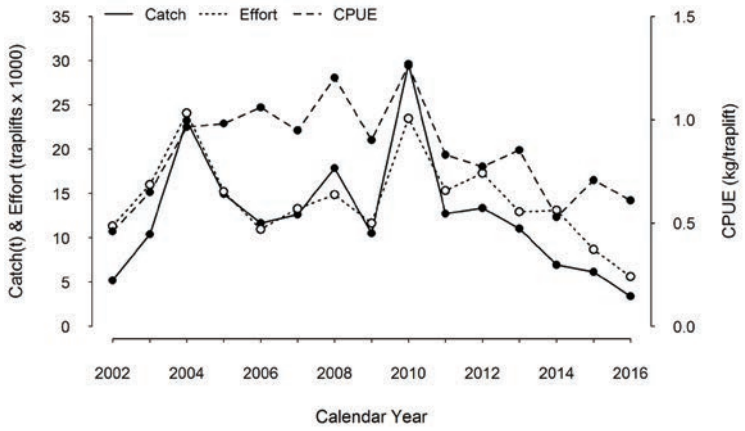


WEST COAST BLUE SWIMMER CRAB FIGURE 3.

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 (30% 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 2016 of 3.4 t from 5,600 trap lifts, representing 44% and 36% decreases compared to 2015, primarily due to reduced fishing effort in Area 1 (West Coast Blue Swimmer Crab Figure 4). These were the lowest catch and effort in over 15 years. The mean catch rate for 2016 of 0.6 kg/traplift was a 14% decrease on the 2015 catch rate of 0.7 kg/traplift (West Coast Blue Swimmer Crab Figure 4). However these catch rates are above the preliminary threshold levels that have been established. On the basis of this evidence, the crab stock in this region is classified as **Sustainable.**



WEST COAST BLUE SWIMMER CRAB FIGURE 4.
Blue swimmer crab trap catch (t), effort (traplifts x 1000) and catch per unit effort (kg/traplift) in Area 1 and Area 2 of the Mandurah to Bunbury Developing Crab Fishery since 2002.

BYCATCH and PROTECTED SPECIES INTERACTIONS

Crab traps 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.

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 and ECOSYSTEM INTERACTIONS

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.

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. These crab fisheries 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 2016, 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 (by number) recreational species. **Moderate-High** risk.

Economic

The commercial blue swimmer crab catch in the West Coast Bioregion for 2016 had an estimated gross value of production (GVP) of approximately $0.38 million, a decrease on the $0.62 million in 2015 (**level 1** <$1 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 and for 2016 was $5.41 per kg. **Moderate-High** risk.

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 based on 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 the 2015 egg production index and 2016 juvenile index were below their respective limit levels, the fishery remained closed for the 2016/17 season**.**

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

As the indicator was above the threshold for 2015/16, no management changes occurred for the 2016/17 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 commercial catch rate using the reference period for Area 1 Comet Bay between 2006 and 2012, and for Area 2 Mandurah-Bunbury between 2004 and 2012.

As the indicators were above the threshold in 2016 (Area 1 Comet Bay ≤0.53 kg/trap lift and Area 2 Mandurah-Bunbury ≤1.22 kg/traplift), no changes to the management occurred 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 in the recreational fishery as it has the highest level of non-compliance in the State, particularly for undersize crabs being taken and during night-time periods.

Consultation

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.

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

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

A south-west blue swimmer crab resource management review is being undertaken during 2017/18 with the aim of increasing efficiency and consistency of management across the entire resource. As a consequence of periodic environmental impacts on the resource, there is likely a need to provide a greater buffer to female breeding stock. Potential options include extending or introducing season closures and increasing minimum size.

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. Temperature appears to be an important factor contributing to the decline of the Cockburn Sound Crab Fishery. The level and timing of rainfall may also affect the Peel-Harvey and Swan River fisheries. The effect of the marine 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. Although these temperature changes have also resulted in the increased abundance of blue swimmer crabs in the South Coast estuaries, on the West Coast this species is rated as having a **high** risk to climate change.

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WEST COAST OCTOPUS RESOURCE STATUS REPORT 2017

A. Hart, D. Murphy, M. Yerman

OVERVIEW

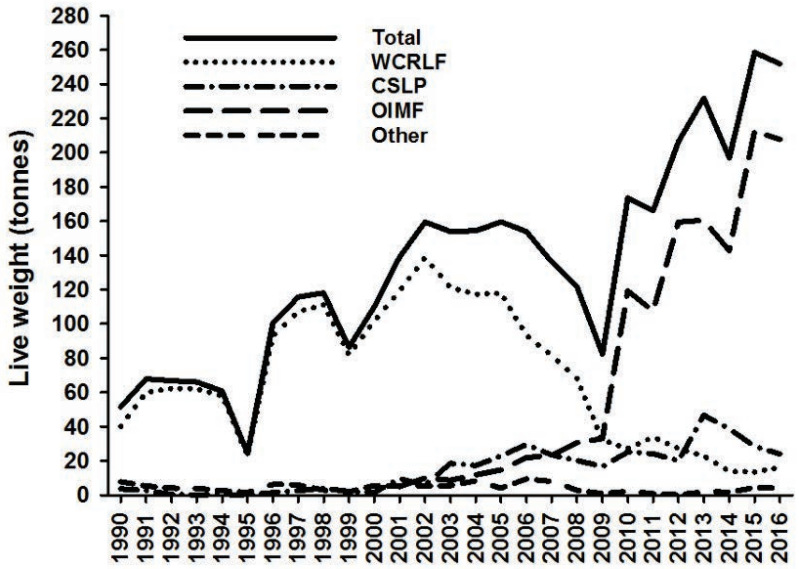
The octopus fishery in Western Australia targets the gloomy octopus (*Octopus tetricus*). Commercial octopus catch is harvested from three different fisheries with the majority of commercial catch coming from the Octopus Interim Managed Fishery (OIMF). The primary harvest method in the OIMF is a 'trigger 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. More details will become available in the octopus Resource Assessment Report (in prep).

SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational	
Total Catch 2016	252 t	2 t (2015/16 boat-based only)	
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 Low Risk	Economic	GVP Level 2 ($2.1 mill) Low Risk
Governance	New Management Plan	External Driver	Low Risk

CATCH AND LANDINGS

In 2016 the total commercial octopus catch was 252 t live weight, which was a 3% decrease over last year's record high catch of 259 t[1] (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 2015/16 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*. 2017).



OCTOPUS FIGURE 1.

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

[1] This figure has been revised down from the 274 t reported last year.

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 in 2016 was 460 km^2, similar to 2015 when it was 507 km^2. This area was only a minor percentage (~2%) of the total estimated habitat area of >30,000 km^2 (Hart *et al*. 2016). The current catch of 252 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

The selective method of fishing used results in a minimal level of bycatch of other species. In 2016 there were no reported entanglements with whales. This compares favourably with 2015 and 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. **Low** risk.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat effects

In the CSLPMF and OIMF, octopus-specific pots are set in similar habitats to those fished in the WCRLMF, 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 12 days in the OIMF and 15-20 days in the CSLPMF. Rock lobster potting in the WCRLMF 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 WCRLMF report for full details). **Low** Risk.

Food chain effects

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

Each dedicated octopus fishing vessel employs between 2 and 4 people. In 2016, ~ 200 vessels caught octopus, although the vast majority of these landings were small (< 100 kg), as they were bycatch in the WCRLMF. Within the octopus specific fisheries, 4 vessels fished in the CSLPMF, and 16 (includes 1 vessel operating under Condition 20) vessels in the OIMF. There is also a substantial processing and value-added component to the octopus catch with factories in Fremantle and Geraldton. **Low** Risk.

Economic

The estimated annual value for 2016 was $2.1 million based on the total catch of 252 t and an average product price of $8.29 /kg live weight. **Low** Risk.

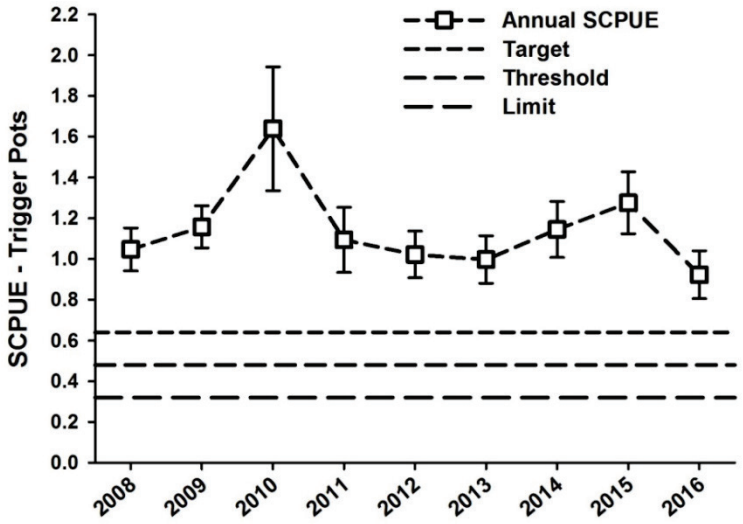
GOVERNANCE SYSTEM

Annual Catch Tolerance Range (Acceptable)

The target catch range for octopus is 200-500 t. The 2016 catch of 252 t was within the acceptable range.

Harvest Strategy

The harvest strategy and catch range was reviewed in 2016 to reflect increased knowledge of sustainable harvest levels. Fishery is in a planned expansion phase. 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. Draft Target, Threshold, and Limit reference points have been proposed, and the fishery is currently above the target level (Octopus Figure 2).



OCTOPUS FIGURE 2.

Standardised catch per unit effort (SCPUE) (±95% CL) in kg / pot (kg in live weight) of *Octopus tetricus*. Proposed biological reference points (Target, Threshold, Limit) are also given.

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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

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) Managed Fishery Management Plan (Plan) 1995 was reviewed following the Minister for Fisheries' decision on octopus pot entitlement allocation in the CSLPMF. Amendments to the Plan were made on 1 May 2015 to introduce an octopus pot scheme of entitlement which is now in effect.

EXTERNAL DRIVERS

Cephalopods in general, including octopus, are known to be subject to large environmentally-driven fluctuations in abundance. Octopus was rated as a **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 WCRLMF remains a low proportion of the overall catch.

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WEST COAST NEARSHORE AND ESTUARINE FINFISH RESOURCE STATUS REPORT 2017

K. Smith, M. Holtz, E. Bunbury, J. O'Malley and M. Yerman

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 western Australian salmon (*Arripis truttaceus*), Australian herring (*Arripis georgianus*), southern school whiting (*Sillago bassensis*), yellowfin whiting (*Sillago schombergkii*), yelloweye mullet (*Aldrichetta forsteri*), whitebait (*Hyperlophus vittatus*), tailor (*Pomatomus saltatrix*), southern garfish (*Hyporhamphus melanochir*), silver trevally (*Pseudocaranx georgianus*) and King George whiting (*Sillaginodes punctatus*). Landings of estuarine finfish are mainly sea mullet (*Mugil cephalus*), estuary cobbler (*Cnidoglanis macrocephalus*) and black bream (*Acanthopagrus butcheri*).

Six 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 for sea mullet (and blue swimmer crabs) in June 2016 (see Department of Fisheries 2015, Johnston *et al*. 2015 for full details).

SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	380 t	58–77 t (2015/16 boat-based only)
Fishing Level	Acceptable	Acceptable
Stock/Resource Performance	Stock Status	Assessment Indicators
Nearshore	Inadequate (Herring, garfish)	Annual: Catch, Catch Rate; Periodic: Fishing mortality, SPR
Estuarine	Adequate (sea mullet)	Annual: Catch, Catch Rate

EBFM Performance Asset	Level	Asset	Level
Bycatch	Low Risk	Listed Species	Negligible Risk
Habitat	Negligible Risk	Ecosystem	Moderate Risk (from fishing)
Social	High Amenity Moderate Risk	Economic	GVP Level 1 (<$1 mill) Low Risk
Governance	Harvest strategy for herring under development	External Drivers	High Risk (habitat degradation, climate change)

CATCH AND LANDINGS

In 2016, the total commercial catch of nearshore and estuarine finfish in the WCB was 380 t, comprising 236 t from ocean waters and 144 t from estuaries (Nearshore and Estuarine Finfish Table 1). The commercial catch was taken predominantly by six fisheries: West Coast Estuarine Managed Fishery, South West Coast Salmon Managed Fishery, South West Beach Seine Fishery, West Coast Demersal Scalefish Managed Fishery, Cockburn Sound (Fish Net) Managed Fishery and the West Coast Beach Bait Managed Fishery.

The total recreational shore-based catch was not estimated but is believed to represent a significant proportion of the overall catches of nearshore and estuarine species. The top 10 nearshore and estuarine species (or species groupings) in the West Coast represented 93% of the total boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range for the top 10 nearshore and estuarine species in the West Coast was steady in 2015/16 compared with estimates from previous statewide surveys (95% CI 58–77 tonnes compared with 68–87 in 2013/14, but lower than 101–126 in 2011/12) (Ryan *et al.* 2017).

NEARSHORE AND ESTUARINE FINFISH TABLE 1.

Total catches (tonnes) of finfish in commercial fisheries in nearshore and estuarine waters in West Coast Bioregion in previous five years. (*Calendar year 2011/12, 2012/13 etc)

Common name	Scientific name	2012	2013	2014	2015	2016
Sea mullet	*Mugil cephalus*	103.7	100.1	123.4	143.4	138.4
Western Australian salmon	*Arripis truttaceus*	47.1	92.7	60.1	37.9	98.0
Australian herring	*Arripis georgianus*	28.5	47.1	46.6	49.0	61.7
White bait	*Hyperlophus vittatus*	65.7 (83)*	18.6 (12)*	63.5 (13)*	61.2 (97)*	16.3 (34)*
Yellowfin whiting	*Sillago schombergkii*	18.4	24.1	36.6	46.5	31.8
Yelloweye mullet	*Aldrichetta forsteri*	22.6	18.6	19.8	6.3	12.5
Tailor	*Pomatomus saltatrix*	9.0	14.2	10.5	9.8	3.0
Southern garfish	*Hyporamphus melanochir*	5.8	4.3	4.8	2.4	2.4
Perth herring	*Nematalosa vlaminghii*	1.0	1.5	2.5	2.5	3.0
Trevallies	*Pseudocaranx* spp.	2.3	2.8	2.2	1.7	1.2
Estuary cobbler	*Cnidoglanis macrocephalus*	5.2	1.8	0.2	1.3	1.2
King George whiting	*SIllaginodes punctatus*	3.7	2.0	0.9	0.8	1.1
Black bream	*Acanthopagrus butcheri*	1.4	1.3	0.8	1.1	3.6
Other finfish		10.9	17.1	6.4	6.8	5.7
Total		325.4	346.4	378.4	370.8	380.1

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 include both spawning potential ratio (SPR) and fishing mortality (F).

Sea mullet (Sustainable-Adequate)

In the WCB, the majority (~60% p.a.) of commercial landings are taken in the 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.* 2017) and, while the current recreational shore-based catch is not known, it is believed to be low.

A level 3 assessment of the WCB stock is underway. Until this assessment is completed, the main performance indicator is the Peel-Harvey standardised commercial catch rate. The 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 **sustainable-adequate.**

Yellowfin whiting (Sustainable-Adequate)

In 2016, the total commercial catch of the southern stock was 37 t. The majority (>95%) of commercial landings of the southern stock occur in the WCB. The West Coast Estuarine Managed Fishery (WCEMF) takes ≥70% 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) rapidly increased in from 10 t in 2012 to 30 t in 2015 in response to strong recruitment. The Peel-Harvey catch fell to 20 t in 2016.

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.* 2017).

A level 3 assessment based on age structure data collected in 2015 and 2016 confirmed that that the higher catches in recent years are due to strong recruitment (Department of Primary Industries and Regional Development, in prep 1). Catches in both sectors are now declining and returning to more typical levels as the influence of the recruitment event wanes. Currently, SPR is estimated to be above the threshold level (30%). On the basis of this evidence, the

yellowfin whiting stock in this Bioregion is classified as **sustainable-adequate.**

King George whiting (Sustainable-Adequate)

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). The estimated boat-based recreational harvest range for King George whiting in the West Coast was steady in 2015/16 (95% CI 8–15 tonnes compared with 9–18 in 2013/14 and 11–20 in 2011/12) (Ryan *et al.* 2017). In those years, the total commercial catch was 15 t and 14 t, respectively. In 2016, the total commercial catch was 19 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. On the basis of this evidence, the King George whiting breeding stock is classified as **sustainable-adequate.**

Australian herring (Sustainable-Recovering)

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 2016, the total WA commercial catch was 83 t (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 catches in 2016. The estimated boat-based recreational harvest range for Australian herring in the SCB was steady in 2015/16 (95% CI 8–14 tonnes) compared with 2011/13 (10–15), but lower than 2011/12 (21–31) (Ryan *et al.* 2017). The current shore-based recreational catch is unknown. Partial estimates of shore-based catch are available for the Perth area, April-June only (Smallwood *et al.* 2012). The April-June catch has progressively declined from 22 t in 2010 to 6 t in 2016.

SPR is the key indicator of stock status. SPR was estimated to be below the limit reference level of 20% in the most recent assessment, based on data collected in 2013/14 and 2014/15. SPR has been below 20% since 2009/10. A recovery plan has been implemented for this stock. On this basis, the Australian herring stock is classified as **sustainable-recovering**.

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. The catch remained at 2 t in 2016. 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 and 2009/10. The estimated boat-based recreational catch of southern garfish was steady in 2015/16 (1,994 kept by number, SE=992) compared with 2013/14 (1,636, SE=673) and 2011/12 (16,340, SE=3,477) (Ryan *et al.* 2017, Smith *et al.* 2016).

Commercial catch rates have been declining since 1996 (Nearshore and Estuarine Finfish Figure 1). Recreational catch rates recorded in voluntary fishing logbooks follow a similar downward trend. The trends suggest a substantial decline in stock level since the late 1990s. SPR declined from 40% in 1998 to approximately 20% in 2010/11 (Smith *et al.* 2016). The current spawning biomass is likely to be below 20% of the unfished level, which is the limit reference level, and therefore the southern garfish stock in this region is classified as **unsustainable-inadequate.**

Whitebait (Unsustainable-Inadequate)

Since 2003/04, virtually all commercial landings have been reported in the Bunbury area by the South West Beach Seine Fishery. 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 likely to be strongly driven by recruitment variability. The 2011 heatwave event along the west coast appears to have resulted in reduced spawning success in winter 2011, followed by exceptionally low catches and catch rates in 2012/13 and 2013/14 (Nearshore and Estuarine Finfish Table 1). The total catch was 34 t in 2015/16. Standardised catch rates in three of the last five years were the lowest since the early 1980s (Nearshore and Estuarine Finfish Figure 2). The evidence suggests that the stock is **unsustainable-inadequate**. The contracted distribution and apparent heatwave impacts also suggest environmental limitations.

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 2016, the total commercial catch of tailor was 14 t. Most of this catch was taken in the Gascoyne Coast Bioregion (11 t, see Inner Shark Bay Scalefish Status Report), with the remainder in the

WCB (3 t) and the South Coast Bioregion (<1 t). In the WCB, the total commercial catch has typically been less than 20 t per year since records commenced in 1912. The majority of the WCB commercial catch is taken in the Peel-Harvey Estuary.

Most of the recreational catch of tailor is taken in the WCB. 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). The estimated boat-based recreational harvest range for tailor in the West Coast was steady in 2015/16 (95% CI 3–7 tonnes compared with 3–7 in 2013/14 and 6–22 in 2011/12) (Ryan *et al.* 2017).

The catch rate of tailor fluctuates markedly in response to recruitment variations, which are linked to environmental factors (Smith *et al.* 2013b). Fishery catch rates and juvenile recruitment are monitored annually in the Perth area. Current catch, catch rates and recruitment levels have been stable (non-directional) over the past 20 years. On this basis, the stock is classified as **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 has 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 2016, 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 (Department of Fisheries 2015). Both catch and catch rate were within the target range in 2016, suggesting a low fishing impact on this stock. On the basis of this evidence, the cobbler breeding stock in this estuary is assumed to be **sustainable-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 slightly above this target level in 2016. The 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 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 have a lower risk of barotrauma-related injuries than deep water oceanic 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 risks to their populations are 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, 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 is a key prey item for little penguins (*Eudyptula minor*) and whitebait availability may affect their breeding success (Cannell *et al*. 2012). Little penguins from colonies at Penguin Island and Garden Island forage for whitebait and other baitfish between Cockburn Sound and Geographe Bay (Cannell 2016). Whitebait removals by fishing pose a **moderate** risk to these penguins when whitebait abundance is low.

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 fishery 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 51 commercial fishers employed (either part or full time) in nearshore and estuarine fisheries in 2016, largely supplying fresh fish to meet demand for locally-caught product.

Economic

Estimated annual value (Gross Value of Production) to commercial fishers for 2015: Level 1 (less than $1 million). **Low Risk**.

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 2016, the catches of sea mullet and yellowfin whiting exceeded their threshold reference levels (70 t and 14 t, respectively). The Department reviewed the risks posed by these catch levels and determined that they were **acceptable**.

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 2016 catch was 83 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 2015/16 state-wide catch of herring, i.e. <16 t.

Whitebait:

The catch tolerance range is 60-275 tonnes. The catch was 34 t in 2015/16 and was therefore **unacceptable**.

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 (Department of Fisheries 2015). A draft Harvest Strategy for Australian herring was released for public comment in 2016 (Department of Primary Industries and Regional Development, in prep 2). 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 Western 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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

A draft Harvest Strategy for Australian herring was released for public comment in 2016. The draft harvest strategy will be finalised and published following a herring stock assessment workshop to be held in September 2017.

On 20 June 2017 the Perth Metropolitan waters were closed to the take of southern garfish. The closure, which extends from 31 degrees south (near Lancelin) to 33 degrees south (adjacent to Lake Preston), was introduced to ease fishing pressure on southern garfish stocks to aid their recovery and following consultation

with WAFIC, Recfishwest and affected commercial fishers.

EXTERNAL DRIVERS

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).

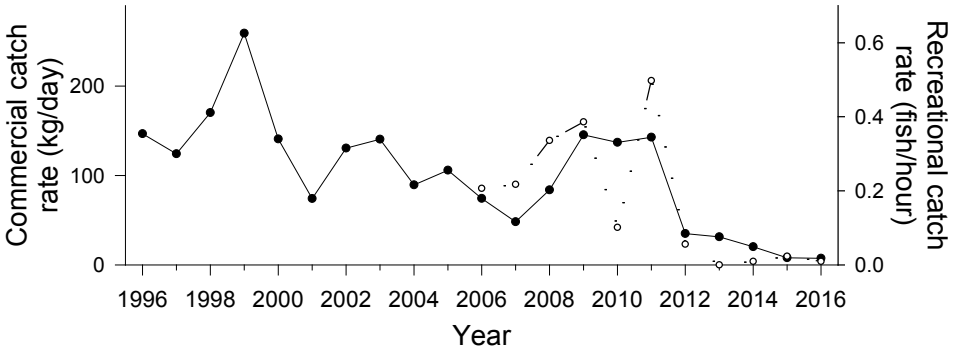
Changes in environmental variables due to climate change (such as ocean temperature, currents, winds, nutrient supply, rainfall, ocean chemistry and extreme weather conditions) are expected to have major impacts on marine ecosystems. These impacts are expected to create both difficulties and opportunities 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 more important than 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).

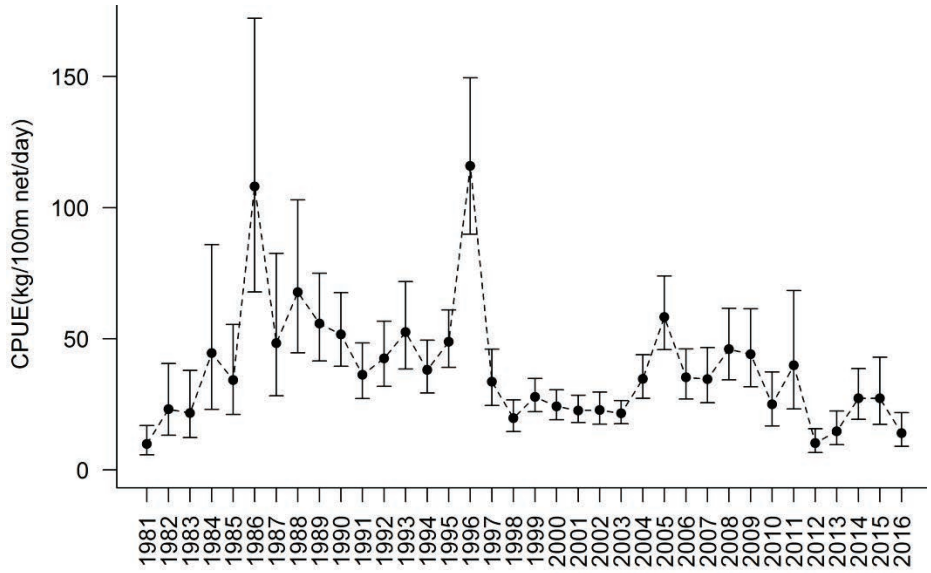
Fluctuating market demand is a significant factor affecting the annual commercial catch levels of many species.

High risk.



NEARSHORE AND ESTUARINE FINFISH FIGURE 1.

Standardised commercial and recreational catch rates of southern garfish in Cockburn Sound.



NEARSHORE AND ESTUARINE FINFISH FIGURE 2.

Standardised commercial catch rate of whitebait in the Bunbury area.

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WEST COAST SMALL PELAGIC SCALEFISH RESOURCE STATUS REPORT 2017

J. Norriss and E. Bunbury

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 West Coast Purse Seine Fishery (WCPSF), using purse seine gear in waters between Geraldton and Cape Leeuwin, which includes three separate zones - Northern Development Zone (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 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	1,177 t	<1 t (2015/16 boat-based only)
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 mill) 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 2016 was 1,177 t, of which about 80% was tropical sardine and 20% pilchards (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.

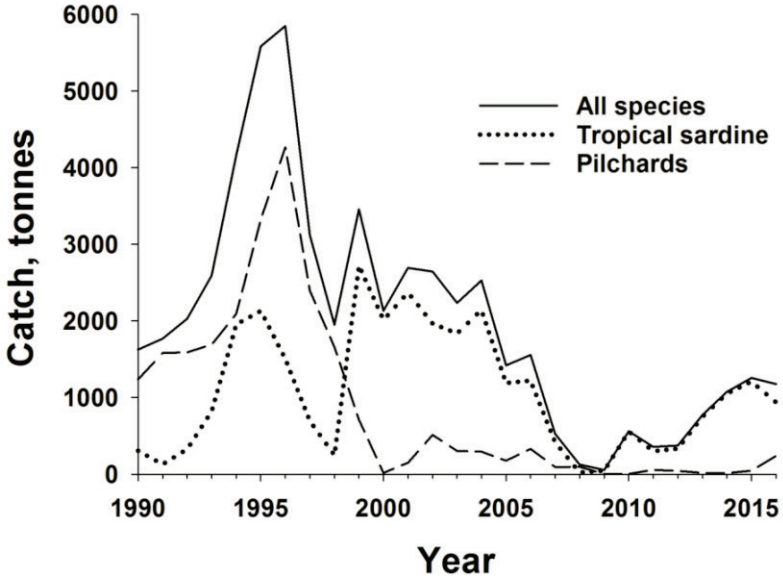
trend since 2011 (West Coast Small Pelagic Scalefish Figure 1). These catches were well below previous historical high levels. The limited spatial distribution of fishing effort for what appears to be a highly mobile species suggests that only a small proportion of a widespread stock is being targeted. Catches are therefore considered sustainable and the biological stock **sustainable-adequate**.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Tropical sardine (Sustainable-Adequate)

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.

The WCPS catch of tropical sardines in 2016 was 938 t, a 22% decrease from 2015 following an upward



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 from 1990 to 2016.

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 WCPSF catch of pilchards in 2016 was 237 t, the highest annual catch since 2006 (West Coast Small Pelagic Scalefish Figure 1). Much higher pilchard catches where recorded in the mid-1990s, primarily from the Perth Metropolitan Zone, declined precipitously during the mid to late 1990s following two mass mortality events. 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 annual 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. Annual catches were below 100 t until 2016. 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 finfish species are sometimes taken as bycatch, but this occurs infrequently and the majority are released from the net unharmed. N**egligible** risk.

Interactions with endangered, threatened and protected species (ETPs) must be reported to the Department on monthly statutory CAES returns. No interactions were reported by the WCPSF in 2016 indicating the fishery poses a **negligible** risk to ETPs.

HABITAT AND ECOSYSTEM INTERACTIONS

Purse seine nets are pelagic in nature, with limited impact on benthic habitats during normal operations. On rare occasions nets may be deployed in shallow waters and come into contact with 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 estimated recreational catch (boat fishing) of small pelagic species is very small (<1 t annually), comprising yellowtail scad, scaly mackerel and pilchards. **Low** risk.

Economic

A small proportion of the catch is sold for human consumption while the vast majority is sold for bait, aquaculture feed or pet food. The estimated gross value of production (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 2015/16 licensing period (1 April 2015 – 31 March 2016) the notional TAC was 2,328 t for pilchards and 672 t for other small pelagic species (including *Sardinella*). Reaching or exceeding the notional TACs will trigger a management response.

Harvest Strategy

The WCPSF is currently managed under a constant catch harvest strategy, with catches limited to zonal TACs.

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 Management 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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

There are no broader management reviews planned for the WCPSF in 2017. Stocks will continue to be monitored principally through Level 1 (catch based) assessments.

EXTERNAL DRIVERS

Climate change is likely to be causing a southward contraction in the natural distribution of of pilchards (**moderate** risk) and facilitating a southward extentsion for tropical sardine (**negligible** risk).

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WEST COAST DEMERSAL SCALEFISH RESOURCE STATUS REPORT 2016

D. Fairclough, S. Walters 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, Snapper and Baldchin groper, while the proposed indicators for offshore waters include Hapuku, Blue-eye trevalla and Eightbar grouper (see DoF 2011).

Following an assessment in 2007 demonstrating overfishing of the inshore demersal resource, management arrangements designed to recover the resource were progressively introduced between late 2007 and early 2010. These include maintaining the retained catches of demersal species by all sectors to below 50% of their 2005/06 catches in order to reduce fishing mortality rates (F) of indicator species to below the threshold reference point and to manage the resource in accordance with 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 arrangements with access, gear, area and/or entitlement limitations. Similarly, boat-based recreational and charter fishers are licensed and managed by input and output controls including a closed season. For further details see the West Coast Demersal Scalefish Resource Assessment Report and SAFS (2016).

SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016 (demersal)	256t	193–230 t (2015/16 boat-based only), 56 t (Charter)
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 -$1-5m Moderate Risk
Governance	Stable	External Driver	Moderate Risk

CATCH AND LANDINGS

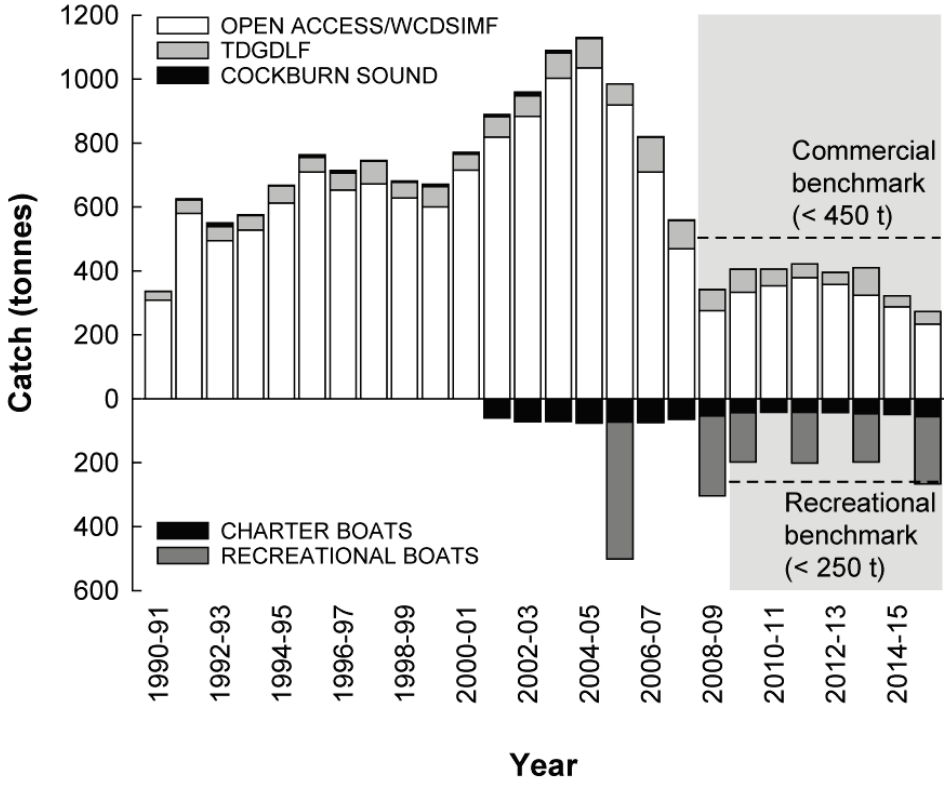
The total retained catch in 2016 by the West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF) was 234 t, comprising 214 t of demersal species. Other commercial fisheries in the WCB landed a total of 42 t of demersal species (during 2016 or 2015/16), with the Temperate Demersal Gillnet and Demersal Longline fisheries taking almost 40 t and the Cockburn Sound Line and Pot Managed Fishery, South-west Trawl Managed Fishery and West Coast Rock Lobster Managed Fishery combined, taking less than 3 t.

Catches of demersal species by the WCDSIMF and by all commercial fisheries in the WCB were below stock recovery benchmarks (50% of 2005/06 catches) of 410 t and 450 t, respectively, and much lower than prior to management changes (West Coast Demersal Scalefish Resource Figure 1). Catches of the WCDSIMF have declined steadily since 2011. This is partly influenced by reductions in available effort entitlement (and thus reduced effort expended) in 2015 in the Kalbarri and Mid-west Areas to limit catches of snapper. Catches of this indicator species had exceeded its stock recovery retained-catch benchmark for over

three years. Catches of demersal species in 2016 in the Kalbarri Area (92 t), Mid-west Area (78 t) and South-west Area (44 t) were each less than their 2015 catches of 111 t, 85 t and 52 t, respectively.

Total annual retained catches of the top 15 demersal species by the recreational sector have remained around or below the stock recovery benchmark of 250 t (Fig. 1). Charter fishers retained 56 t of the top 15 demersal species in 2015/16, an increase from 50 t landed in 2014/15 and 46 t in 2013/14. This is despite a gradual decrease in effort from ~22,000 lines fished in 2012/13 to 20,400 lines fished in 2015/16.

The top 15 species in the West Coast demersal suite represented 93% of the total boat-based recreational catch (kept by numbers) of demersal species in 2015/16. The estimated boat-based recreational harvest range for the top 15 demersal species in the WCB was higher in 2015/16 (95% CI 193–230 t) compared with 140–169 t in 2013/14 and 146–174 t in 2011/12) (Ryan *et al*., 2017).



WEST COAST DEMERSAL SCALEFISH RESOURCE 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*., 2017). 2011/12, 2013/14 and 2015/16 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

Annual assessments are undertaken using catch levels. Periodic Level 3 assessments of stock status of indicator species 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 for WA dhufish and Snapper 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 around or below respective stock recovery benchmarks of 82 t, 72 t and 126 t, since inception of the current management regime in 2008, e.g. 37 t, 28 t and ~127 t (Charter fishers: 14 t; boat-based fishers: 113 t, 95% CI: 97-129 t) in 2016 or 2015/16 (Fig. 2a). WCDSIMF catches of WA dhufish in the Mid-west and South-west areas have remained around or below recovery benchmarks of 44 t and 19 t since 2008, but had declined to 20 t and 4 t in those areas by 2016. The reduction in effort entitlements in

the Mid-west in 2015 would have contributed to catch declines in that area.

The estimated boat-based recreational harvest range of West Australian dhufish was higher in 2015/16 (95% CI 97–129 t) compared with 2013/14 (69–94 t) and 2011/12 (64–87 t) (Ryan *et al*. 2017). The numbers of discarded dhufish represented 45% of the ~4,600 landed by charter fishers in 2015/16 and 68% of the 49,020 (95% CI: ±8,063) landed by boat-based recreational fishers in 2015/16. Boat-based recreational fishers discarded dhufish mainly as a result of them being undersize.

The last assessment (Fairclough *et al*., 2014) of *F* at the biological stock (bioregion) level, using age composition data collected between 2008/09 and 2010/11 (during management changes), was lower than from the previous period 2005/06-2007/08 (Fig. 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 points. These results indicate an improvement in status of the stock.

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

Snapper (Sustainable - Recovering)

Retained catches of Snapper in the WCB by all commercial fisheries and the WCDSIMF were continuously above respective recovery benchmarks of 126 t and 120 t between 2010 and 2014. Reductions in entitlements to fishers in the Kalbarri and Mid-west areas of the WCDSIMF in 2015 contributed to reducing catches below those benchmarks in that year (84 t) and in 2016 (68 t) (Fig. 2b). Catches of snapper in 2016 in the Kalbarri (40 t) and Mid-west (26 t) areas were more than 20% below benchmarks of 65 t and 43 t for those areas.

Estimated total retained catches of the recreational sector (recreational boat-based fishers and charter fishers) during years of the integrated surveys of 2011/12, 2013/14 and 2015/16 have been above the recovery benchmark of 37 t, e.g. ~54 t in 2015/16 (Charter fishers: 19 t; boat-based fishers: 36 t, 95% CI 30-42 t).

The estimated boat-based recreational harvest range of snapper was steady in 2015/16 (95% CI 30–42 tonnes) compared with 2013/14 (25–36) and 2011/12 (27–38) (Ryan *et al*. 2017). The numbers of discarded snapper represented 44% of the ~10,370 landed by charter fishers in 2015/16 and 74% of 50,741 (95% CI: 9,698) landed by boat-based recreational fishers in 2015/16. Boat-based recreational fishers discarded snapper mainly as a result of them being undersize.

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 (Fig. 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 if maintained should allow the stock to recover from overfishing. The biological stock is classified as **sustainable-recovering**.

Baldchin groper (Sustainable - Recovering)

Retained catches of Baldchin groper in the WCB by all commercial fisheries and the WCDSIMF have been around or below stock recovery benchmarks of 22 t and 17 t respectively, since commencement of the current management regime, e.g. ~9 t and 7 t in 2016 or 2015/16 (Fig. 2c). Retained catches of Baldchin groper by the recreational sector have varied above and below the benchmark of 33 t, but were at their highest in 2015/16, i.e. ~48 t (Charter fishers: 12 t, boat-based recreational fishers 36 t, 95% CI: 28-42 t).

The estimated boat-based recreational harvest range of Baldchin groper in 2015/16 (95% CI 28–42 tonnes) was higher than the harvest range in 2013/14 (17–25) and similar to the harvest range in 2011/12 (24–36) (Ryan *et al*. 2017). The numbers of discarded Baldchin groper represented 38% of the ~6,500 landed by charter fishers in 2015/16 and 40% of 24,302 (95% CI: 5,116) landed by boat-based recreational fishers in 2015/16. Boat-based recreational fishers discarded baldchin groper mainly as a result of them being undersize.

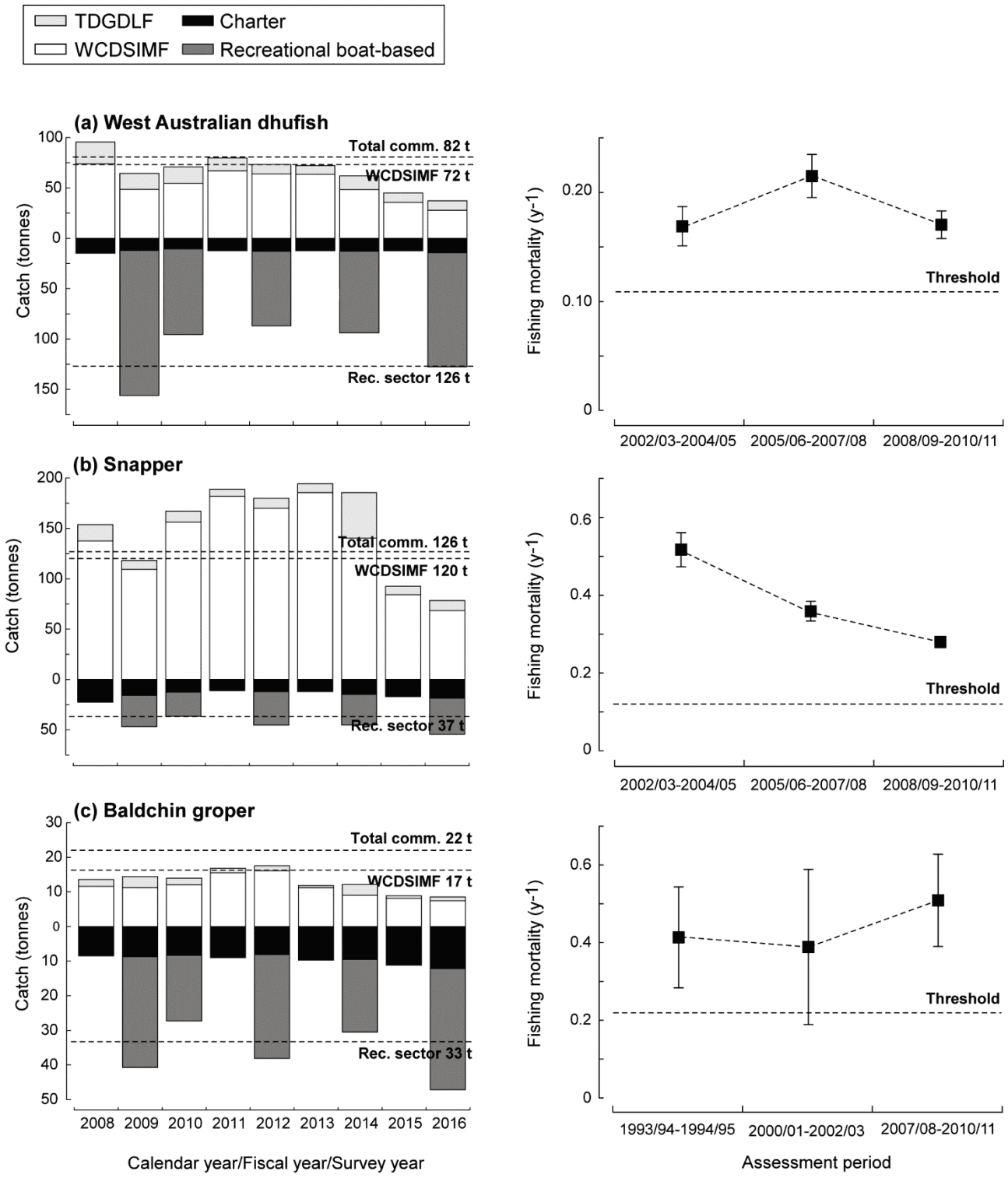
The last assessment of Baldchin groper demonstrated that rates of *F* at the biological stock level, using age composition data collected from 2008/09 to 2010/11 (i.e. during management changes) did not change from the previous assessment. *F* estimates were above the limit reference point of 1.5*M* (Fig. 2c; Fairclough *et al*., 2014). Similarly, little change was identified in SPR, with point estimates between 0.2and 0.3.

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

Offshore Demersal

Estimated retained catches of the dominant offshore demersal species (6-14 t) by the WCDSIMF have remained below the nominal sustainable catch range for this suite (20-40 t) since the fishery commenced in 2008. Offshore demersal species are rarely caught by other state commercial fisheries, but are sometimes caught by the Commonwealth Western Deepwater Trawl Fishery. However, effort and estimated annual catches since 2002 have remained relatively low (e.g. Ruby snapper < 25 t, Hapuku/Bass groper < 1 t, Blue-eye trevalla = 0 t) (http://data.gov.au/dataset/reported-retained-annual-catch-from-commonwealth-fisheries-logbooks).

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



WEST COAST DEMERSAL SCALEFISH RESOURCE FIGURE 2.

Commercial and recreational estimated 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*., 2017). 2012/13 and 2014/15 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 demersal species that are caught but not normally retained during demersal fishing activities (including inedible species, e.g. Silver Toadfish, and small species, such as wrasses) may not all survive, this still represents a minor impact to their stocks and therefore a **low risk**.

Protected Species: Commercial WCDSIMF and charter fishers are required to record listed species interactions in their statutory returns. Interactions with listed species by commercial, charter and recreational demersal fishers in the WCB are minimal. During 2016, no interactions with protected species were reported by WCDSIMF fishers. In 2015/16, charter fishers caught and released alive one grey nurse shark. The level of interactions with listed species is therefore considered a **negligible risk** to their populations.

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 137,388 Recreational Fishing from Boat Licences held in WA from September 2015 to August 2016. The annual estimated boat-based recreational fishing effort in the West Coast was steady in 2015/16 (271,311 boat days, SE=11,032) compared with 2013/14 (249,719, SE=10,563) and 2011/12 (293,112, SE=10,688) (Ryan *et al*. 2017).

WCDSIMF vessels operating in 2016 employed between zero and three crew excluding the skipper. Sixty three licensed charter operators fished in the WCB in 2015/16. 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 2016 was $1-5 million (level 2). There is currently a **moderate level of risk** to this level of return.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels (Acceptable)

The catch levels of both the commercial and recreational sectors indicate that the fishery performance for both sectors is considered **acceptable**. Total catches of demersal species by the commercial and recreational sectors were maintained around or below recovery catch benchmarks of 450 t and 250 t, respectively. 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 t, 120 t, 65 t and 43 t for more than three years. Subsequent management changes reduced entitlements to the WCDSIMF Kalbarri and Mid-west Areas at the beginning of 2015, which has reduced retained catches to acceptable levels (below recovery benchmarks) in each year since then.

Harvest Strategy

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 (see 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 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 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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

The trial of filleting on-board commercial vessels presented no compliance issues and will therefore be formalised in the management plan for the fishery. The current management arrangements will be reviewed following the release of the latest stock assessment in 2017. A formal harvest strategy for the WCDSR is ecpected to be completed in 2018. No other reviews of management are anticipated for 2018.

EXTERNAL DRIVERS

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) that could influence recruitment and the biology of demersal species. Declines in demersal catch in the South-west Area followed an extreme event, a marine heatwave in 2011 (Caputi *et al*., 2014). 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 small with no estimated catch of demersal species in the WDWTF in 2014, the most recent year of data. 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.

Moderate risk.

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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 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 distributions 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.

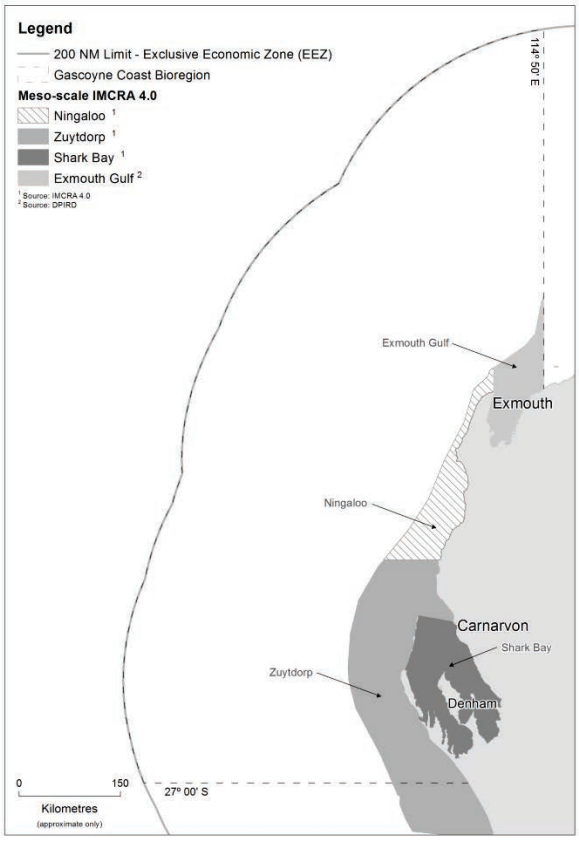
The waters off the Gascoyne Coast are also strongly influenced by the southward-flowing Leeuwin Current, generated by flow from the Pacific through the Indonesian archipelago. This tropical current becomes evident in the North West Cape area and flows along the edge of the narrow continental shelf where, coupled with low rainfall and run-off plus the north flowing Ningaloo Current, it supports the 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 are 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 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 west coast of WA, particularly the lower west coast;

- 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.

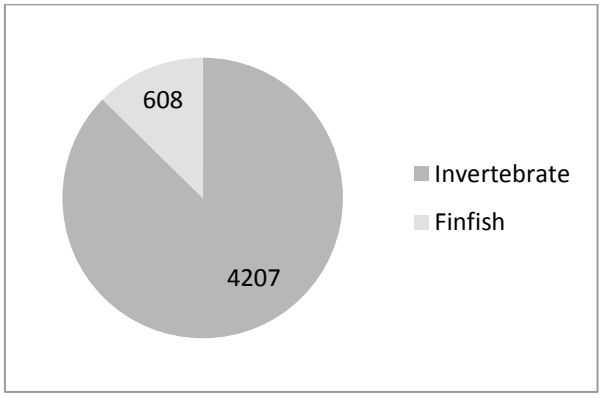
The Gascoyne Coast Bioregion is predicted to be at enhanced risk from the effects of climate given that it spans a transitional zone between tropical and temperate regions. The variables expected to drive climate change impacts include changes in water temperature, ocean currents, winds, rainfall, sea 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. Changes in the distribution of key species are monitored in a national citizen-science program (www.redmap.org.au) in which the Department is a collaborator.

Commercial Fishing

Commercial fishing is a significant industry in the region, with catch dominated by invertebrate resources (Gascoyne Coast Overview Figure 2), including 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. Both prawn fisheries as well as the west coast deep sea crab fishery have achieved Marine Stewardship Council (MSC) certification. 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 to the NT border and is reported 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, and 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. However, it is now recovering quite well. 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, and some fishing for cockles.

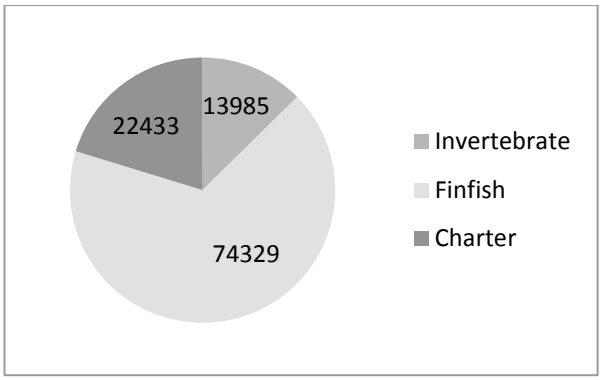
Recreational Fishing

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 (Gascoyne Coast Overview Figure 3). 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.

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 2015/16, 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.

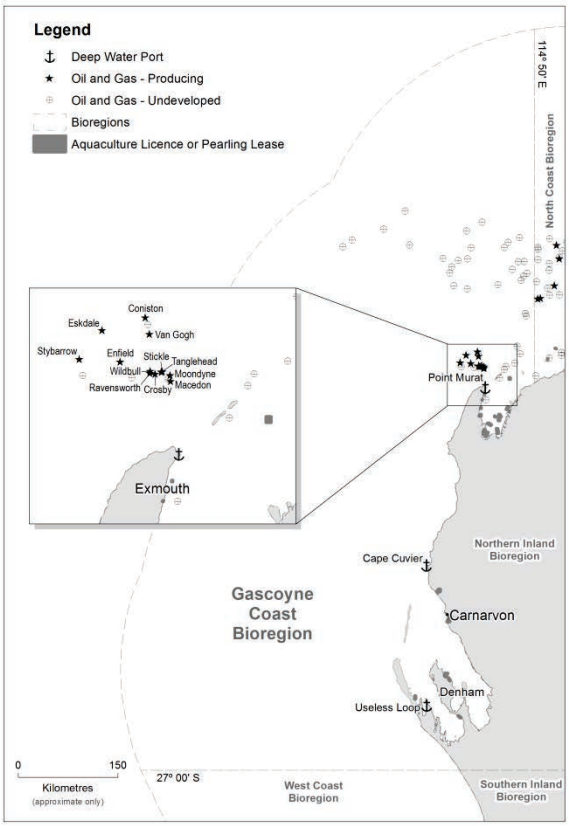
Tourism

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.

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 (see Gascoyne Overview Figure 6).

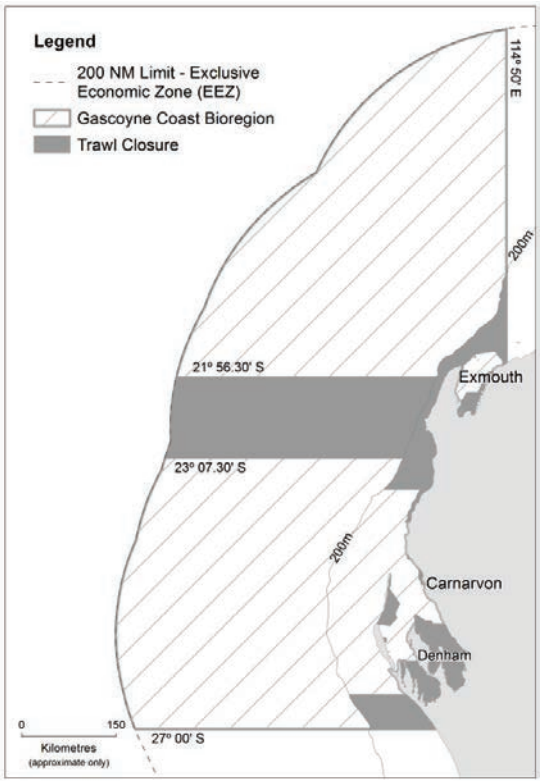
GASCOYNE ECOSYSTEM MANAGEMENT TABLE 1

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] This table does not yet include the closures that may be implemented by the Commonwealth as part of their marine planning zones (see next Gascoyne Overview Figure 6).

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

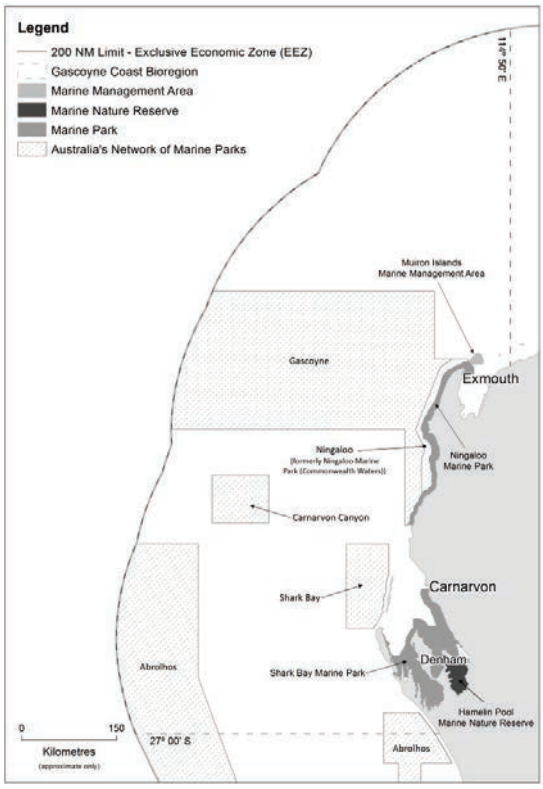
1 Dudley N. (editor) 2008. Guidelines for applying protected area management categories. IUCN. Gland, Switzerland.

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



GASCOYNE OVERVIEW FIGURE 5

Map showing the Gascoyne Coast Bioregion and areas permanently closed to trawling, consistent with IUCN marine protected area category I. The area from Point Maud to Tantabiddi Well (23° 07.30' S to 21° 56.30' S) is closed to all commercial fishing activities.



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.

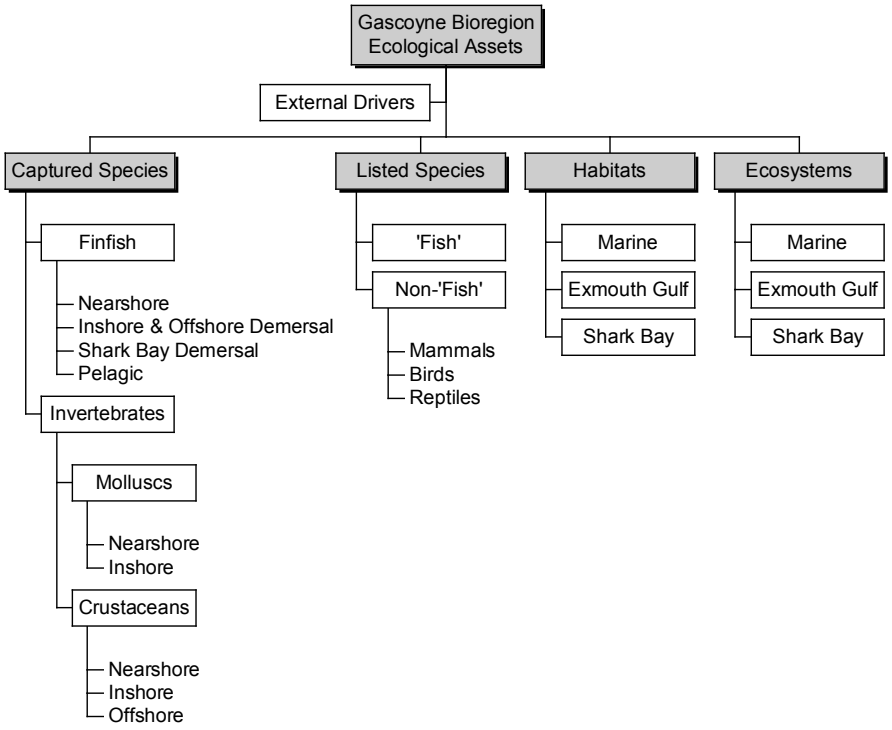
External Drivers

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, water temperature) 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 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 1960s to the early 1990s, the strength of the Leeuwin Current has shown an increasing trend in the past two decades which has been driven by changes in frequency of El Niño/La Niña Southern Oscillation (ENSO) patterns.



GASCOYNE OVERVIEW FIGURE 7

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

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 coasts. 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 appears to have 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. Recruitment to the Gascoyne pink snapper stock may also have been affected.

A preliminary assessment of fisheries-dependent indicators of climate change in WA was undertaken in 2010. This work has now been completed as part of a three-year FRDC-funded project (2010/535) that assessed the effects of climate change on the marine environment and key fisheries, as well as management implications. The first phase of the project was to understand how environmental factors, such as water temperature and salinity, affect fish stocks in Western Australia based on available historical data. The second phase was to look at historical trends and possible future scenarios of Western Australian marine environments using climate model projections. Lastly, existing management arrangements were reviewed to examine their robustness to climate change effects.

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. Previous research has focussed on vessel risk analysis; the Department is not currently undertaking a surveillance program in the region. A summary of pest detections resulting from surveillance at major ports is provided in the Overview section of this report (Overview Table 5).

Captured Species

FINFISH

The Gascoyne supports a diverse fish fauna and is noted for its high quality of both commercial and recreational fishing. Approximately 1,400 species of fishes 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 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 $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 Managed Fishery) is based primarily in Carnarvon but operates throughout the waters of Shark Bay. 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.

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. Bycatch reduction devices ('grids') have been mandatory in all trawl nets in this bioregion since early 2000's and 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 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

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.

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 commercial fishing 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 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 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 150-1200 m. 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 has been 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].

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.

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 heat wave 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 and is also being investigated in FRDC project 2015/027.

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)[1]. Therefore, the closed areas provide protection to those species more vulnerable to trawling (Kangas *et al.* 2007).

1 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 2017

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

OVERVIEW

The Shark Bay Prawn Managed Fishery (SBPMF) 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*). The SBPMF is managed in accordance with the *Shark Bay Prawn Managed Fishery Management Plan 1993* (SBP Management Plan). Management of the SBPMF is based on input controls such as limited entry, gear controls (e.g. maximum headrope units per vessel), seasonal and spatial openings and 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. It was also accredited for export under the provisions of the EPBC Act (1999) in 2015 for ten years.

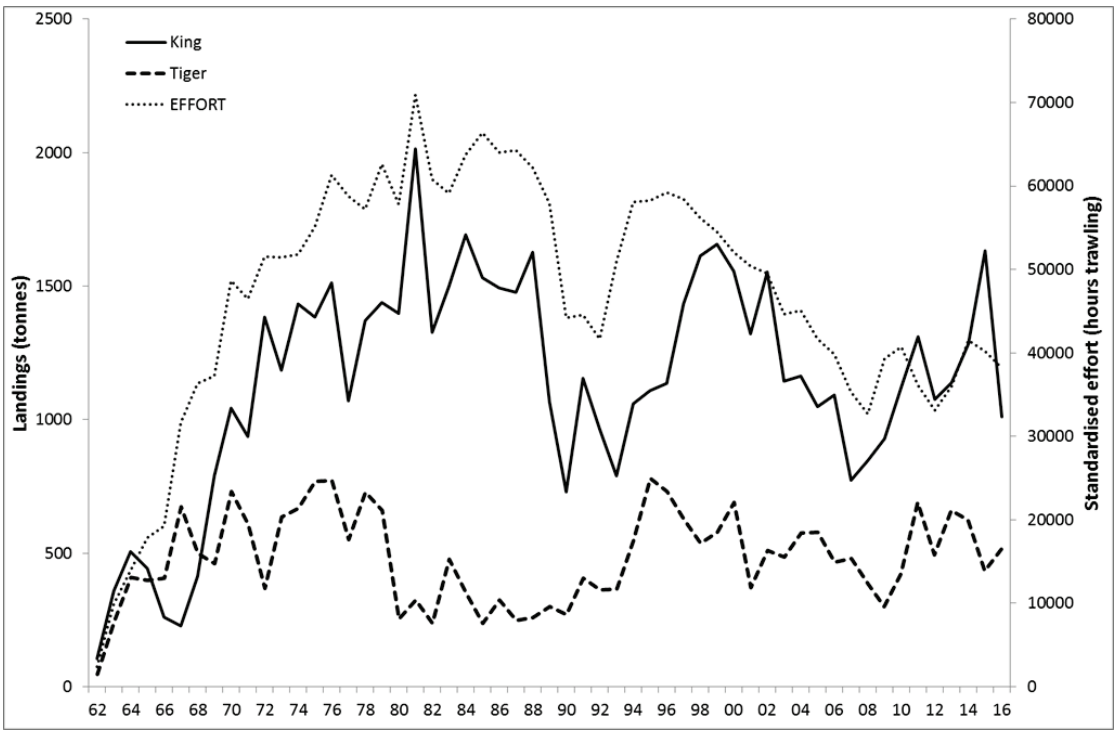
SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	1529 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	Low Amenity Negligible risk	Economic	GVP Level 4 - ($24.0 mill)
Governance	Stable	External Drivers	High risk (Western king prawn) for climate

CATCH AND LANDINGS

The total landings of target prawns in Shark Bay in 2016 were 1,529 t, with 1,010 t of western king prawn, 514 t of brown tiger prawns and 4 t of endeavour prawns (Shark Bay Prawn Figure 1). The recorded landings of byproduct were 120 t of coral prawns, 52 t of mixed finfish, 31 t of cuttlefish, 15 t of squid, 10 t of bugs (*Thenus orientalis*) and 1 t of octopus. Scallop and blue swimmer crab landings are reported in Saucer Scallop Resource and Blue Swimmer Crab Resource Status Reports.



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 1962-2016.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Western king prawns (Sustainable-Adequate)

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).

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 has never been reduced to levels where it had a significant effect on recruitment.

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). This indicates that most of the recruitment variability is driven by environmental factors (e.g. water temperature, Caputi *et al*. 2015, 2016). The fishery-independent recruitment survey in 2016 indicated a catch prediction for western king prawns between 755 and 1135 t with a catch of 1010 t achieved.

In 2016 the mean spawning stock survey catch rate was 29 kg/hr, which is in-line with the average level since 2000.

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 the catch tolerance range for this stock (950 to 1,350 t) and mean catch rate (21 kg/hr; range 16 to 29 kg/hr). The total commercial western king prawn landings for 2016 were within the target catch tolerance range and an overall mean catch rate of 26.5 kg/hr was at the upper end of the catch rate range.

Brown tiger prawns (Sustainable-Adequate)

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 is the key management objective (Kangas *et al*. 2015).

The spawning stock survey in June 2016 showed a mean standardised catch rate of 10.1 kg/hr in the key northern spawning area; northern Carnarvon Peron Line (NCPL). Surveys in August and September indicated a catch rate of 14.5 kg/hr and 13.5 kg/hr respectively. These were above the limit level (10 kg/hr) but below the target level of 25 kg/hr.

The southern Carnarvon Peron Line (SCPL) is the most southern area of the fishing grounds on the eastern side of the fishery. It mostly provides important protection for small size prawns (recruits) before they migrate to more northerly spawning areas. Fishery-independent

surveys conducted in June, August and September showed brown tiger prawn catch rates of 31.9, 18.7 and 11.0 kg/hr respectively in the SCPL. As such the SCPL only opened partially in 2016 to protect the brown tiger stocks due to the NCPL being below the target catch rate level. The use of a combined brown tiger prawn catch rate for the two areas, with the development of an appropriate catch rate target reference level, will be examined during the next harvest strategy review.

The current harvest strategy has an annual catch tolerance range of 400 to 700 t. The brown tiger prawn catch prediction (based on fishery-independent recruitment surveys) was 425 to 635 t. The total catch (514 t) was within the catch tolerance 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 2016 being 38 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

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. Bycatch reduction devices have been fully implemented since 2003 and reduce the quantity of small fish and invertebrates retained in trawls. **Low** risk.

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. Protected species reporting by skippers has improved in the last three years following targeted education and monitoring of daily logbooks. Interactions with protected species are also recorded during Departmental fishery independent surveys in the fishery. 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). **Low** risk.

SHARK BAY PRAWN TABLE 1.

Protected species interactions recorded in the daily logbooks during 2016

Species	Alive	Dead
Turtles	80	0
Syngnathids	275	0
Sea Snakes	4633	593
Saw Fish	1	0

HABITAT AND ECOSYSTEM INTERACTIONS

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 legislated 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 2016 the total area trawled, at approximately 717 square nautical miles, was 15% of inner Shark Bay, and 6% of the total fishery. **Moderate** risk.

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 of prawns, 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. **Low** risk.

SOCIAL AND ECONOMIC OUTCOMES

Social

This industry is a major contributor to regional employment. During 2016, approximately 100 skippers and crew were employed in the fishery. There are also approximately 37 processing and support staff employed at Carnarvon. One of the key operators with 10 licensed fishing boats is based in Carnarvon with administration, wharf and engineering staff based at the small boat harbour and a processing factory at Babbage Island. Eight other boats travel to the region and utilise local contractors during the fishing season. The prawn sector also utilises, wherever possible, Western Australian service companies providing engineering supplies, packaging, transport logistics, ship stores and fuel. **Low** risk.

Economic

The value of the fishery including coral prawns, cuttlefish, squid and bugs is $24.0 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 2016 were generally higher than 2015: western king prawns $14.16, brown tiger prawns $17.59, blue endeavour prawns $7.71, coral prawns $5.36. **High** risk.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

The total landings, plus the western king prawn and brown tiger prawn annual landings in 2016, were all within their respective annual catch tolerance ranges. The annual fishing levels are 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

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 of each target species at a level where the main factor affecting recruitment is the environment

Although the brown tiger prawn stock indicator was below the target level, it remained above the limit reference level with further protection provided by additional spatial closures. Therefore, no formal changes to management arrangements will occur for 2017.

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 Fisheries Division of the Department of Primary Industries and Regional Development (Fisheries) to monitor the fleet using a Vessel Monitoring System (VMS) and manage compliance with temporal and spatial closures. Fisheries also undertakes regular vessel inspections to ensure fishing is being undertaken in accordance with the governing legislation (e.g. gear requirements, catch reporting).

Consultation

Management Meetings are held between Fisheries 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 management to ensure the protection of smaller prawns and to maintain the spawning stock biomass.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

The Department is progressing an amendment to the SBP Management Plan to incorporate arrangements which are currently outlined under separate long term exemptions and licence conditions. This will remove the need for additional approvals. The amendment will also increase economic and operational flexibility for licensees by improving transferability of units and provide options for gear configurations. The amendment will provide clearer statutory compliance capability which will allow for more effective use of compliance resources and complement the improved co-management arrangements introduced in 2016/17 to manage industry (voluntary-agreed) closures within the SBPMF. It is anticipated that the amendment will come into effect prior to the 2018 season.

Management initiatives for 2017 also include undertaking work to address conditions of MSC certification.

EXTERNAL DRIVERS

Economic

Most of the economic drivers for this fishery are positive for 2016. The cost to fish has stabilised and the lower Australian dollar has improved value to the fishery. The aquaculture prawn price has been driven up by the higher demand from the Chinese market for both wild-caught and aquaculture prawns. Therefore, the price difference between the farmed (brown tiger prawn) and wild-caught prawns has almost reached parity. Prawn demand in the domestic market was strong and the traditional export markets remained stable. Industry has sought to maximise the return from byproduct species in the fishery where possible. **Low** risk.

Environmental

The major environmental factors influencing these stocks appears to be i) increases in water temperature associated with the Leeuwin Current has resulted in increase in growth and catchability of prawns; and ii) higher turbidity during flood events are likely to increase production due to lower natural mortality. An increasing trend in winter water temperature is being monitored and its effect on spawning needs to be assessed. **High** risk

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SAUCER SCALLOP RESOURCE STATUS REPORT 2017

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

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), while the South Coast Trawl is a small fishery (four vessels) that targets scallops on the south coast. The South West Trawl Managed Fishery (SWTMF) is a multi-species trawl fishery that primarily targets scallops. Management is generally based on limited entry, gear controls and seasonal closures, however a quota management trial has been undertaken in the SBSMF since the fishery reopened in 2015with 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, can have a significant impact on scallop stocks, particularly in Shark Bay and the Abrolhos Islands.

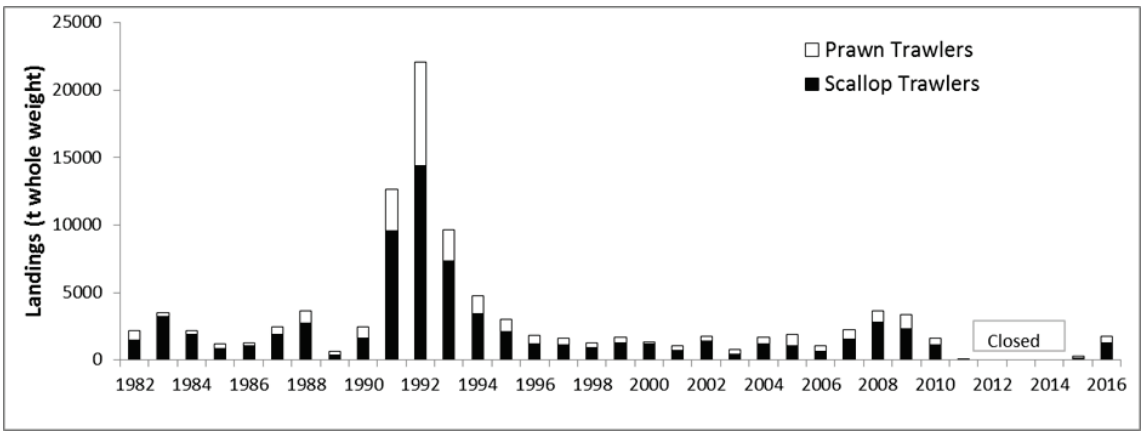
SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	192 t meat weight (959 t whole weight)	Not applicable
Fishing Level	Acceptable	
Stock/Resource Performance	Stock Status	Assessment Indicators
Shark Bay:	Recovering	Level 4: Direct survey/catch rate
Abrolhos:	Environmentally limited	Level 4: Direct survey, catch and effort
South-west:	Adequate	Level 2: Catch and effort
South coast:	Adequate	Level 2: Catch and effort

EBFM Performance Asset	Level	Asset	Level
Bycatch	Low risk	Listed Species	Low Risk
Habitat	Low Risk	Ecosystem	Low Risk
Social	Low Amenity Negligible Risk	Economic	GVP Level 3 ($8.3mill) High risk
Governance	Plan review	External Driver	Significant Risk

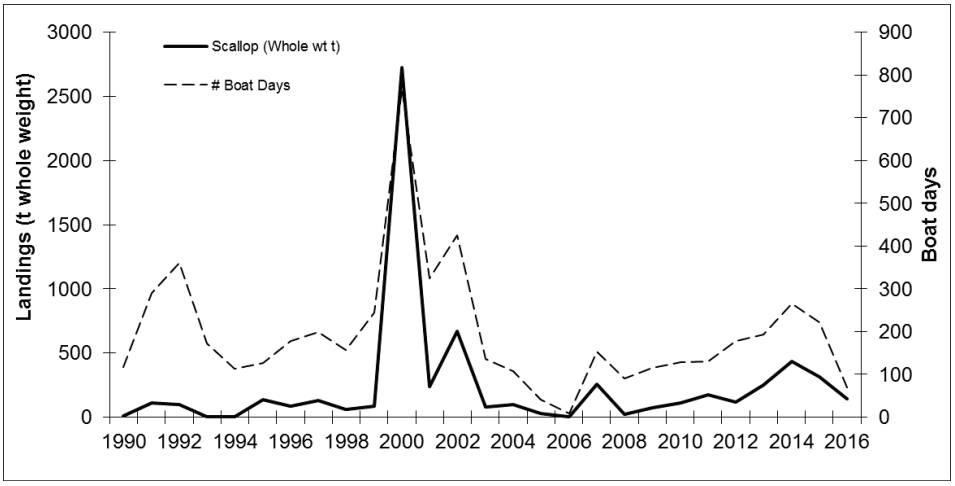
CATCH AND LANDINGS

The total scallop landing was 192 t meat weight (959 t whole weight) in WA in 2016. There was 163 t meat weight (816 t whole weight) taken from Shark Bay out of a quota of 166 t meat weight. The Class A boats landed 103 t (63.3 %) and the Class B boats landed 60 t (Saucer Scallop Figure 1). Minimal by-product was retained by Class A boats. The landings in the South Coast Fishery were 29 t meat weight (143 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 2016. 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 2016.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Shark Bay Scallop Managed Fishery (Sustainable: recovering)

The status of the stock in Shark Bay is determined from the annual pre-season fishery-independent survey of recruitment (0+) and residual (1+) 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 resulted 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*. 2014, 2015, 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 low levels but recruitment of 0+ scallops had increased in November 2016. Continued favourable environmental conditions for recruitment during 2016/17 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 continued to be considered as **environmentally limited**. During the 2016 survey, scallop abundance had increased in the southern part of the Abrolhos Islands indicating partial recovery with fishing possible in 2017.

South West Trawl Managed Fishery (Sustainable-adequate)

Effort in the South West Trawl Managed Fishery 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. 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 in 2016. There has been no scallop fishing in this fishery since 2014.

South Coast Trawl Fishery (Sustainable-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 2016 a total of 143 t whole weight was landed for 69 boat days. A small area of Bremer Bay was fished in the South coast Trawl for ten days in 2016, the first time in three years, due to sufficient abundance of scallops.

The mean catch rate in 2016 was 2072 kg whole weight per boat day compared to a mean of 1276 kg per boat day (range 656 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

Limited and restricted fishing occurred in Shark Bay in 2016 by Class A vessels. Bycatch and protected species interactions for Class B vessels is discussed in Shark Bay Prawn resource section of this document. Owing to the legislated 100 mm mesh size of the nets and the relatively short duration of the fishing season for Class A vessels, the total bycatch landed is minimal. Grids have been fully implemented in this fishery since 2003. Protected species are occasionally captured but generally released alive due to the relatively short duration of trawls. There was one turtle reported and returned alive by Class A vessels within the SBSMF in 2016. **Low** risk.

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 has been minimised. No fishing took place in the AIMWTMF and SWTMF in 2016. **Low** risk.

HABITAT AND ECOSYSTEM INTERACTIONS

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 8.7% of the allowable trawl area was fished in 2016 (noting there was limited fishing in northern Shark Bay by the Class A fleet). Only 0.8% 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 in 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 (Class B) that can also retain scallops. The overall GVP for the two fisheries that operated in 2016 (including Class B boats in Shark Bay) was $8.3 million.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

Shark Bay: A catch limit of 830 t (whole weight) (equivalent to 166 tonnes meat weight) was set for 2016 and 816 t was achieved.

Abrolhos Islands: No fishing in 2016.

South West: Catch range not developed.

South Coast: 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 2016, derived from surveys in November 2015 were low for northern Shark Bay but back to recovered levels in Denham Sound. Consequently, to provide protection to the breeding stocks and aid recovery, management measures used in 2016 included a limited pre-spawning scallop harvest from both northern Shark Bay and Denham Sound with a combined quota of 166 t meat

weight. Further improvement in scallop abundance in the November 2016 survey allowed an increase in the trial quota allocation in both parts of the Shark Bay fishery in 2017/18.

A formal harvest strategy for the SBSMF is currently under development.

In Abrolhos Islands, the 2016 survey indicated that catches are above the target level so some fishing will occur in 2017 with commercial fishers ceasing fishing at a catch rate level.

Compliance

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

Under the trial quota management arrangements in the SBSMF, operators are required to provide catch and disposal records (CDRs), including the weight of scallops landed. Fisheries undertakes inspections at landing and monitors CDRs throughout the season to maintain the integrity of the quota system.

Consultation

Management Meetings are held between Fisheries and licensees, in conjunction with the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC). These meetings provide an opportunity for Fisheries, 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 Fisheries and licensees.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

During 2017, the Department will be reviewing the trial quota management arrangements that have been in place for the past three years in the SBSMF. The quota system has provided industry and Fisheries with certainty around the total annual catch for the recovering stock and increased security of access for licence holders.

Fishing is likely to resume in the AIMWTMF in 2017 after a five year closure due to adverse environmental conditions. A scallop stock enhancement trial is taking place at the Abrolhos Islands, with scallops tagged and translocated from recovering areas to historical areas of abundance that have shown limited signs of recovery.

EXTERNAL DRIVERS

Strong La Niña events that are typically associated with strong Leeuwin Currents and warm sea-surface temperature often result in below-average scallop recruitment. Between 2012 and 2014, the SBSMF and AIMWTMF were closed 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). The AIMWTMF remained closed for 2015 and 2016. Further research continues into understanding recruitment variation (including the collapse) of scallop stocks including the stock enhancement project discussed above. **Significant** risk.

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SHARK BAY BLUE SWIMMER CRAB RESOURCE STATUS REPORT 2017

A. Chandrapavan, S. Wilkin, R. Oliver and P. Cavalli.

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 t) but regionally important recreational fishery. Management of the commercial sector moved from an effort-controlled system to a notional quota management system in 2013/14. The Individual Transferable Quota (ITQ) management system was formally implemented for the fishery at the start of the 2015/16 season under the *Shark Bay Crab Managed Fishery Management Plan 2015*.

Recreational fishing for blue swimmer crabs mainly takes place using 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 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). Further details on biology and assessments can be found in the Resource Assessment Report for this stock.

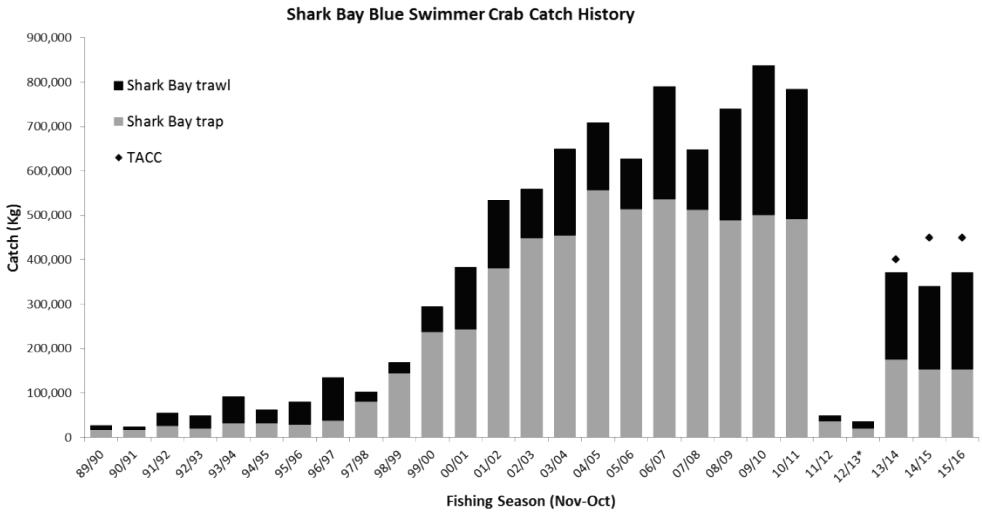
SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational	
Total Catch 2016	372 t (2015/16)	1–2 t (2015/16 boat-based only)	
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 (trap) Moderate Risk (trawl)	Ecosystem	Low Risk
Social	Low amenity Moderate risk	Economic	GVP Level 2 ($2 mill) Significant risk
Governance	New management plan (Nov 2015)	External Drivers	Significant risk

CATCH AND LANDINGS

A Total Allowable Commercial Catch (TACC) of 450 tonnes was set for the 2015/16 fishing season (20 November 2015 to 31 October 2016). The total catch landed for the 2015/16 season was 372 t (~83% of the TACC), leaving 78 tonnes of unfished quota (Shark Bay Blue Swimmer Crab Figure 1). The trap sector's total catch was 152.9 t and represented 41% of the total landings for this season. The prawn trawl sector's total catch was 219.5 t which represented 59% of the total landings. No crabs were landed by scallop trawl sector.

The estimated boat-based recreational catch of blue swimmer crab in the Gascoyne Coast represented 2% of the statewide boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range for blue swimmer crab in the Gascoyne Coast was steady in 2015/16 (95% CI 1–2 tonnes compared with 1–4 in 2013/14 and 1–8 in 2011/12) (Ryan *et al*. 2017).



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 tonnes was set for the 2013/14 and increased to 450 tonnes for the 2014/15 and 2015/16 fishing seasons.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

The Shark Bay crab stock experienced a significant stock decline in late 2011, following a series of adverse environmental conditions between 2010 and 2011. 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 and 2015/16 seasons with a TACC of 450 t.

Indices of peak and residual spawning biomass and recruitment levels (survey data and modelling data) showed an increase from the low levels when the fishery was closed, but have stabilised since the resumption of fishing in 2013. Under the 2015/16 environmental conditions and fishing levels, no further increase in stock recovery was evident. As a result, the TACC for the 2016/17 season was reduced to 400 tonnes.

Commercial trap catch rates significantly improved over the 2016/17 summer months to be above historical levels, concsistent with high residual legal biomass during November 2016 and the highest level of peak spawning biomass recorded during the June 2017 surveys. This improvement in stock status indicates that the TACC could be increased from 400 to 450 tonnes.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

The trap sector operates in a manner that avoids mortality or injury to endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities. Hourglass traps, used in the commercial fishery, 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.

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 this fishery.

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. **Low** risk. The impacts of interactions specific to the trawl sectors are described in the relevant status reports.

SOCIAL AND ECONOMIC OUTCOMES

Social

The trap sector employs approximately 12 people as skippers and crew on vessels fishing for blue swimmer crabs in the Gascoyne Coast Bioregion, as well as additional employment for 30-35 workers for the post-harvest processing of the crab catch. The closure of the Shark Bay crab fishery during 2012/13 had a significant socio-economic impact on both the trap and trawl sectors however the resumption of fishing has relieved some economic pressure.

For the trawl sector, approximately 100 skippers and crew were employed in the fishery for the 2016 season. There are also approximately 37 processing and support staff employed at Carnarvon. One of the large operators with 10 licensed fishing boats is based in Carnarvon with administration, wharf and engineering staff based at the small boat harbour and a processing factory at Babbage Island. Eight other boats travel to the region and utilise local contractors during the fishing season. The trawl sector also utilises, wherever possible, Western Australian service companies providing engineering supplies, packaging, transport logistics, ship stores and fuel.

Economic

The average beach price for uncooked crabs across WA was $5.41/kg. The estimated value of the commercial blue swimmer crab resource from Shark Bay for 2015/16 was $2.02 million.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

TACC of 450 t: The total catch for 2015/16 was 372 t (~83% of TACC).

Harvest Strategy

A constant catch harvesting strategy is applied to the commercial fishery. A weight-of-evidence approach is adopted to support the TACC setting process. The weight-of-evidence approach takes into account information from fishery-independent surveys, commercial catch and effort, environmental conditions and also results from a biomass dynamic model.

A formal harvest strategy document is currently under development.

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, including the weight of crabs landed after each fishing trip. This information enables the Department to monitor the TACC and investigate any breaches of relevant legislation.

Consultation

The Department undertakes consultation directly with commercial licensees on operational issues. 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. Focused recreational consultation occurs with Recfishwest, and broader recreational consultation processes are facilitated by Recfishwest under a SLA.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

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 ITQ system of entitlement and includes two zones to maintain the previous access arrangements.

The Department is also developing a harvest strategy for this resource in consultation with the relevant stakeholders. This will outline the long and short-term management objectives for the fishery, 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. Blue swimmer crabs are ranked "**high** risk" under the current climate change scenario impacting the WA coastline.

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GASCOYNE EXMOUTH GULF PRAWN RESOURCE STATUS REPORT 2017

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 spatial openings and closures and monthly 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 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 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 2018. This certification allows licensees to export product to the US market.

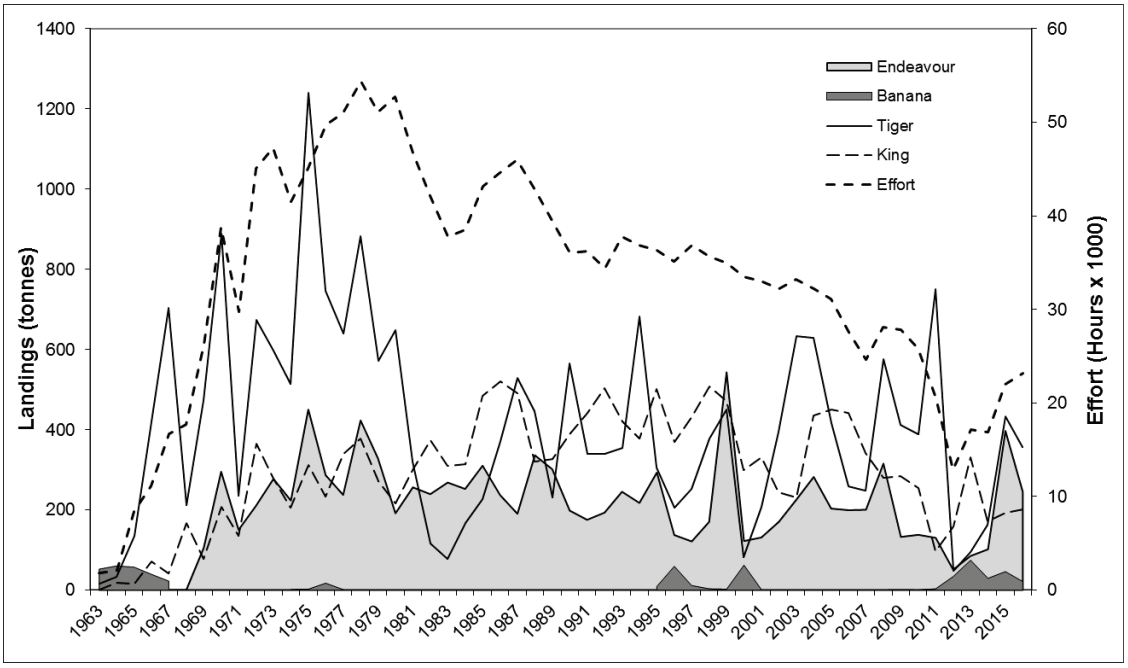
SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	Commercial: 822 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 4 - Direct 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 ($12.4 mill)
Governance	Stable	External Driver	Risk Level 5 (climate)

CATCH AND LANDINGS

The total landings of prawns in 2016 were 822 t, comprising 356 t of brown tiger prawns, 201 t of western king prawns and 244 t of endeavour prawns (Exmouth Gulf Prawn Figure 1). Recorded landings of by-product were; 2.9 t of blue swimmer crab (*Portunus armatus*), 3.6 t of squid, 4.0 t of bugs (*Thenus orientalis*), 29.1 t of coral prawns, 3.3 t of cuttlefish and 0.3 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 1963-2016.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

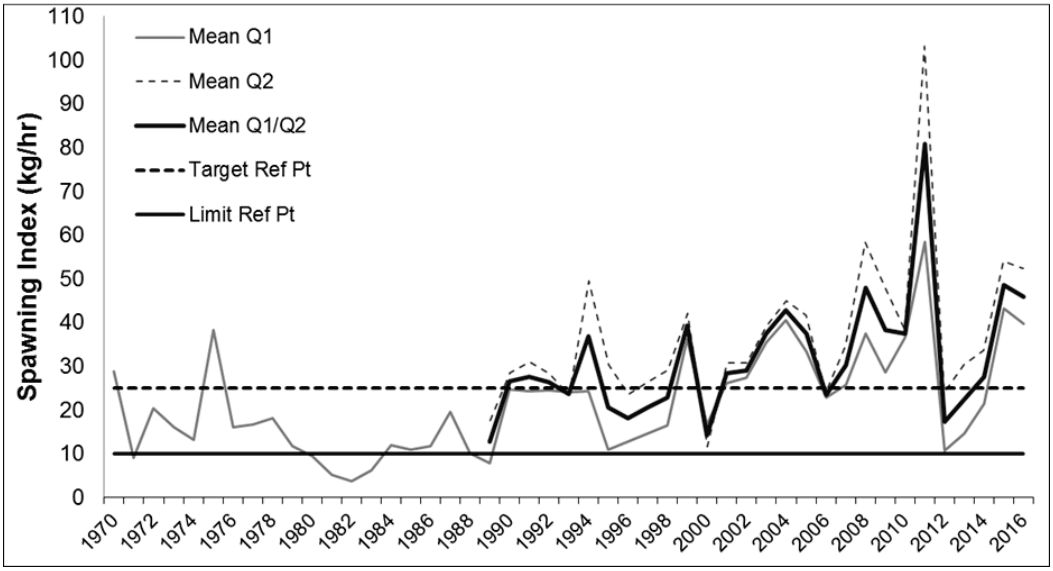
Brown tiger prawns (Sustainable-Adequate)

The status of the stocks 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. Recruitment surveys provide the basis of an annual catch prediction (Caputi *et al*. 2014a).

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). The standardised spawning stock surveys carried out from August to October 2015 had an average catch rate of 46.0 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 stock is highly unlikely to be recruitment overfished.

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 495 t and a range of 396 to 594 t for 2016. The total catch (356 t) was within the catch tolerance range but below the catch prediction which may be due to more, larger size brown tiger prawns being present during the recruitment phase which has inflated the recruitment index.

The standardised fishing effort in 2016 was 23 thousand trawl hours. This is a reduction from historical levels (35 to 50 thousand hours standardised to twin gear). The current level of fishing mortality is unlikely to cause the stock to become recruitment overfished and stock level is considered **adequate**.



EXMOUTH GULF PRAWN FIGURE 2.

Brown tiger prawn spawning stock mean catch rate (kg/hr) for August, September and October combined for two areas (Q1 and Q2) and target (upper line) and limit (lower line) reference levels.

Western king prawns (Sustainable-Adequate)

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) and management decisions such as spatial-temporal opening of fishing areas. In 2016 the recruitment index was 25.5 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 2016 (commercial catch rates in key western king prawn fishing ground in August and October) was 32.4 kg/hr, which was above the target (25 kg/hr).

Catch and catch rate levels from 1989 to 1998 have been used as the basis for calculating catch tolerance ranges of 350 to 500 t and a mean catch rate of 12 kg/hr (with a range between 8 and 14 kg/hr). This catch tolerance 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 2016 (201 t) was well below the catch tolerance range with a mean catch rate of 8.7 kg/hr at the lower end of the 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 and stock levels are considered **adequate**.

Blue endeavour prawn (Sustainable-Adequate)

Exmouth Gulf 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. 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. 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.

In 2016 the mean catch rate for the blue endeavour prawn on the brown tiger prawn recruitment survey sites of 17 kg/hr was above the 15-year mean (1997-2011) of 15 kg/hr). On the western king prawn recruitment survey sites the mean catch rate was 22 kg/hr, which was well above the 6-year mean (2007-2012) of 14 kg/hr. A catch tolerance range is set at 120 to 300 t, based on historical catches between 1989 and 1998. The total catch in 2016 (244 t) was within the catch tolerance range and above 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 and stock levels are considered **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

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 add another level of improvement for bycatch survival and product quality. **Low** risk.

While protected species including dugongs, turtles and sea snakes occur in the general area, only sea snakes, sawfish 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. The increase in reported species numbers, in particular sea snakes and sawfish, is due to an increase in awareness, education and commitment from both crew and skippers to improve reporting. **Low** risk.

EXMOUTH GULF PRAWN TABLE 1.

Protected species interactions recorded in the daily logbooks during 2016

Species	Alive	Dead	Unknown
Turtle	16	0	NA
Sea Snake	1262	267	NA
Seahorse	13	11	NA
Pipefish	2	3	NA
Saw Fish	11	9	NA
Dolphin	1	0	NA

HABITAT AND ECOSYSTEM INTERACTIONS

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 2016, the performance measure was met as the total area trawled, at approximately 325 square nautical miles (28.5%) per cent of trawlable grounds in Exmouth Gulf, was below the 40% level. **Low** risk.

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. **Low** risk.

SOCIAL AND ECONOMIC OUTCOMES

The estimated employment in the fishery in 2016 was 18 people including skippers and other crew. Twenty three support staff were based in Exmouth 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 $12.4 million for 2016.

GOVERNANCE SYSTEM

Total landings of 822 t were within the tolerance range as were the landings of brown tiger prawns with blue endeavour prawns within their acceptable range. The western king prawns were below their catch tolerance range and continues to be 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

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 stock biomass of each target species at a level where the main factor affecting recruitment is the environment.

The key stock indicator for each primary species was above their respective target levels hence no changes to management arrangements will occur for 2017/18.

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 Primary Industries and Regional Development (Fisheries) to monitor the fleet using a Vessel Monitoring System (VMS) and manage compliance with temporal and spatial closures. Fisheries also undertakes regular vessel inspections to ensure fishing is being undertaken in accordance with the governing legislation (e.g. gear requirements, catch reporting).

Consultation

Fisheries, in conjunction with the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC), holds Management Meetings (MM) for this fishery. The MM is an opportunity for Fisheries, WAFIC and industry to discuss research outcomes, initiatives, management of the fishery and industry issues. Season arrangements are developed each year in consultation between Fisheries and the licence holder. During the season, Fisheries and the licence holder undertake collaborative in-season management to ensure the protection of smaller prawns and to maintain the spawning stock biomass.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department Stakeholder Engagement Guidelines.

Management Initiatives (Stable)

The Department is proposing to review the Harvest Strategy to incorporate blue endeavour prawns as a target species. This is in response to increased catch levels and to allow the endeavour prawn component of the fishery to undergo MSC assessment.

EXTERNAL DRIVERS

External drivers for this fishery include economic and environment.

Most of the economic drivers were positive for 2016. The costs to fish have stabilised and the lower dollar value has increased export potential. The Chinese market demand for prawn product has increased, whether it is wild caught or aquaculture grown prawn. Therefore, the price difference between farmed (tiger prawn) and wild caught prawns almost reached parity. Prawn demand in the domestic market was strong and the traditional export markets remained stable. The focus of the fishing strategy remains on targeting larger prawns during high catch rate periods to maximise fishing efficiency.

Cyclones appear to have a significant effect on the productivity of Exmouth Gulf and 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 **moderate-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 also appear to be having a negative effect on western king prawn catches (Caputi *et al.* 2014b, 2015) and will continue to be investigated.

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WEST COAST DEEP SEA CRUSTACEAN RESOURCE STATUS REPORT 2017

J. How and M. Yerman

OVERVIEW

The West Coast Deep Sea Crustacean resource consists primarily of Crystal (snow) (*Chaceon albus*), Champagne (spiny) (*Hypothalassia acerba*) and Giant (king) (*Pseudocarcinus gigas*) crabs. The resource is accessed primarily by the commercial West Coast Deep Sea Crustacean Managed Fishery (WCDSCMF) which targets crystal crabs, with the West Coast Rock Lobster Managed Fishery (WCRLMF) retaining a small amount of champagne crabs as by-product. The WCDSCMF is a 'pot' fishery 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 WCDSCMF achieved Marine Stewardship Council 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 2017

Fishery Performance	Commercial		Recreational
Total Catch 2016	WCDSCMF – 153.3 t WCRLMF – 1.2 t		Nil
Fishing Level	Acceptable		NA
Stock/Resource Performance	Stock Status		Assessment Indicators
DSCF	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 ($4.8 mill) Moderate Risk
Governance	Minor Adjustments	External Drivers	Low Risk

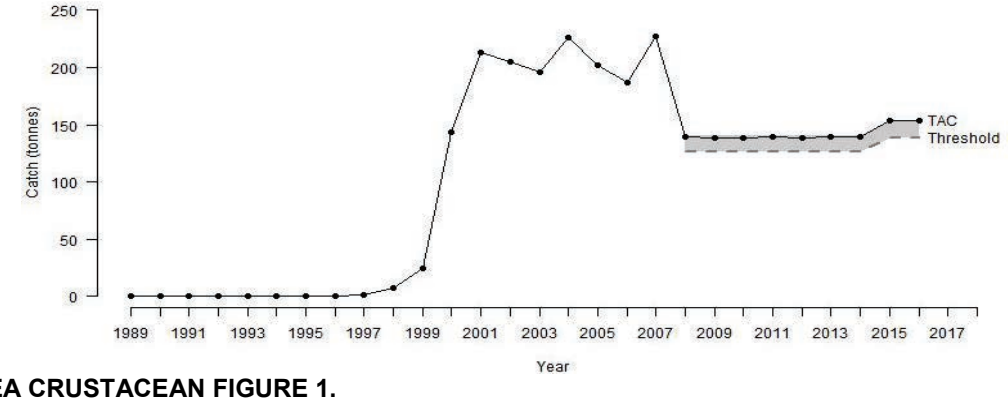
CATCH AND LANDINGS

The total landings from this west coast offshore resource in 2016 as targeted by the WCDSCMF was 153.3 t. Catches are dominated by crystal crabs, with >99% of the TAC) landed. Thirty kilograms of champagne crabs and no giant crabs were landed in 2016. Landings of champagne and giant crabs predominantly occur off the south coast, as accessed by the South Coast Crustacean Managed Fishery (SCCMF). In the 2015-16 season the SCCMF landed 6.7 t of giant crabs and 2.1 t of champagne crabs. For more information on SCCMF landings see South Coast Crustacean Resource Status Report.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

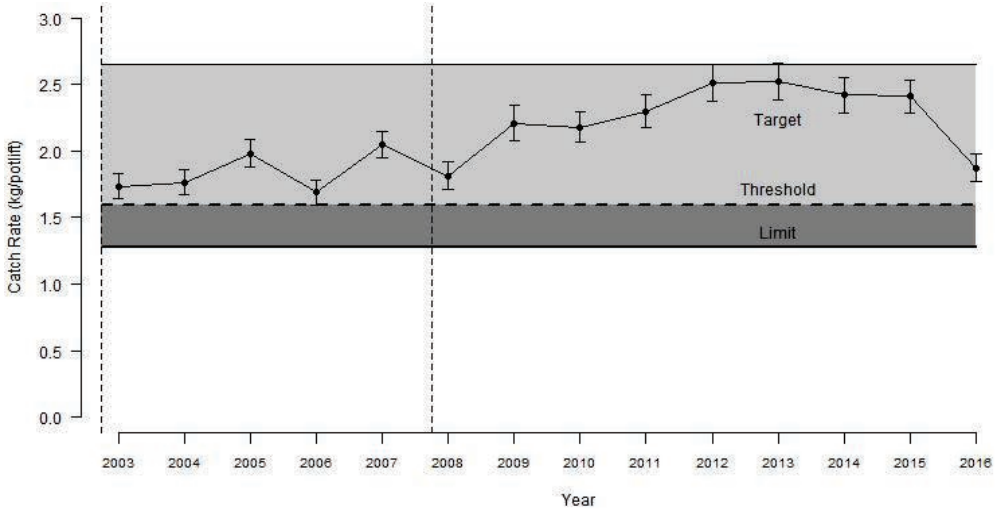
Crystal crab

All lines of evidence 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 2016 was 1.87 kg/pot-lift (Deep Sea Crustacean Figure 2) which was a decline from 2015 (potentially due an increase in high grading) but still within the target range.



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, shaded) and catch threshold level (dotted).



DEEP SEA CRUSTACEAN FIGURE 2.

Annual standardised catch rate (kg / pot-lift) of legal crystal crabs (± 95 CI) with their associated target (light grey) and threshold region (dark grey) 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. **Low** risk.

Protected Species: There have been no reported interactions of WCDSC gear with protected species in 2016. **Low** risk.

The bycatch 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. **Low** risk.

Ecosystem: The effects of the removal of deep sea crabs has been assessed for the WCDSCMF as having negligible food chain effects by the removal of crabs. Therefore, at current catch levels, it is unlikely that removal of crabs is likely to result in food chain effects. **Low** risk.

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 WCDSCMF is considered to have a low social amenity. This fishery is based on vessels that employ a skipper and two or three crew and there is 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 2016. **Low** risk.

Economic

The GVP (gross value of production) for the fishery was about $4.8 million in 2016 with the majority of the catch sold live to Asian markets both locally and internationally. **Moderate** risk.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

For the 2016 season (1 January 2016 – 31 December 2016) the crystal crab quota was set at 154 t. With an annual tolerance range of > 90%, based on the catch of 153 t the annual fishing level is **acceptable**. The combined quota of champagne and giant crab (B Class Units) was set at 14 t. The combined catch of these two species was only 30 kg due to a lack of targeting.

Harvest Strategy

The West Coast Deep Sea Crustacean Harvest Strategy 2015-2020 (see Fisheries Management Paper No. 272) is the basis for the setting of the Total Allowable Catch (TAC) for the WCDSCMF. For 2016:

- The crystal crab TAC was achieved,
- The standardised catch rate of legal crystal crabs was within the target range, and
- The standardised catch rate of the secondary performance indicators: berried females and undersized crabs, were above their respective threshold reference points.
- The catch of champagne and giant crab were both within their respective target ranges

Consequently, for 2017 the TAC remained at 154 tonnes for crystal crabs, and 14 tonnes for giant and champagne crabs combined.

Compliance

The compliance program is developed using a risk assessment process, and intelligence led investigations, particularly TAC verification which is undertaken at unload inspections.

Consultation

Management Meetings are held between Fisheries 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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines

Management Initiatives

Management initiatives in 2017 are primarily focused on 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

Given product is exported; fluctuation in the Australian dollar can have impacts on the economic performance of the fishery. The WCDSCMF is thought to be relatively robust to environmental change due to the depth of fishing operations. **Low** risk.

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GASCOYNE DEMERSAL SCALEFISH RESOURCE STATUS REPORT 2017

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 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	270 t	87–118 t (2015/16 boat-based only)
Fishing Level	Inadequate	Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Demersal	Pink snapper – Inadequate Other demersals – Sustainable - Adequate	Annual: Catch Periodic*: Spawning Biomass, Fishing Mortality, SPR

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 mill) Moderate Risk
Governance	Stable	External Drivers	Moderate Risk

* pink snapper and goldband stocks only.

CATCH AND LANDINGS

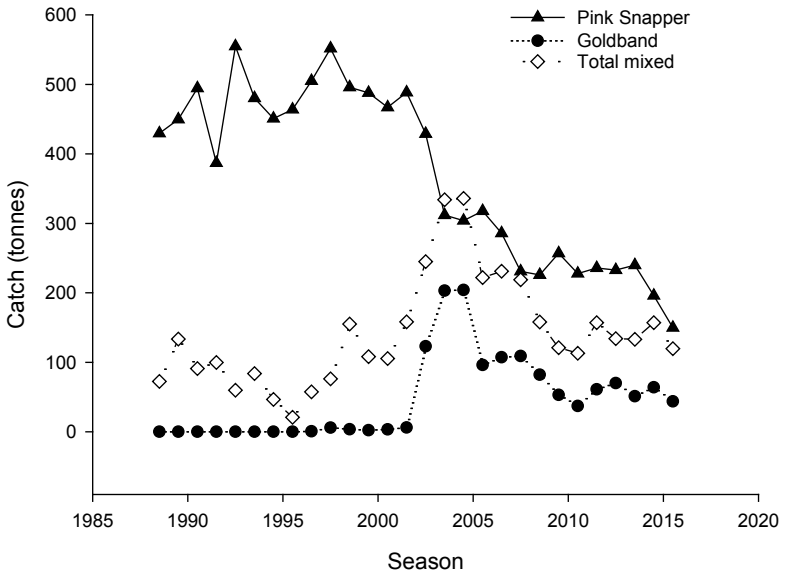
In 2015/16, the total commercial catch reported by the GDSMF was 270 t, comprising 150 t pink snapper, 44 t goldband snapper and 76 t of other mixed species (Gascoyne Demersal Scalefish Table 1).

The top 10 demersal species in the Gascoyne Coast represented 82% of the total boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range for the top 10 demersal species in the Gascoyne Coast was steady in 2015/16 (95% CI 87–118 tonnes compared with 88–115 in 2013/14, but lower than 127–159 in 2011/12) (Ryan *et al*. 2017).

GASCOYNE DEMERSAL SCALEFISH TABLE 1.

Total catches of scalefish (excluding mackerel and tunas) taken by GDSMF in the previous five years.

Species	2011/12	2012/13	2013/14	2014/15	2015/16
Pink Snapper	235.5	232.8	240.0	195.8	149.8
Goldband Snapper	61.0	69.5	50.9	63.5	43.6
Other Jobfish	4.9	3.8	3.4	4.3	4.4
Red Emperor	13.2	8.0	10.1	10.9	10.0
Ruby Snapper	7.3	2.8	4.2	5.1	1.2
Other Snappers	1.6	1.0	1.1	1.7	1.5
Spangled Emperor	0.4	2.3	2.0	2.5	2.6
Redthroat Emperor	10.5	5.0	6.1	10.9	8.0
Other Emperors	1.1	0.2	0.3	1.3	0.6
Rankin Cod	12.2	6.2	6.9	8.0	10.5
Other Cods	11.7	8.3	11.2	11.3	10.7
Eightbar Grouper	4.0	4.3	3.5	1.9	1.6
Mulloway	3.0	4.0	8.6	9.0	6.4
Trevallies	5.6	4.6	6.8	7.9	3.6
Other Species	16.7	13.9	18.0	18.6	15.1
Total	388.7	366.7	373.1	352.7	269.5



GASCOYNE DEMERSAL SCALEFISH FIGURE 1.

Commercial catches of pink snapper, goldband snapper and total mixed (excludes pink snapper) taken in oceanic waters of the Gascoyne Coast Bioregion from 1988/89-2015/16.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Pink snapper Oceanic Stock (Inadequate)

Following the first integrated age-based assessment in 2002 which indicated this spawning stock was below the threshold (30% of unfished level) at that time, 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 (2017) assessment, which incorporated catch-at-age data up to 2014/15, and catch rate up to 2015/16, indicated that the spawning biomass was around the limit (20% of unfished).

Based on the weight of evidence available, the status of the oceanic stock is **inadequate** and will require additional management settings to ensure that the stock does not breach the limit level during the next 5-year period.

Goldband snapper (Sustainable-Adequate)

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 40-60 t.

Based on biological data collected during 2010-2013, the SPR was well below the threshold level. Based on the weight of evidence approach, the status of the goldband snapper stock in the Gascoyne is **sustainable-adequate** at current levels of fishing.

BYCATCH and PROTECTED SPECIES INTERACTIONS

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**.

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 and ECOSYSTEM INTERACTIONS

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**.

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 2016, 17 GDSMF vessels fished during the entire season, 9 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. The annual estimated boat-based recreational fishing effort in the Gascoyne Coast Bioregion was steady in 2015/16 (43,237 boat days, SE=3,152), but lower than 2013/14 (53,832, SE=3,603) and 2011/12 (58,123, SE=3,672) (Ryan *et al*. 2017).

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 2016 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 150 t landed in 2015/16 was substantially lower than the 'annual tolerance' range as was also the case in 2014/15.

The pink snapper catch rate has fallen below the threshold level of 500kg/standard boat day and is therefore **unacceptable**. Recent discussions with fishers suggest that a number of factors may have contributed to this, including loss of experienced skippers to the industry, low peak season prices and an increased level of interaction with sharks (depredation). The increased level of interaction with sharks has resulted in recent changes in fishing operations such as gear used and locations and times fished. A review of catch rates based on daily/trip logbook data has been completed with kg/line/hour the recommended catch rate for future assessments.

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 44 t landed in 2015/16 was **acceptable**.

Recreational:

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

Harvest Strategy

The primary ecological objective of the Gascoyne Demersal Scalefish Resource (GDSR) Harvest Strategy is to maintain spawning stock biomass of each retained species above B_{MSY} to maintain high productivity and ensure the main factor affecting recruitment is the environment.

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 (CDRs) must be lodged for pink snapper and other demersal scalefish separately at the designated landing ports (Coral Bay, Carnarvon and Denham only).

Consultation

Management Meetings are held between Fisheries 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.

Focused recreational consultation occurs with Recfishwest. Broader recreational consultation processes are facilitated by Recfishwest under an SLA.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

A formal harvest strategy for the GDSR was developed by a stakeholder working group in 2016/17. The GDSR Harvest Strategy defines the ecological, economic and social objectives and establishes the explicit rules that determine the appropriate catch levels for the GDSR.

The 2017 assessment indicates that the pink snapper spawning stock is currently below the threshold level and around the limit. The annual catch and catch rate performance levels of pink snapper in the GDSMF were also triggered during 2016/17. In accordance with the GDSR Harvest Strategy, a management review will be undertaken in 2017. It is anticipated that the review will result in the introduction of new management arrangements that are designed to rebuild the pink snapper spawning stock to above the threshold level

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 2016 (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 2017

G. Jackson, H. Zilles 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 2017

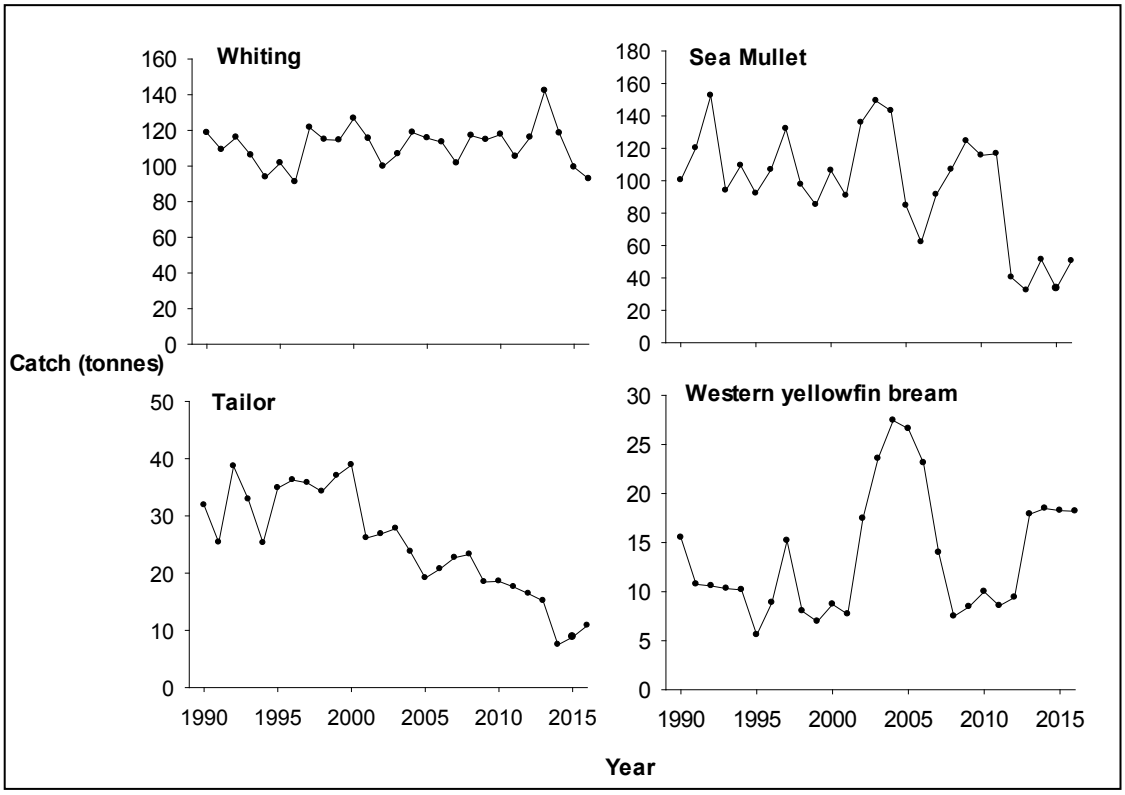
Fishery Performance	Commercial	Recreational
Total Catch 2016	178 t	~15-20 t (pink snapper only)*
Fishing Level	Acceptable	Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Demersal	Sustainable – Adequate	Annual: Catch, Catch rate; Periodic: Spawning biomass, Fishing mortality, 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 mill) 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 2016

CATCH AND LANDINGS

In 2016, the total catch reported by the commercial fishery (Shark Bay Beach Seine and Mesh Net Managed Fishery [SBBSMNF]) was 178 t, comprising 93 t of whiting, 51 t of mullet, 18 t of western yellowfin bream, 11 t of tailor and 6 t of other mixed species including 2 t of pink snapper. The charter catch of pink snapper reported in 2016 was 2.1 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 late 2017.



INNER SHARK BAY FIGURE 1.

Commercial catches of whiting, tailor, sea mullet and western yellowfin bream taken by SBBSMNF 1990-2016.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Pink snapper Inner Gulf Stocks (Sustainable-Adequate)

The three separate biological stocks found in inner Shark Bay (i.e. Eastern Gulf, Denham Sound, Freycinet Estuary) are predominantly fished by the recreational and charter sectors. Commercial catches of pink snapper in the inner gulfs are relatively small (~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 **sustainable-adequate.**

Yellowfin whiting (Sustainable-Adequate)

In 2016, the commercial catch of yellowfin whiting taken by the SBBSMNF was 93 t, which is within the target catch range (93-127 t), and the Catch Per Unit Effort (CPUE) at 163 kg/boat day 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 (Inner Shark Bay Figure 1). Whiting species (mostly yellowfin) are the third most retained species group taken by boat based recreational fishers in inner Shark Bay (Wise *et al*. 2012).

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 **sustainable-adequate**.

Sea mullet (Sustainable-Adequate)

In 2016, the commercial catch of sea mullet taken by the SBBSMNF was 51 t, which although a marked increase on the 2015 catch, remains below the target catch range (77-144 t). The CPUE in 2016 increased to 89 kg/boat day which is around the threshold catch rate (62 kg/boat day).

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

Tailor (Sustainable-Adequate)

In 2016, the commercial catch of tailor taken by the SBBSMNF was 11 t, the third lowest catch on record and continues the trend with catches since 2004 below the target catch range (25-40 t). The CPUE in 2016 increased to 19 kg/boat day which is just below the threshold level (21 kg/boat day). The low landings of tailor that have been 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 **sustainable-adequate.**

Western yellowfin bream (Sustainable-Adequate)

In 2016, the commercial catch of western yellowfin bream taken by the SBBSMNF (18 tonnes) and CPUE (32 kg/boat day) were above the target catch range (7-15 t) and the threshold catch rate (5 kg/boat day), as has been the case since 2013. 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 **sustainable-adequate.**

BYCATCH and PROTECTED SPECIES INTERACTIONS

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

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 and ECOSYSTEM INTERACTIONS

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.**

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 2016, 7 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. The annual estimated boat-based recreational fishing effort in the Gascoyne Coast Bioregion was steady in 2015/16 (43,237 boat days, SE=3,152), but lower than 2013/14 (53,832, SE=3,603) and 2011/12 (58,123, SE=3,672) (Ryan *et al.* 2017).

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 568 boat days in 2016 which again was the lowest level on record. While the total commercial catch in 2016 at 178 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 2016 were assumed to be similar to those estimated in 2010 (more recent data will be available in late 2017) and therefore within the respective notional TARCs in each area, are therefore **acceptable**.

Harvest Strategy

The 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 managed to notional maximum acceptable catch levels: 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).

Compliance

The Department of Primary Industries and Regional Development undertakes regular compliance inspections at-sea and on-land.

Consultation

Fisheries 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 Fisheries'.

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

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

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 were 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 and an increase in the daily bag limit from one to two per person per day. 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).

These drivers represent a **moderate risk**.

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NORTH COAST BIOREGION

ABOUT THE BIOREGION

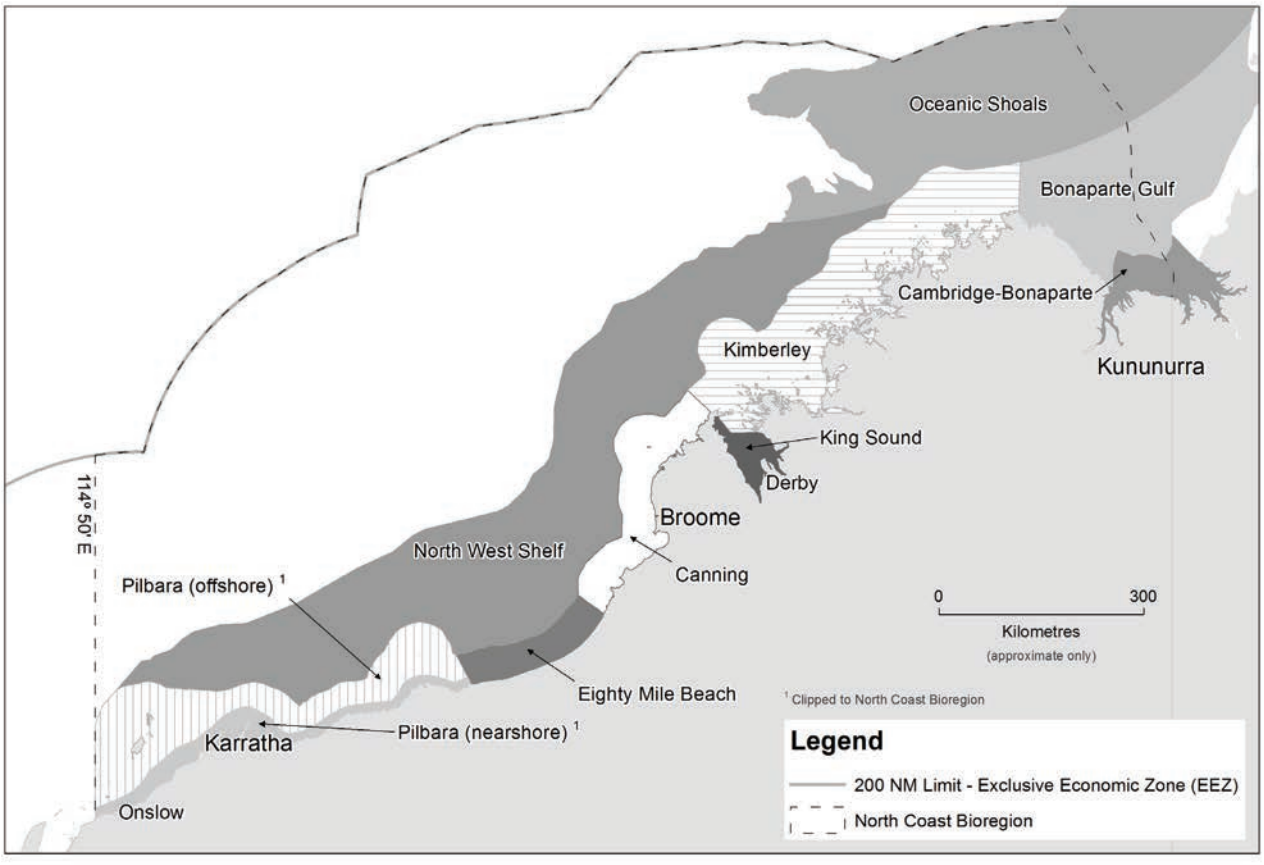
The oceanography of the North Coast Bioregion (North Coast Overview Figure 1) includes waters of Pacific Ocean origin that enter through the Indonesian archipelago bringing warm, low salinity waters polewards via the Indonesian Throughflow and Holloway Currents which flow seasonally and interact with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

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 rainfall over summer.

Significant river run-off and associated localised coastal productivity can be associated with cyclone events, with run-off ceasing during the Austral 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.

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, low productivity 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 potential threats and risks to IMCRA 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, risks were 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 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.

Climate change will impact the biological, economic, and social aspects of many fisheries, potentially in both positive and negative ways. 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 species are monitored in a national citizen-science program (www.redmap.org.au) in which the Department is a collaborator.

Commercial Fishing

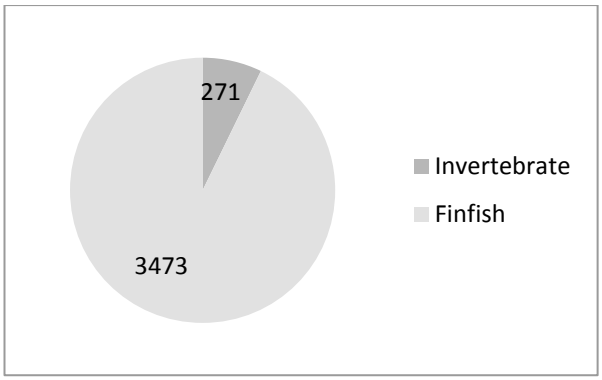
There are 15 different State-managed commercial fisheries operating within the North Coast Bioregion. These fisheries target a variety of species including finfish, crustaceans, molluscs and echinoderms (North Coast Overview Figure 2). The principal commercial fisheries in the North Coast Bioregion focus 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 Fishery (trap and line). The typical catch is in the order of 3,000 t annually, making these fisheries the most valuable finfish sector in the State, with an estimated annual value of at least $12 million. 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 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 200-300 t annually, valued at around $33 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 traditionally collected trochus in this area.

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 the Governments of Australia and Indonesia. The MOU allows Indonesian fishers to continue fishing using traditional methods within Australian waters of the MOU Box under an agreement formalised in 1974.

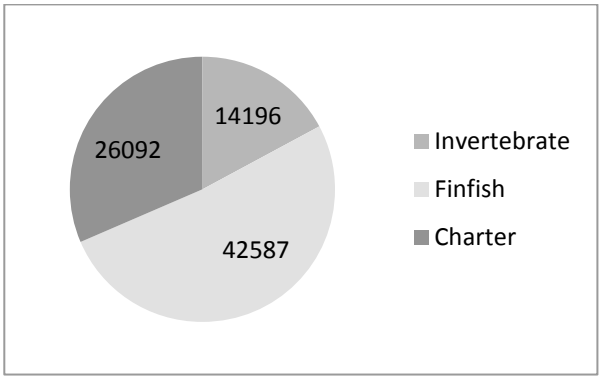


NORTH COAST OVERVIEW FIGURE 2

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 increased by significant numbers of intra-state and inter-state tourists travelling through the area and visiting Onslow, Dampier Archipelago and Broome sections of the coastline. This adds to the increased recreational fishing effort resulting from people employed 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, rivers and 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 recreational fishing opportunities for species including tropical snappers, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish.

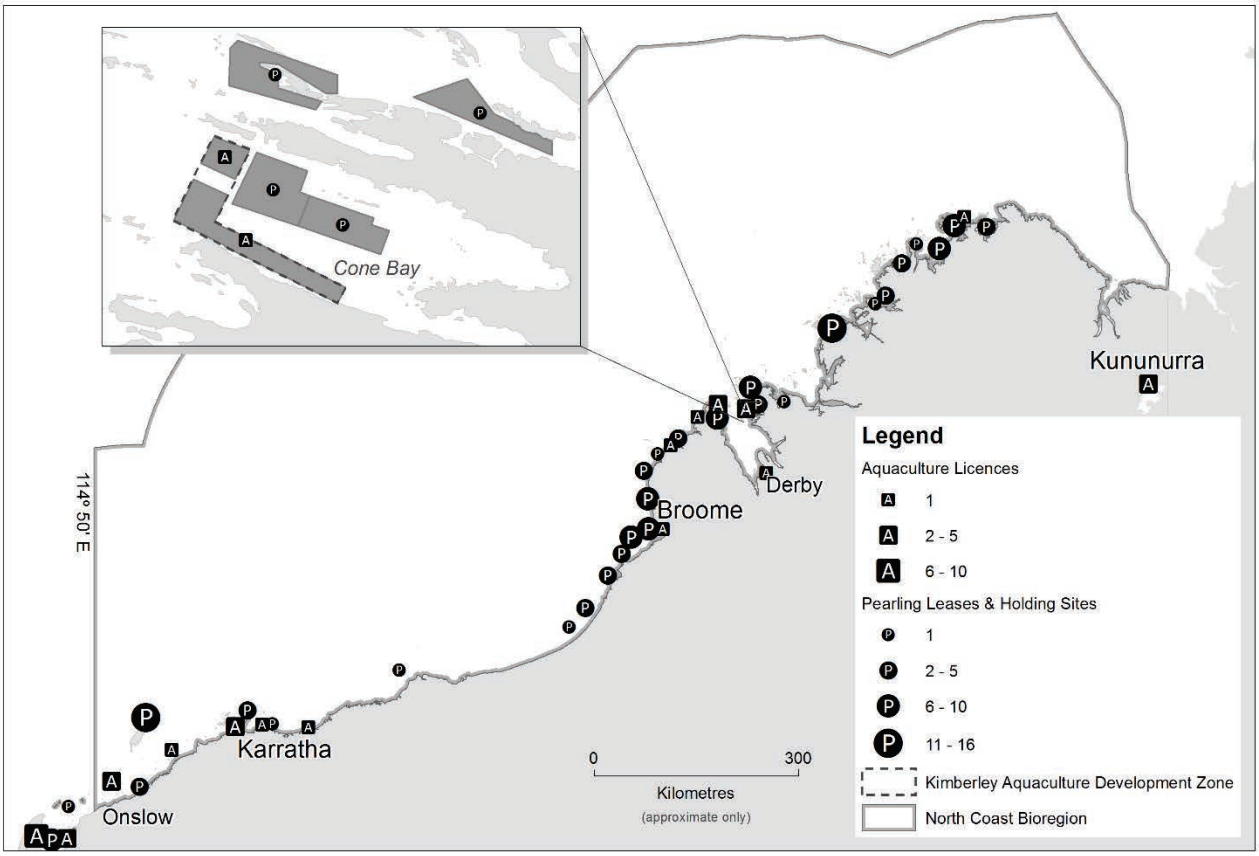


NORTH COAST OVERVIEW FIGURE 3

The North Coast Bioregion finfish and invertebrate catch numbers as assessed in the integrated survey of boat-based recreational fishing in WA 2015/16, 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 (A) and pearling leases (P). Also indicated is the Kimberley Aquaculture Development Zone.

Aquaculture in the Kimberley region is dominated by barramundi farming within the Kimberley Aquaculture Development Zone, which was declared in August 2014. Located about 215 kilometres north-east of Broome, this zone encompasses almost 2,000 hectares of coastal waters within Cone Bay. The zone was declared after the completion of a strategic environmental study, which demonstrated the zone would be capable of producing 20,000 tonnes of finfish annually without significant environmental impact. MPA Fish Farms Pty Ltd, already established within the zone, has been granted an aquaculture licence to grow up to 15,000 tonnes of barramundi and other marine finfish per year on a 1,344-hectare site. A second aquaculture licence has been granted to Aarli Mayi Aquaculture Project Pty Ltd, which is authorised to grow 5,000 tonnes per annum.

A focus of aquaculture development is provided by the Departments' Broome Tropical Aquaculture Park, which houses a commercial pearl oyster hatchery and the Kimberley Training Institute aquaculture training facility.

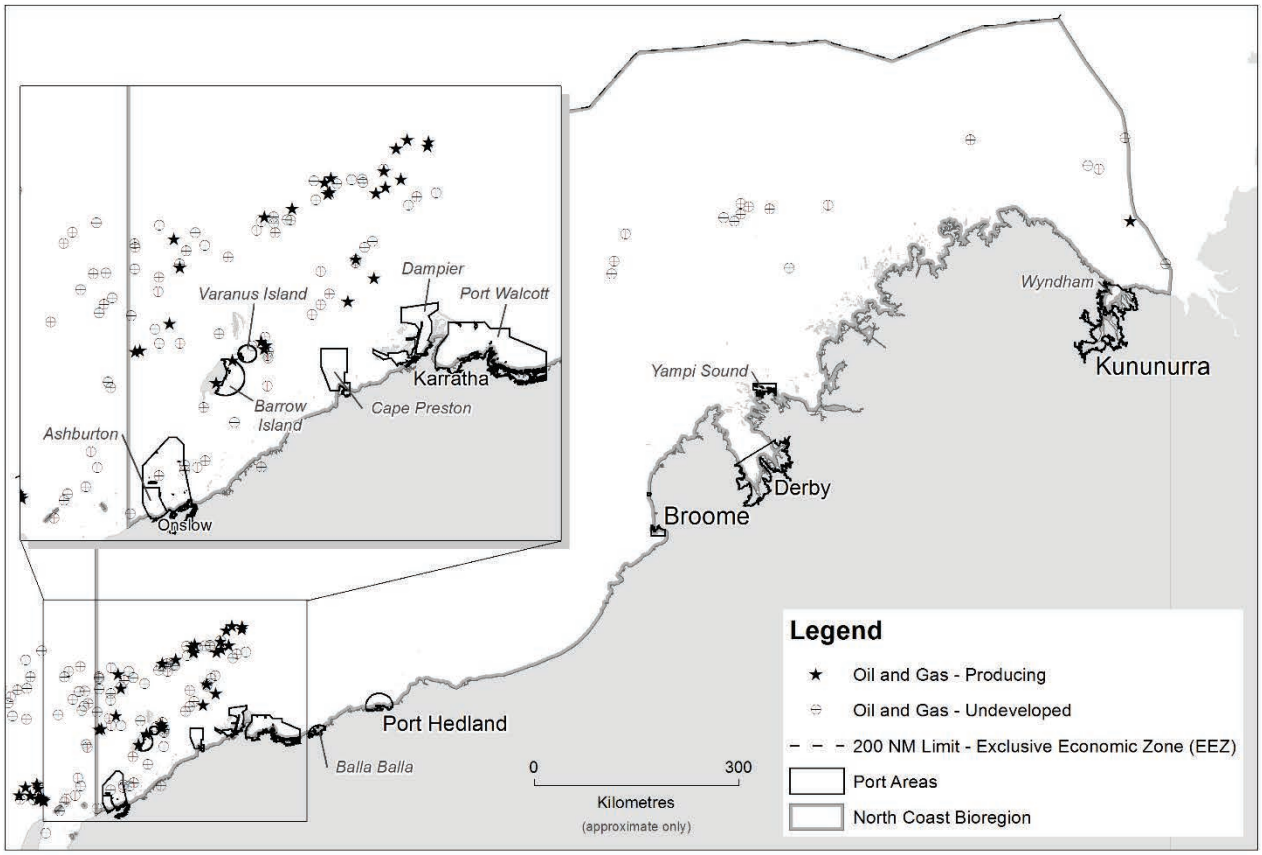
A company developing a project culturing marine microalgae for the production of bio-fuels, omega-3 lipid and protein biomass previously established a demonstration facility near Karratha. The company is currently assessing alternative sites for the project.

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, snorkelling, 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 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 spills.

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 breakwater construction, 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 sea surface temperature (SST) to the south, there were no significant effects expected from climate change on the species selected (Caputi *et al*. 2015a,b). However, if a southward expansion in the range of Narrow-Barred Spanish Mackerel occurred then it is possible that the total biomass of this species in Western Australia may increase due to various factors associated with breeding and availability of suitable habitats (Caputi *et al*. 2015b).

The Department 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 managing the impacts of climate change on marine resources. The project focused on a literature review relating to the coastal and marine environments in the Pilbara and Kimberley. The literature review 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) is likely to 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 represent 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 Biodiversity, Conservation and Attractions (DBCA) 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 is yet to announce the final reserve network for the North-West which spans the North Coast and Gascoyne Bioregions.

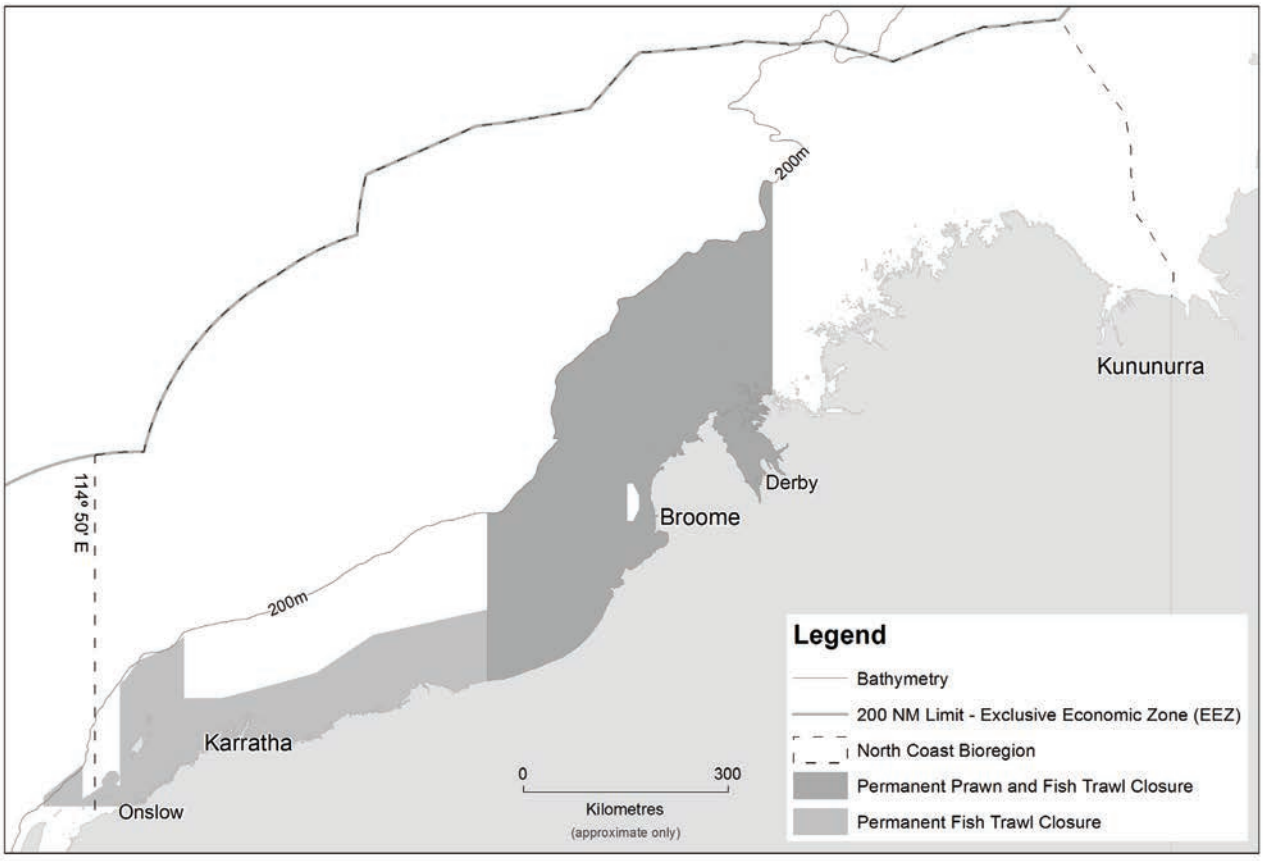
1 Dudley N. (editor) 2008. Guidelines for applying protected area management categories. IUCN. Gland, Switzerland.

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

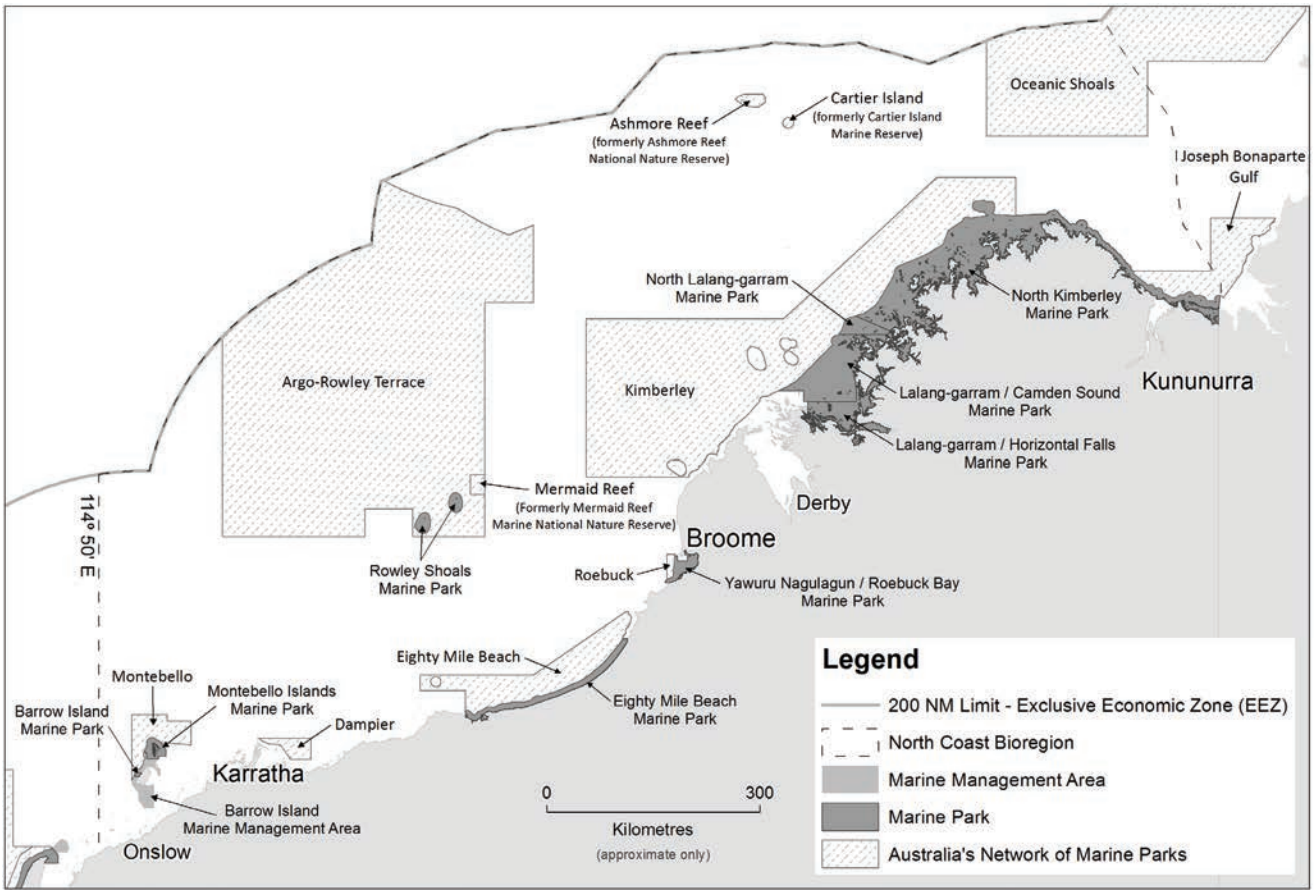
The areas and proportions of the North Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which are consistent with the IUCN criteria for classification as marine protected areas. This table does not yet include the closures that may be implemented by the Commonwealth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

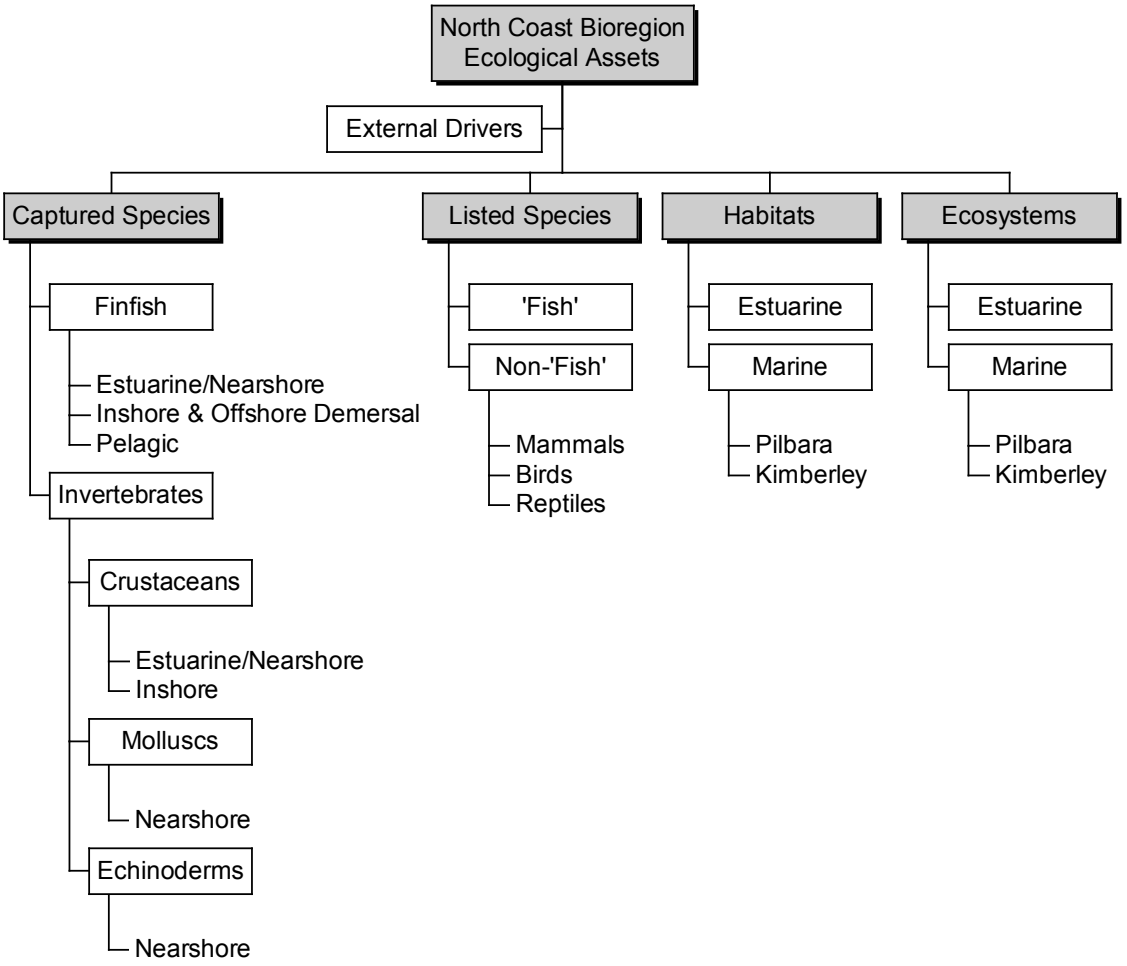


NORTH COAST OVERVIEW FIGURE 7

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.

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 low 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.

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 in place or planned.

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 finfish 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.

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 traditionally collected trochus in this area.

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. The fishery achieved Marine Stewardship Council certification in 2017.

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.

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[1] (ETP) species can be found within the North Coast Bioregion, including cetaceans, dugongs, marine turtles, sea snakes, elasmobranchs, seahorses and pipefish, crocodiles and seabirds and migratory shorebirds. These species are protected by various international agreements and national and state legislation. International agreements include:

- Convention on the Conservation of Migratory Species of Wild Animals 1979 (Bonn Convention);
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES);
- The Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974 (JAMBA)[2];
- The Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 (CAMBA)[2];
- The Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds 2007 (ROKAMBA)[2]; and
- Any other international agreement, or instrument made under other international agreements approved by the environment minister including the EBPC Act 1999.

Primary pieces of national and Western Australian legislation include the Commonwealth Environment Protection and Biodiversity Act 1999 (EPBC Act), the Western Australian Wildlife Conservation Act 1950 (WC Act), and the Fish Resources Management Act 1994 (FRMA).

Fisheries in the region that have reported interactions with ETP species include trawl fisheries (the Onslow Prawn Managed Fishery (OPMF), the Nickol Bay Prawn Managed Fishery (NBPMF), the Pilbara Fish Trawl Fishery) 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 crocodiles and sawfish.

Fish

Listed species	Risk
Fish	MODERATE

The sawfish (Pristidae), speartooth shark (*Glyphis glyphis*) or the northern river shark (*Glyphis garricki*) are incidentally 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.

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

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

Non-Fish

Listed species	Risk
Mammals	LOW
Reptiles and Birds	MODERATE

Dolphins are incidentally captured by the Pilbara fish trawl fishery. To assist in mitigation of shark, reptile and cetacean bycatch, species-specific responses to three bycatch reduction device (BRDs) configurations were investigated using both *in situ* subsurface and onboard observations. The upward inclined exclusion grid significantly improved the escape proportions for most sharks by 21-29 %. All BRDs were highly effective in reducing reptile (turtles and seasnakes) bycatch, but irrelevant for the few sawfish (n = 13) that readily entangled in the anterior of the net. Cetacean (bottlenose dolphins only) interactions with BRDs were very rare (n = 7) despite high levels of attendance and depredation during trawling. Loss of targeted teleosts through the BRDs was also very rare (1.3 % of day trawls). The study also provided evidence that the subsurface expulsion of megafauna in poor condition is negligible. The Pilbara fish trawl fishery operates under WTO with conditions around dolphin and sawfish interactions and monitoring.

Sea snakes and turtles are encountered occasionally in trawl catches. Both of these taxa 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 are typically 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.

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 areas that are not trawled are taken into account, 89 % of statewide benthic habitats out to the 200 m isobath are 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 that 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 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 catch compositions 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 2017

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

OVERVIEW

The four northern prawn managed fisheries (Kimberley, Broome, Nickol Bay and Onslow) 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 2017

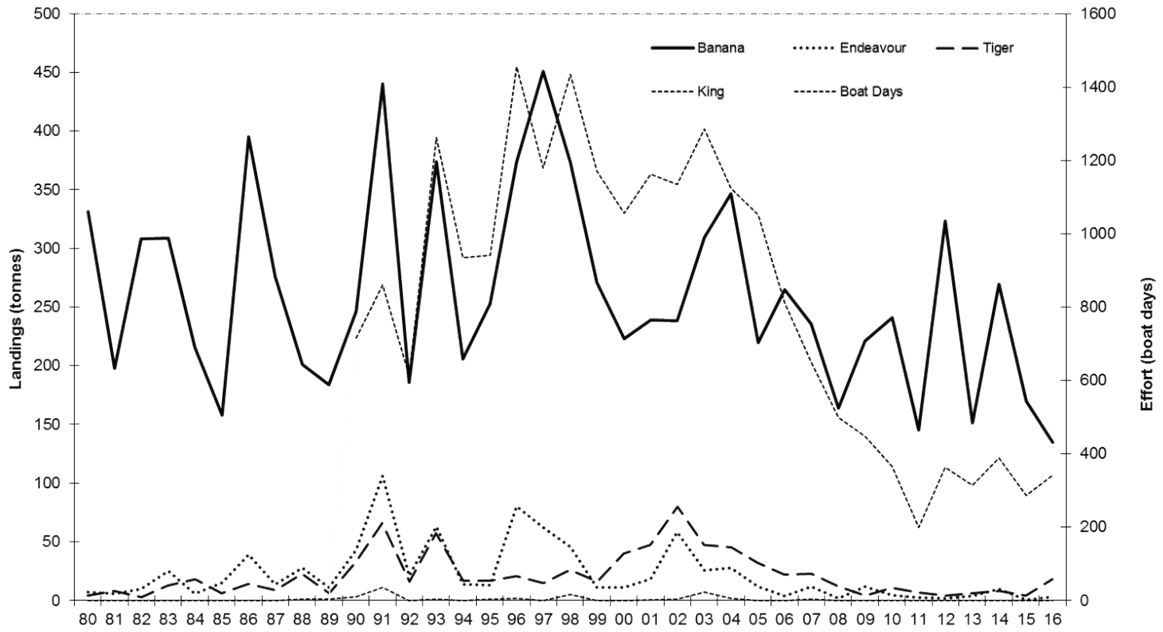
Fishery Performance	Commercial	Recreational
Total Catch 2016	175 t	Not applicable
Fishing Level	Acceptable	
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Nickol Bay	Adequate	Catch, Effort, Rainfall-Catch Relationships
Kimberley	Adequate	Catch, Effort, Biomass, Rainfall-Catch Relationships
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	Low Amenity Negligible Risk	Economic	KPMF: Level 2 ($1 – 5 mill) NBPMF: Level 1 (<$1 mill) BPMF: Negligible. OPMF: Negligible. High Risk
Governance	Kimberley - Plan review	External Drivers	Risk Level 4 (climate)

CATCH AND LANDINGS

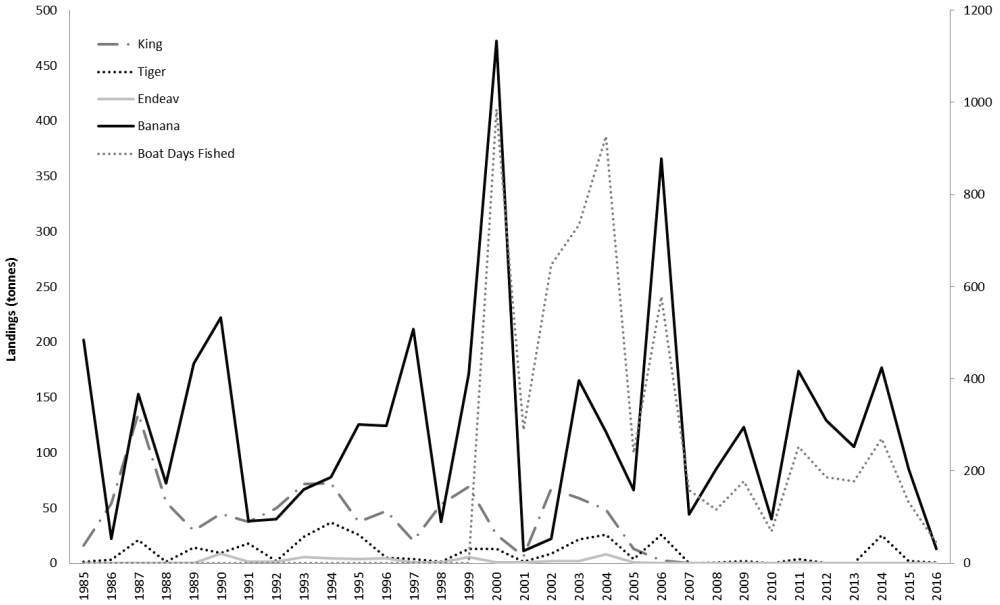
Kimberley Prawn Managed Fishery (KPMF)

The total landings in 2016 for the KPMF were 155 t, similar to the levels caught during the past 8 years. However the catch of 135 t of banana prawns was the lowest in over 35 years, with 17 t of brown tiger prawns and 3 t of endeavour prawns also taken (North Coast Prawn Figure 1). There are two fishing periods for the complete season (April and May, then from August to December). 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 1980-2016.



NORTH COAST PRAWN FIGURE 2.

Annual prawn landings (t) and fishing effort (total adjusted hours) for the Nickol Bay Prawn Managed Fishery 1985-2016.

Broome Prawn Managed Fishery (BPMF)

Extremely low fishing effort was recorded as only trial fishing was undertaken by one boat to investigate whether commercial fishing was warranted. This resulted in negligible landings of western king prawns with no byproduct recorded.

Nickol Bay Prawn Managed Fishery (NBPMF)

The total landings of major penaeids for the 2016 season were 17 t, the second lowest catch since 1966 (North Coast Prawn Figure 2). This comprised 16 t of banana prawns, which was below the predicted range (35 – 53 t, based on updated data), 1 t of brown tiger prawns, negligible quantity of endeavour prawns and no recorded landings of western king prawns.

Onslow Prawn Managed Fishery (OPMF)

The total landings of major penaeids for the 2016 season were 3 t, comprising 2 t of banana prawns, and <1 t each of brown tiger prawns and endeavour prawns. No western king prawns were recorded as landed.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Kimberley Prawn Managed Fishery – Banana prawns (Sustainable-Adequate)

Due to a change associated with the fleet structure and economics of fishing, there has been a marked reduction in the number of fishers each year with fishing effort (boat-days) below historical levels since 2005 (North Coast Prawn Figure 1). However, total catches have generally been in line with seasonal catch predictions. The breeding stock is considered **sustainable-adequate**.

Broome Prawn Managed Fishery – Western king prawns (Sustainable-Adequate)

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. Higher average water temperatures appear to be having a negative effect on western king prawn catches in recent years in the north coast prawn fisheries. However, the breeding stock is considered **sustainable-adequate.**

Nickol Bay Prawn Managed Fishery – Banana prawns (Sustainable-Adequate)

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

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

One boat fished in the OPMF in 2016. However, because this boat can operate in other fisheries where catches were more profitable, this fishery recorded very low effort and catch. Therefore the breeding stocks of brown tiger and western king prawns were protected and are considered **sustainable-adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch levels for all these fisheries are relatively low by tropical trawl fishery standards, with few species of significance to other fishing sectors being taken. In addition to grids, fish escape secondary bycatch reduction devices (FEDs) (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. **Low** risk.

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. **Low** risk.

Protected species interactions recorded in the daily logbooks for each fishery in 2016 are;

Kimberley: 72 sea snakes were recorded as being caught with 58 returned to the sea alive, 10 with status unknown and 4 returned dead. Four sawfish were recorded as captured with three returned to the sea alive and 1 recorded dead.

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

Nickol Bay/Onslow: There were no reported protected species interactions for either fishery, and this was likely due to the limited effort applied in these two fisheries this season.

HABITAT AND ECOSYSTEM INTERACTIONS

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 fisheries and controls on effort indicate that its environmental impact is likely to be low. The area fished in the four northern prawn fisheries ranged from 1.4% in the KPMF to <1% in the BPMF, within the boundaries of these fisheries. **Low** risk.

Prawn species are generally managed at relatively moderate levels of annual harvest, and this has declined in recent years for economic reasons. Therefore, the impact of the catch on local food chains is unlikely to be significant in view of the high natural mortality of prawns, the extent of non-trawled nursery areas in each fishery and variable biomass levels of prawns resulting from variable environmental conditions such as cyclone events. **Low** risk.

SOCIAL AND ECONOMIC OUTCOMES

Social

The estimated employment in 2016 was 40 to 50 people including skippers and other crew for all north coast prawn 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 excluding byproduct are; KPMF - $2.0 M, NPMF - $0.2 M, BPMF and OPMF - negligible.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

KPMF: 240 - 450 t (**Acceptable**). Banana prawn landings were below their allowable range as well as the predicted range due to low fishing effort because of expected low landings (low rainfall).

BPMF: 55 -260 t (**Acceptable**). Minimal fishing occurred in 2016.

NPMF: 90 - 300 t (**Acceptable**).

All catches were below their tolerance ranges with banana prawns well below their predicted range. Due to low rainfall and the low predicted catch, fishing effort was directed into other prawn fisheries.

OPMF: 60-180 t (**Acceptable**). Effort and catch were minimal in 2016.

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. For the KPMF, an effort cap of 1500 vessel days is set for the two parts of the season. For the NBPMF, a conservative harvesting strategy of the banana prawn resource provides protection from recruitment overfishing, allowing adequate spawning biomass to survive to the key spawning period each year by opening the key fishing grounds in May. For the BPMF, trial fishing is undertaken to assess the stock level of western king prawns prior to commercial fishing commencing thus retaining spawning biomass. Bycatch reduction devices, including grids and FEDs (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 Primary Industries and Regional Development (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

Biannual meetings between the Department, WAFIC and licence holders are held to consider the status of the stocks and recommend the opening and closing dates and fishing arrangements that operate within the season.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives/Outlook

The Department is currently investigating the potential of a review of the KPMF in 2017/18. The review proposes to unitise effort days to address latent effort and allow for improvements in the fishery's seasonal management arrangements.

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 those 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 **moderate-high** and will need to be monitored (Caputi *et al.* 2014b, 2015).

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NORTH COAST NEARSHORE AND ESTUARINE RESOURCE STATUS REPORT 2017

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OVERVIEW

The Kimberley Gillnet and Barramundi Fishery (KGBF) operates in the nearshore and estuarine zones of the North Coast Bioregion and extends 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 four licences, following the buyout of the two licences from the Broome Coast (Roebuck Bay) area in 2013. Commercial fishing is now prohibited between the southern boundary if the fishery (19º00′ S) to north of Willie Creek (17º44′ S). Fishing is also restricted to within three nautical miles of the high water mark for the remainder of the fishery. 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 2016	74.6 t	20–35 t (2015/16 boat-based only)
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

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 2016 was 74.6 tonnes (t) (North Coast Nearshore and Estuarine Table 1). The total landings of barramundi in 2016 were 50.8 t (North Coast Nearshore and Estuarine Table 1, Figure 1), slightly less than the 2015 catch of 52.4 t. The 2016 landings of threadfin from the KGBF were 19.4 t (North Coast Nearshore and Estuarine Table 1, Figure 1), down from the 26.2 t reported in 2015.

The top 10 nearshore and estuarine species (or species groupings) in the North Coast represented 83% of the total boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range for the top 10 nearshore and estuarine species in the North Coast was steady in 2015/16 compared with estimates from previous statewide surveys (95% CI 20–35 tonnes compared with 15–27 in 2013/14 and 20–36 in 2011/12) (Ryan *et al*. 2017). No recent estimates of shore-based recreational catches are available.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Barramundi (Sustainable-Adequate)

The barramundi catch in 2016 was 50.8 t, above the target catch range but did not exceed the limit range. The catch rate reduced from 136.1 kg/ block day in 2015 to 96 kg/block day in 2016, but remains high relative to catch rates recorded prior to 2011 (North Coast Nearshore and Estuarine Figure 2).

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 **sustainable-adequate**.

King threadfin (Sustainable-Adequate)

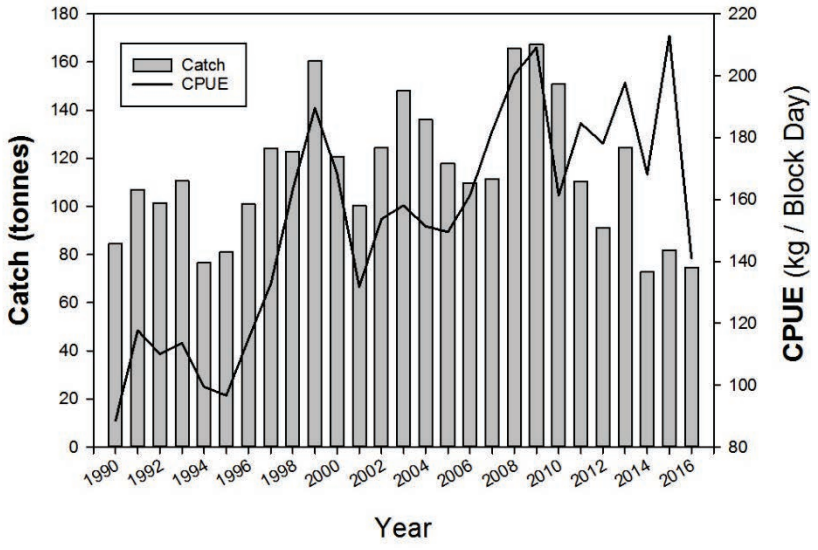
Threadfin catches are dominated by king threadfin. Catch of king threadfin in 2016 was 19 t, lower than that reported in previous years and well below the average of 74.5 t for the 10-year period from 2004–13. This is due to the low effort levels now available in the fishery. This follows the removal of two fishing licenses from the Broome coast area, with this area now closed to commercial fishing. The lower commercial catches in recent years (post closures) are relatively stable. 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 **sustainable-adequate**.

NORTH COAST NEARSHORE AND ESTUARINE TABLE 1

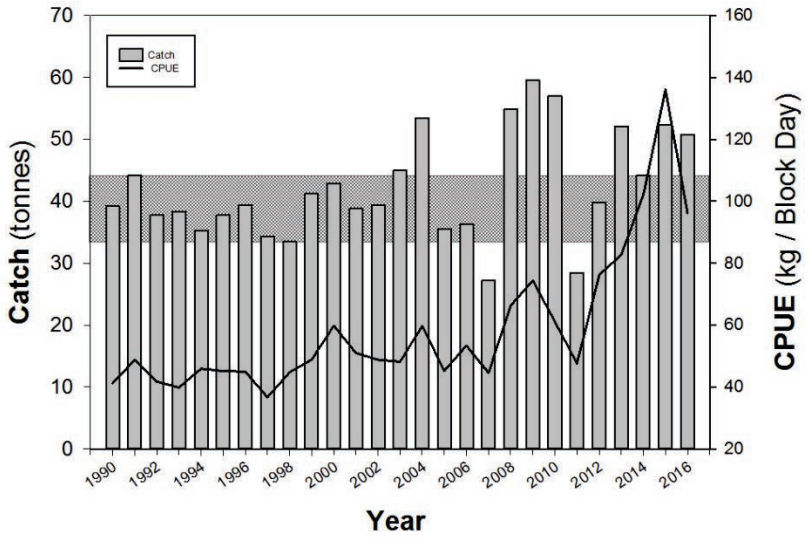
Summary of the reported catch (t) in the Kimberley Gillnet Barramundi Fishery in 2016 and the percentage composition of each of the major species retained.

Species	Catch (tonnes)	Composition %
Threadfin	19.4	26
Barramundi	50.8	68.1
Tripletail	0.2	0.2
Black jewfish	1.7	2.3
Sharks	0.1	0.2
Other fish	2.4	3.2
Total	74.6	100



NORTH COAST NEARSHORE AND ESTUARINE FIGURE 1

The annual total catch and catch per unit effort (CPUE, kg block day^{-1}), from all areas of the KGBF including sharks and rays over the period 1990 to 2014.



NORTH COAST NEARSHORE AND ESTUARINE FIGURE 2

The annual catch and catch per unit effort (CPUE, kg block day^{-1}) for barramundi from the KGBF over the period 1990 to 2016. The upper and lower bounds of the target commercial catch range for barramundi are shown by the shaded catch area between 33 and 44 tonnes.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch

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. **Negligible** risk.

Protected species

The fishing gear used for this fishery (gillnets) is known to result in the occasional 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 2016, 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. L**ow** risk.

HABITAT AND ECOSYSTEM INTERACTIONS

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

During the 2016 season (February to November), four vessels fished in the KGBF with an average crew level of approximately 2.5 people, with an estimate of at least 10 people directly employed in the fishery. There was additional employment through local processors and distribution networks. The fishery provides fresh fish for 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

The fishery's score value in 2016 was estimated to be Level 1 (i.e. Risk level – **Low**; Economic value – < $1 million). The establishment of new marine parks may impact on the future 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. There is a need to further review the catch ranges within 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 the 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

Fisheries 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 Fisheries. 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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

The KGBF management plan was amended in June 2012 to modernise the fishery management arrangements. New marine parks are currently being developed for the Kimberley region.

EXTERNAL DRIVERS

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 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).

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 remain open to fishing and are easily accessible, increasing risks of local depletion of barramundi and threadfin stocks.

Low risk.

NORTH COAST DEMERSAL RESOURCE STATUS REPORT 2017

S. Newman, C. Wakefield, C. Skepper, D. Boddington, R. Jones and E. Smith

OVERVIEW

A range of commercial and recreational fisheries target demersal scalefish resources in the North Coast Bioregion (NCB) of Western Australia. The major demersal fish species in the NCB (in order of gross tonnage) are; 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 in the NCB include the Northern Demersal Scalefish Managed Fishery (NDSMF) in the Kimberley subregion, and the Pilbara Demersal Scalefish Fisheries (PDSF) in the Pilbara subregion.

The PDSF 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 the fisheries in the Pilbara subregion are bluespotted emperor, red emperor, and rankin cod.

The permitted methods in 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. The main species landed by this fishery in the Kimberley subregion are goldband snapper and red emperor. The inshore area of the NDSMF (Area 1) permits line fishing only, between the high water mark and a line approximating the 30 m isobath.

Recreational fishing activities in the NCB are mostly line-based fishing from private boats and charter vessels with effort concentrated 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 demersal scalefish species targeted by the commercial fisheries.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2016	Kimberley : 1,173 t Pilbara: 2,150 t	North Coast Bioregion: 34–47 t (2015/16 boat-based only)
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: Negligible Risk	Listed Species	Kimberley: Negligible Risk Pilbara: Low-Moderate Risk
Habitat	Kimberley: Low Risk Pilbara: Low-Moderate Risk	Ecosystem	Kimberley: Negligible Risk Pilbara: Low Risk
Social	Kimberley: Low Risk Pilbara: Low Risk	Economic	Kimberley: Level 3 ($5-10 mill) Pilbara: Level 3 ($5-10 mill)
Governance	Stable	External Drivers	Low Risk

*Top 10 demersal species only from 2015/16 survey (Ryan *et al.* 2017)

CATCH AND LANDINGS

Kimberley

Since 2008, NDSMF annual catches have exceeded 1,000 t. The 2016 catch of 1,173 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 NDSMF were also within the range of those recorded since 2008. The majority of the catch is landed from Zone B, with a catch of 965 t in 2016.

Pilbara

The PDSF annual catches from the domestic fish trawl, trap and line fisheries peaked at 3,600 t in 1996. In 2008, following declining catch rates and relatively high levels of fishing mortality for red emperor in the western areas of the PFTIMF, effort was reduced for the PFTIMF in these areas. In 2016, the PDSF annual catches exceeded 2,000 t for the first time since effort reductions in 2008. In 2016, 71% (1,529 t) of the total commercial catches of demersal scalefish in the Pilbara (2,150 t) were landed by the trawl sector, with 23% (495 t) taken by the trap sector and 6% (126 t) taken by the line sector.

Total annual 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 from 2008-15, in response to the effort reductions imposed on the PFTIMF since 2008. The total demersal scalefish catch in the PFTIMF in 2016, despite having the same annual effort allocations as those imposed since 2008, slightly exceeded the acceptable catch range (i.e. 940-1,416 t). These increasing catch rates (combined with fishing mortality spawning biomass estimates) suggest effort reductions since 2008 have resulted in increased fish abundance and stock rebuilding in the PFTIMF.

The total annual catch taken by the trap and line sectors have remained relatively consistent over the past decade, averaging 440 t and 100 t per year, respectively. The total catch of the trap and line fisheries were within the acceptable catch ranges in 2016 (i.e. 241-537 t for trap and 36-127 t for line).

The top 10 demersal species in the North Coast represented 77% of the total boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range for the top 10 demersal species in the North Coast was lower in 2015/16 (95% CI 34–47 tonnes compared with 48–69 in 2013/14 and 73–92 in 2011/12) (Ryan *et al*. 2017).

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*).

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 were 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.

On the basis of the evidence provided above, the biological stocks are classified as **sustainable-adequate**.

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*), rankin cod (*Epinephelus multinotatus*), and bluespotted emperor (*Lethrinus punctulatus*). The status of ruby snapper (*Etelis* sp) is also used as an indicator species for the offshore demersal scalefish resources targeted by the Pilbara Line Fishery. The stock status of indicator species are assessed periodically (~ every 5 years) using a weight-of-evidence approach that considers all available information as described above.

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 rankin cod, bluespotted emperor and ruby snapper are **well above** the target spawning biomass levels.

Representative age structure samples of 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 stocks are classified as **sustainable-adequate**.

NORTH COAST DEMERSAL TABLE 1.

Summary of the commercial catches and the relative contribution (% composition of the total NCB demersal catches of each species) of each of the major species taken within the Pilbara and Kimberley subregions of the NCB in 2016.

Species	Pilbara (PDSF) catch		Kimberley (NDSMF) catch		Total catch
	tonnes	% total	tonnes	% total	tonnes
Goldband snapper (all *Pristipomoides* sp.)	209.9	32	437.8	68	647.7
Bluespotted emperor	311.4	83	63.3	17	374.7
Red emperor	132.3	49	135.3	51	267.6
Saddletail snapper	96.9	46	112.9	54	209.8
Crimson snapper	155.4	76	49.2	24	204.6
Rankin cod	88.9	53	79.8	47	168.7
Brownstripe snapper	126.6	87	18.4	13	145.0
Rosy threadfin bream	128.4	>99.9	0.6	<0.1	129.0
Spangled emperor	78.8	78	22.4	22	101.2
Moses snapper	36.3	74	12.5	26	48.8
Frypan snapper	46.1	>99.9	0.2	<0.1	46.3
Mozambique bream	25.28	82	5.5	18	30.7
Barcheek coral trout	13.4	71	5.5	29	18.9
Ruby snapper	17.4	93	1.3	7	18.7
Longnose emperor	4.5	32	9.4	68	13.9
Grass emperor	0.1	3	3.0	97	3.1
Other demersal scalefish	678.6	76	215.6	24	894.2
Total all demersal scalefish	2150.2	65	1172.7	35	3322.9

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 because most individuals encountered are large in size and girth which limits their capacity to pass through the entrance funnel into the traps. **Neglible** risk.

The Kimberley and Pilbara trap fisheries regularly capture sea snakes. In 2016, the Pilbara and Kimberley trap fisheries reported ~213 and ~26 sea snakes, respectively. Sea snakes are returned to the water alive. **Low** risk.

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.

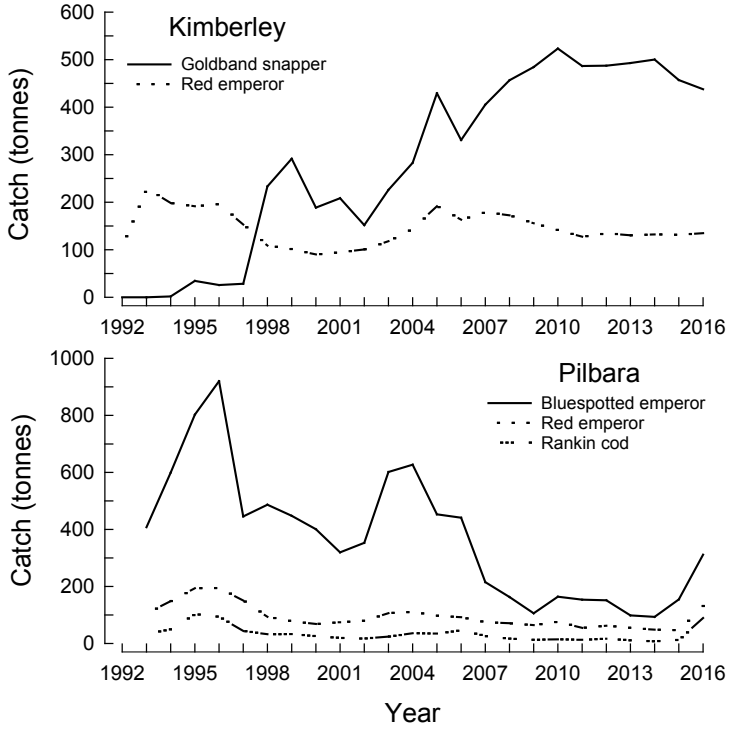
The use of Bycatch Reduction Devices (BRDs) has been mandatory in the PFTIMF since 2006. BRDs are highly effective in reducing reptile (turtles and sea snakes) bycatch. Bottlenose dolphin interactions with BRDs are rare (5.2 per 1,000 trawls) despite high levels of attendance and depredation during trawling. 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). **Low-moderate** risk.

The PFTIMF was re-accredited a Wildlife Trade Operation (WTO) under the Commonwealth of Australia's *Environmental Protection and Biodiversity Conservation Act 1991* (EPBC) for three years from mid-2014. This was extended until 30 May 2018. The accreditation 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 PFTIMF in 2016. *Where the condition was not reported, the animal was considered deceased.

Species	Number released Alive	Number deceased*	Total Reported
Bottlenose dolphins	3	30	33
Pipefish	6	26	32
Green sawfish	21	12	33
Narrow sawfish	8	2	10
Seahorses	3	6	9
Sea-snakes	46	23	69
Turtles	7	0	7



NORTH COAST DEMERSAL FIGURE 1.

Annual commercial catches of indicator species from the Kimberley and Pilbara demersal scalefish fisheries from 1993 to 2016.

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 PFTIMF is restricted to less than ~2% of the North West Shelf (NWS). 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 (~2% of NWS) but a **negligible risk** to the total habitat in the North West Shelf.

The PFTIMF 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 2016 fishing season, and at least 24 people (3-4 crew per vessel) were directly employed in the NDSMF. 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 ~10 fishers on 2 vessels were directly employed during 2016 in the trawl sector, and 8 fishers on 3 vessels in the trap sector, and at least ~15 fishers on 5 vessels in the line sector. Overall, at least ~33 people (e.g. 3-4 crew per vessel) were directly employed in the PDSF.

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, including offshore locations such as the Rowley Shoals.

The annual estimated boat-based recreational fishing effort in the North Coast Bioregion was lower in 2015/16 (31,375 boat days, SE=2,414) compared with 2013/14 (45,604, SE=3,603) and 2011/12 (47,721, SE=3,778) (Ryan *et al*. 2017).

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 NDSMF 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 2016 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 total 2016 catches were within the **acceptable** catch range.

Pilbara

The total catch of the trawl fishery slightly exceeded the acceptable catch range in 2016 despite having the same reduced annual effort allocations as those imposed since 2008. This increased catch represents an increase in stock abundance following nine years of reduced effort in the western trawl managed areas. The total catch of the trap and line fisheries were within the **acceptable** catch ranges in 2016.

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

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives/Outlook Status

Kimberley

Age structure data for the indicator species were collected in late 2016 and early 2017 in order to revise the next assessment scheduled for 2017/18.

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

Age structure data for the indicator species were collected in 2015 in order to revise the next assessment schedule for 2017/18.

In 2016/17, 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.

In 2017/18, the Department will be working with the Commonwealth Department of Environment and Energy and Pilbara Trap licence holders to complete an assessment of the Pilbara Trap Fishery under the EPBC for export approval.

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 represents 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 risks to North Coast demersal fisheries.

Low risk.

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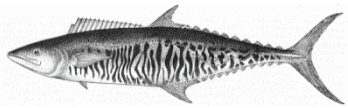
STATEWIDE LARGE PELAGIC FINFISH RESOURCE STATUS REPORT 2017



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 for most species released (Ryan *et al*. 2017). For further details see the Statewide Large Pelagic Scalefish Resource Assessment Report and relevant species chapters in SAFS (2016).

SUMMARY FEATURES 2017

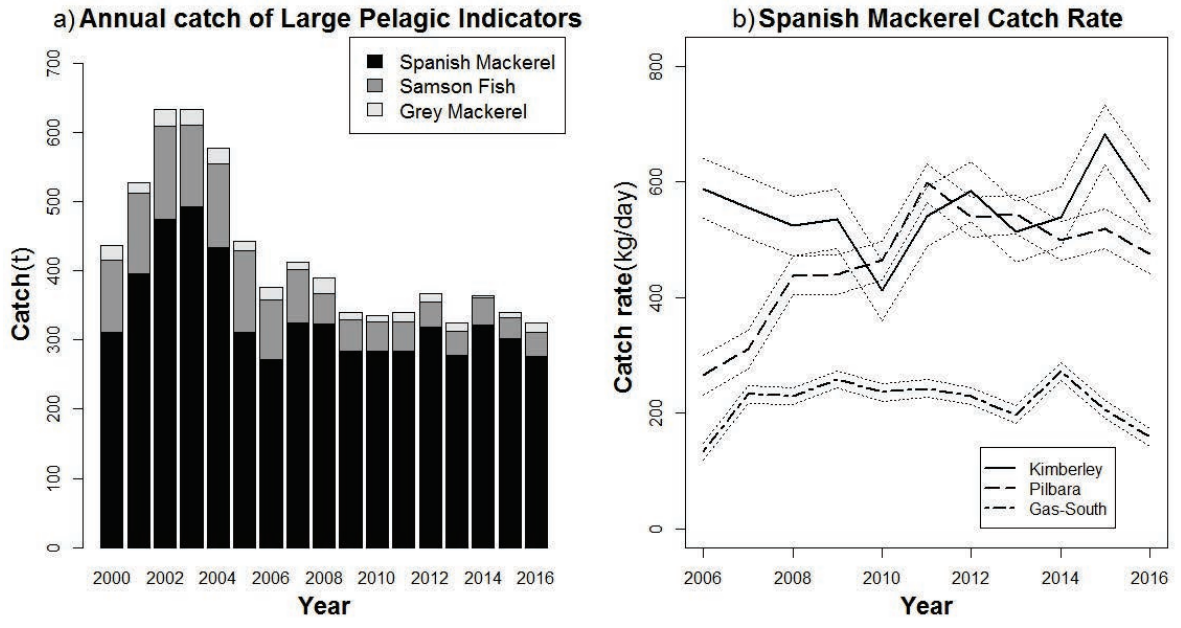
Fishery Performance	Commercial	Recreational
Total Catch 2016	276 t (Spanish only)	21–31 t (2015/16 boat-based only)
Fishing Level	Acceptable (≤ 430 t)	Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Tropical Large Pelagic	Sustainable - Adequate	Annual: Catch; Catch Rate
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 – ($1-5 mill) Low Risk
Governance	Stable	External Drivers	Low Risk

CATCH AND LANDINGS

The commercial catch of Spanish mackerel by the MMF was 276 t in 2016 and has been 270-330 t since quotas were introduced in 2006 (Large Pelagic Finfish Figure 1a). The commercial landings of Amberjack (*Seriola dumerili*), Cobia (*Rachycentron canadum*) and Golden Trevally (*Gnathanodon speciosus*) in the NCB were 17, 12, and 11t, respectively, with other large pelagic species in the NCB and GCB all <10 t in 2016. In the WCB and SCB only the annual catch of Samson fish was >10 t, at 25 t in 2016.

The top 10 pelagic scalefish species (or species groupings) in 2015/16 represented 99% of the total resource catch (kept by numbers). The estimated recreational harvest range for the top ten pelagic species in the North Coast was mostly steady in 2015/16 (95% CI 21–31 tonnes compared with 23–41 in 2013/14, but lower than 40–61 in 2011/12) (Ryan *et al*. 2017). A similar or higher amount was released.



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 management zone, 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), have 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. The catch rates in the Kimberley and Pilbara management zones are stable or increasing (Large Pelagic Finfish Figure 1b), suggesting that the overall spawning stock is stable or increasing. The catch rate in the southern Gascoyne-South zone has declined after a peak in 2014 when catches were high, possibly due to the effects of the marine heatwave (Pearce 2011). The annual charter boat operators' catch of Spanish mackerel in WA has been 17-37 t since 2003 with 34-61% released/discarded. The estimated boat-based recreational harvest range of Spanish Mackerel in the North Coast was steady in 2015/16 (95% CI 12–22 compared with 16–32 in 2013/14, but lower than 27–47 in 2011/12) (Ryan *et al*. 2017). The decline in catch for the NC and GCB can be partly attributed to the 20-35% decline in recreational effort, particularly during the months from April-August, when higher catches of these species occur. In addition, for the WCB the decline in Spanish mackerel catch in 2015/16 (704 kept by number, SE=243) compared with 2013/14 (2,376, SE=425) and 2011/12 (2,927, SE=443) is likely due to lower water temperatures reducing the abundance of the species in the southern extent of their range. The spawning biomass of Spanish mackerel in Western Australia is therefore considered to be **sustainable-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). In 2016 the WA catch was 14 t, with 9 t taken in the Pilbara being the highest since 2004. 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 annual charter boat operators' catch of grey mackerel in WA has been 1 t or less since 2003. The estimated recreational catch of Grey Mackerel was been <1 tonne in 2011/12, 2013/14 and 2015/16, although the uncertainty for this species is high (Ryan *et al.* 2017). On the basis of the evidence provided above, the breeding stock is classified as **sustainable-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 (40 kg+), 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 2016 the statewide commercial catch of Samson fish was 25 t, split evenly 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 West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF) and Temperate Demersal Gillnet and Demersal Longline Managed Fishery (TDGDLMF). Over the past 5 years the catches of Samson fish have been 7-16 t in each of the South Coast open access line fishery, WCDSIMF, and TDGDLMF. The species is targeted recreationally with the majority (>70%) discarded. The annual charter boat operators' catch of Samson fish in WA has been 10-17 t since 2010 with 68-76% released/discarded.

The estimated boat-based recreational catch of Samson fish was steady in 2015/16 (1,962 kept by number, SE=258) compared with 2013/14 (2,769, SE=393) and 2011/12 (2,143, SE=249), with a similar high release rates of 74-84% (Ryan *et al*. 2017). On the basis of the evidence provided above, the breeding stock is classified as **sustainable-adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch: The non-mackerel bycatch taken by the MMF are predominantly other large pelagic species which annually contribute <1 t (2016). 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 2016 mackerel fishing season, primarily from May - November. The estimated participation rate for recreational fishing in the population of WA is 29.6% in 2013/14 (DoF 2015). Recreational boat based surveys indicate that Spanish mackerel is one of the highest retained species in the NCB and GCB (Ryan *et al*. 2017) while other iconic large pelagic species are targeted but 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 2016, the estimated value (to fishers) of the Spanish mackerel annual catch was level 2, approximately $2.5 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 2016 Spanish mackerel catch of 191 t in the Kimberley is within the range while the catches of 71 and 14 t in the Pilbara and Gascoyne/West Coast, respectively, are below the tolerance 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

Management Meetings are held every two years 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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives (Stable)

In August 2015, the MMF received an exemption from the export controls of the EPBC for a period of ten years.

EXTERNAL DRIVERS

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. Finally, the past two Indian Ocean Tuna Commission (IOTC) assessments of the Spanish mackerel catch have determined the species is overfished and subject to overfishing. However, this outcome does not apply to the Western Australian component of the northern Australian stock which is distinct from that of other parts of the Indian Ocean.

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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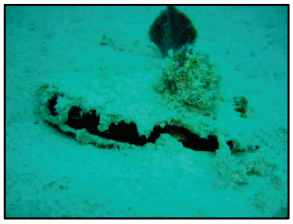
PEARL OYSTER MANAGED FISHERY RESOURCE STATUS REPORT 2017



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 the *Pearling Act 1990* 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 has achieved MSC certification. Further information can be sourced from Hart *et al*. (2016).

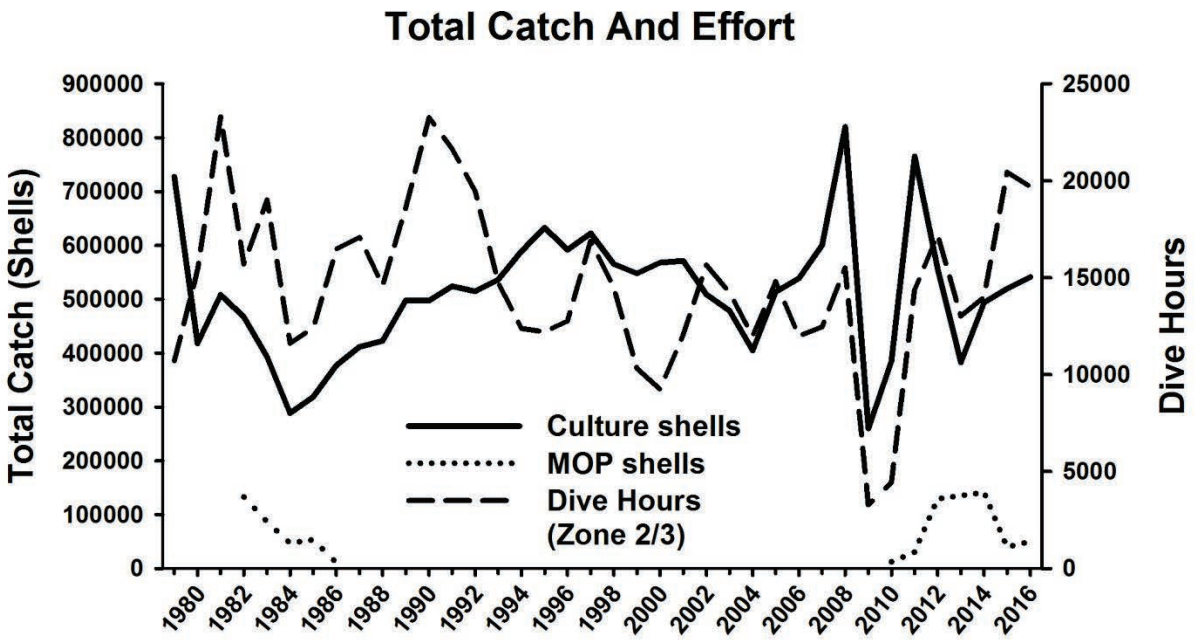
SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	541,260 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 Low Risk	Economic	GVP Level 5 $71 mill High Risk
Governance	MSC certification. The ARMA will subsume the *Pearling Act 1990.*	External Driver	Moderate - High Risk

CATCH AND LANDINGS

In 2016, catch was taken in Zones 1, 2, and 3 and the number of wild-caught pearl oysters was 541,260 comprising of 490,804 culture shells and 50,456 MOP shells (Pearl Figure 1). Total effort was 19,699 dive hours (Pearl Figure 1), a decrease of 4% from the 2015 effort of 20,455 hours. Of this total effort, 18,411 hours was focused on culture shell fishing, and the remaining 1,288 hours was applied to MOP fishing. Fishing continued in Zone 1 for the third year, after a hiatus from 2008 to 2013, however it was only a minor proportion (<1%) of the catch. In 2016, the number of wild-caught pearl oyster shell in Zone 1 was 4,594 comprising only culture shells.



PEARL 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

Zone 1 Pinctada maxima (Sustainable - Adequate)

Based on the information and analyses available, the current risk level for pearl oysters in Zone 1 is estimated to be LOW. The low risk reflects the minimal levels of fishing mortality. All the lines of evidence are consistent with a low level of risk, hence the overall Weight of Evidence assessment indicates the status of the Zone 1 pearl oyster stock is adequate and that current management settings are maintaining risk at acceptable (low) levels.

Zone 2 Pinctada maxima (Sustainable - Adequate)

Based on the information and analyses available, the current risk level for pearl oysters in Zone 2 is estimated to be **moderate**. The moderate risk reflects the controlled levels of fishing mortality. Some lines of evidence are inconsistent with a low level of risk, in particular, the breaching of the threshold reference points in the standardised catch rate data series. This breach however, has been clearly shown to be a function of lower than average recruitment years, rather than evidence of broodstock depletion. Preliminary data on catch rates in 2017 confirm the predicted increase in abundance to above target levels. Overall, the weight of evidence assessment indicates the status of the Zone 2 pearl oyster stock is adequate and that current management settings are maintaining risk at acceptable (moderate) levels

Zone 3 Pinctada maxima (Sustainable - Adequate)

Based on the information and analyses available, the current risk level for pearl oysters in Zone 3 is estimated to be LOW. The low risk reflects the minimal levels of fishing mortality. All the lines of evidence are consistent with a low level of risk, hence the overall Weight of Evidence assessment indicates the status of the Zone 3 pearl oyster stock is adequate and that current management settings are maintaining risk at acceptable (low) levels.

BYCATCH and PROTECTED SPECIES INTERACTIONS

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). **Negligible** risk.

HABITAT and ECOSYSTEM INTERACTIONS

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 effects (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 2016 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 2016 was considered to be approximately $71 million, which is 9% lower than 2015 when it was $78 million.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels (Acceptable)

TAC (612,550 pearl oysters in 2016) to be caught in 14,071-20,551 dive hours.

Commercial catch (pearl oysters) for season 2016: 541,260 oysters at 19,699 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 Western 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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives

This fishery has been accredited for export under the EPBC Act for a period of ten years (re-assessment in 2025) and has recently been certified under the MSC certification process. The announcement of MSC accreditation is expected in mid-2017. Further information can be sourced from Hart *et al*. (2016).

A new State Act of Parliament to ensure the sustainability and management of all WA's aquatic biological resources was introduced into Parliament in

2015-16. The *Aquatic Resource Management Act 2016* 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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SEA CUCUMBER RESOURCE STATUS REPORT 2017

A. Hart, D. Murphy, C. Syers 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.

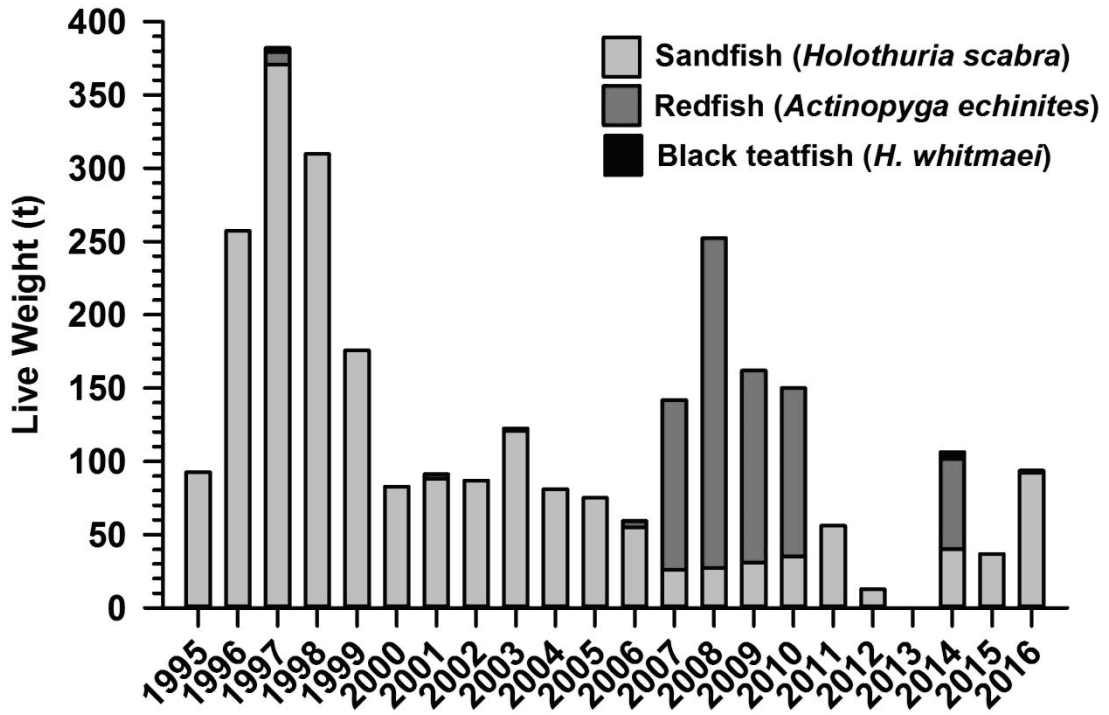
SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	93 t	NA
Fishing Level	Acceptable	NA
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Sandfish	Sustainable - Adequate	Level 2: Annual: Catch, CPUE
Redfish	Sustainable - Adequate	Level 2: 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 Low Risk	Economic	GVP Level 1: < $1 mill Low Risk
Governance	MSC assessment and review planned	External Driver	Low Risk

LANDINGS

In 2016, both species were targeted, with a total catch of 93 t (Sea Cucumber Figure 1). This catch comprised of 91 t of sandfish (*H. scabra)* and 2 t of deepwater redfish (*A. echinites*). In 2015 only sandfish was targeted with a catch of 37 t, an increase of 150% on this species and the highest catch in 13 years. The industry has generally adopted a rotational fishing strategy for both sandfish and redfish with limited catch taken for either species in 2012 and 2013.



SEA CUCUMBER FIGURE 1:

Annual total retained catches (tonnes) in the Western Australian Sea Cucumber Fishery (WASCF) between 1995 and 2016.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Kimberley Sandfish (Sustainable-Adequate)

Based on the information and analyses available, the current risk level for Kimberley sandfish was estimated to be **moderate**. This is consistent with previous assessments of the fishery. Therefore the overall Weight of Evidence assessment indicates the status of the Kimberley sandfish stock is adequate and that current management settings are maintaining risk at acceptable (moderate) levels.

Pilbara Sandfish (Sustainable-Adequate)

Based on the information and analyses available, the current risk level for Pilbara sandfish was estimated to be **low**. Therefore the overall Weight of Evidence assessment indicates the status of the Pilbara sandfish stock is adequate and that current management settings are maintaining risk at low levels.

Pilbara Redfish (Sustainable-Adequate)

Based on the information and analyses available, the current risk level for Pilbara redfish was estimated to be **moderate**. This is consistent with previous assessments of the fishery. Therefore the overall Weight of Evidence assessment indicates the status of the Pilbara redfish stock is adequate and that current management settings are maintaining risk at acceptable (moderate) levels.

BYCATCH and PROTECTED SPECIES INTERACTIONS

Given the hand only method of fishing no bycatch is taken by the fishery and there are no known protected species interactions. **Negligible** risk.

HABITAT and ECOSYSTEM INTERACTIONS

Divers collect sea cucumber as they drift over the bottom of the seabed; 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. **Negligible** risk.

SOCIAL AND ECONOMIC OUTCOMES

Social (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 and Victoria where the fishing fleet is based.

Economic (Low Risk)

The estimated annual value for 2016 was $300,000 based on an average product price of $3.00 per kg live weight and total catch of 94 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 (Kimberly): 0-100 t; Sandfish (Pilbara): 0-80 t; Redfish (Pilbara): 0-150 t

The catch of sea cucumber was within the tolerance ranges for all species. This indicates the status of sea cucumber stocks is adequate and that current management settings are maintaining risk at acceptable levels.

Harvest Strategy

The key considerations informing the harvest strategy for the sea cucumber resource in Western Australia are its geographical isolation, status as a developing fishery, the spatially discrete nature of the resource, and the intrinsic vulnerability of sea cucumber stocks when effort is difficult to constrain. Consequently the performance indicators include area and species-specific indices, such as quantity of harvest (catch) as well as density of stocks (standardised catch rates).

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. The revised harvest strategy is expected to include a new series of performance indicators, threshold levels, and control rules.

Compliance

There are no current issues.

Consultation

Industry 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 2017. It is anticipated that this review will result in the fishery transitioning from Exemption based to a formal management arrangement in 2018. 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.

Low risk.

NORTH COAST CRAB FISHERY RESOURCE STATUS REPORT 2017

D. Johnston, R. Marks, C. Marsh and E. Smith

OVERVIEW

Blue swimmer crabs (BSC) 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 (MC) are harvested by the Kimberley Developing Mud Crab fishery using crab traps between Broome and Cambridge Gulf and Aboriginal Body Corporate Commercial Mud Crab Exemption holders. There is also a small recreational fishery for mud crabs.

SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	36.9 t	1–3 t blue swimmer crab. 2–3 t mud crab (2015/16 boat-based only)
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 -<$1m Low Risk
Governance	Stable	External Driver	Moderate Risk

CATCH AND LANDINGS

Commercial Sector

The total commercial catch of blue swimmer crabs and mud crabs in the North Coast Bioregion for 2016 was 36.9 t. The catch of blue swimmer crabs decreased 27% from that taken in 2015. The North Coast catch accounts for 7 % of the state total commercial blue swimmer crab catch of 487 t for 2016.

The catch of mud crab for the Kimberley Developing Mud Crab Fishery represents the entire mud crab catch landed in WA in 2016. The catch in 2016 was approximately 96% lower than 2015 primarily due to the cessation of fishing by one operator. In 2016 the majority of catch was recorded as green mud crab, while a small proportion was recorded as brown mud crab.

Recreational Sector

The estimated boat-based recreational catch of blue swimmer crab in the North Coast represented 4% of the statewide boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range for blue swimmer crab in the North Coast was steady in 2015/16 (95% CI 1–3 tonnes compared with 2–6 in 2013/14 and 2–5 in 2011/12) (Ryan *et al*., 2017).

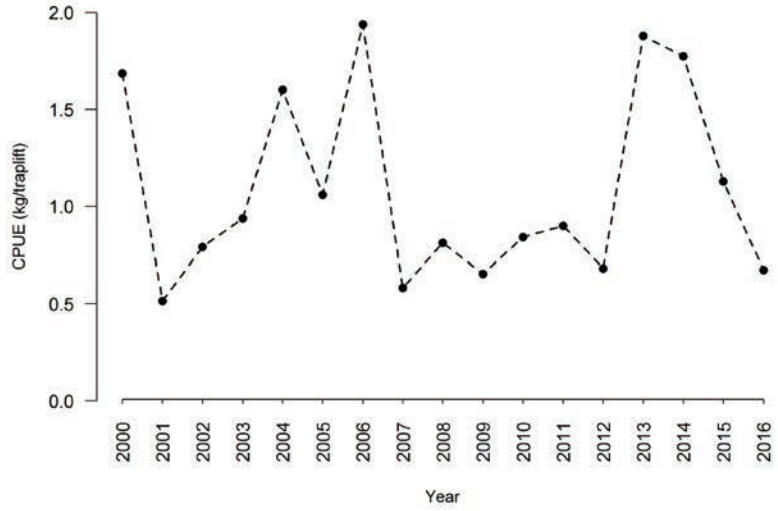
The estimated boat-based recreational catch of mud crab in the North Coast represented 70% of the statewide boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range of mud crab in the North Coast was lower in 2015/16 (95% CI 2–3 tonnes compared with 5–10 in 2013/14 and 6–10 in 2011/12) (Ryan *et al*., 2017).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Blue Swimmer Crabs (Sustainable-Adequate)

Catch rates from the Pilbara crab trap fishery provide an index of abundance to assess fishery performance. Crab trap catch rates increased steadily during exploratory fishing from 2001-2003 (North Coast Crab Figure 1) along the Pilbara coast. The increase in catch rate can be attributed to improvements to fishing gear, vessels and fisher knowledge. Favourable environmental conditions may have led to a significant increase in catch rates (1.6-1.8 kg/traplift) from 2004 to 2006, before returning to longer-term mean catch rates of 0.7 -1.0 kg/traplift between 2007 and 2012. (North Coast Crab Figure 1). Catch rate increased significantly in 2013 and 2014 (1.8 -1.9 kg/traplift) but declined to 1.1 kg/traplift in 2015.

The fishery recorded a mean nominal catch rate of 0.8 kg/traplift for 2016. Although this represented a 27% decrease from 2015, it was above the preliminary harvest strategy threshold of 0.6 kg/traplift, indicating there should be adequate egg production under typical environmental conditions. Therefore the breeding stock is considered **sustainable-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.

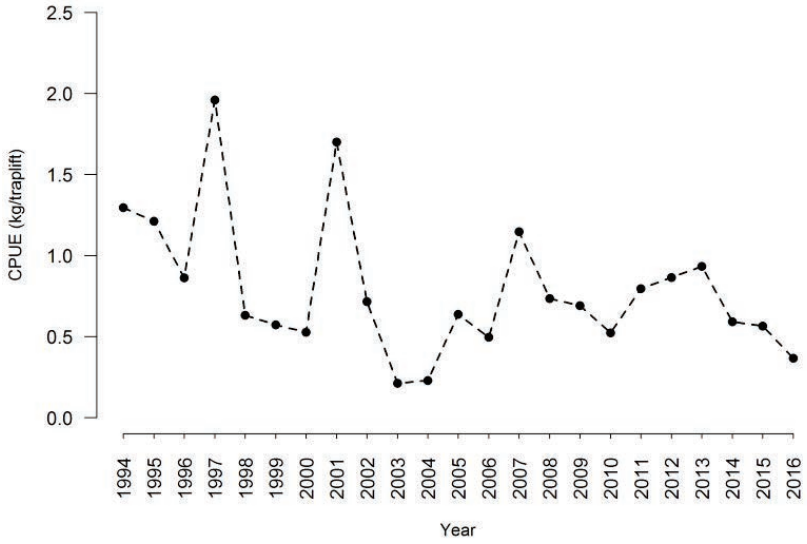
Mud Crab (Sustainable-Adequate)

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 green mud crab is predominantly found in estuarine habitats in north-western Australia from the Northern Territory border to Shark Bay. 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*). These are set well above the size at first maturity of 90-120 mm 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 rates between 2012 and 2015 fluctuated between 0.4 and 0.9 kg/traplift, with a nominal catch rate of 0.4 kg/traplift reported in 2016. This represents a significant (35%) decline from last year (0.6 kg/traplift), and is below the (draft) harvest strategy threshold of 0.5 kg/traplift and only slightly above the limit of 0.35 kg/traplift (North Coast Crab Figure 2). The significant decrease in fishing effort from 220 fisher days in 2015 to 50 fisher days in 2016 is the most likely cause of the decline, as fishing efficiency declined due to a lack of continuous fishing and the introduction of a new operator to the fishery.

Catch and effort has been limited to such a low level in recent years that based on the relatively small impact of commercial operations, the wide distribution of the species throughout the region, and the minimum legal size set well above size at maturity, the risk to sustainability has been considered to be negligible and currently the breeding stock is considered **adequate.** The stock is classified as **sustainable** and the level of fishing is considered **acceptable.** Nevertheless, considering the proximity of the 2016 catch rate to the limit reference level, catch, effort and catch rate is being monitored closely in this fishery during the 2017 season.



NORTH COAST CRAB FIGURE 2

Annual commercial trap catch per unit effort (CPUE) (kg/traplift) for green and brown mud crabs 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. Prior to 2006 the fishery was managed via a Fishing Boat Licence condition.

BYCATCH and PROTECTED SPECIES INTERACTIONS

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.

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

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.

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 and ECOSYSTEM INTERACTIONS

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.

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 2016, four 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 2016, with effort concentrated between April and October.

Economic

The estimated gross value of product (GVP) for the crab fishery within the Northern Bioregion for 2016 was approximately $218 k (**Level 1** <$1million).

Blue Swimmer Crabs: The average beach price for trap caught blue swimmer crabs across all Western Australian fisheries for 2016 was around $5.41/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 2016 was around $36.43/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 has 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 in 2016, no changes to the management occurred 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 in 2016 was below the threshold but above the limit, the fishery will be closely monitored to ensure adequate stock protection in the 2017 and 2018 seasons.

Compliance

Current risks to enforcement are low for North Coast Bioregion crab fisheries.

Consultation

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

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

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

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 2018. 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 2018.

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.

REFERENCES

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SOUTH COAST BIOREGION

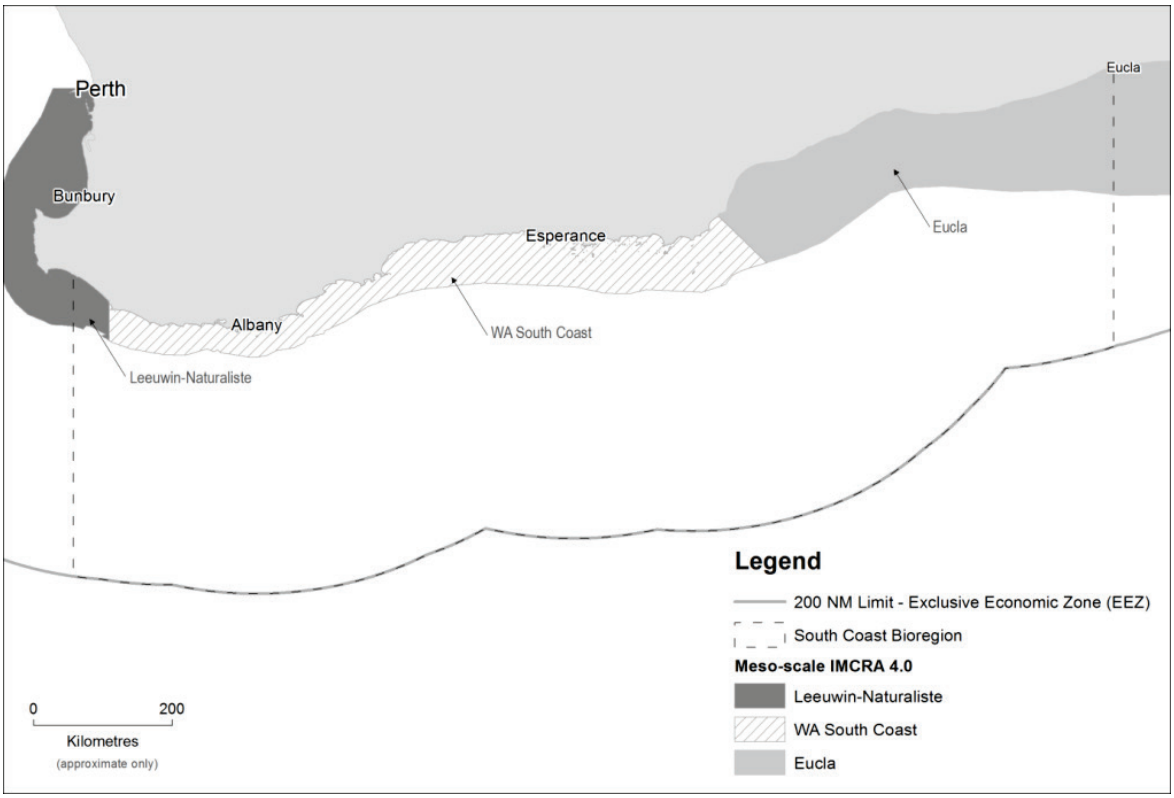
ABOUT THE BIOREGION

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 have affected 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 and 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 (160 km) 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 experiencing 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

Climate Change

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

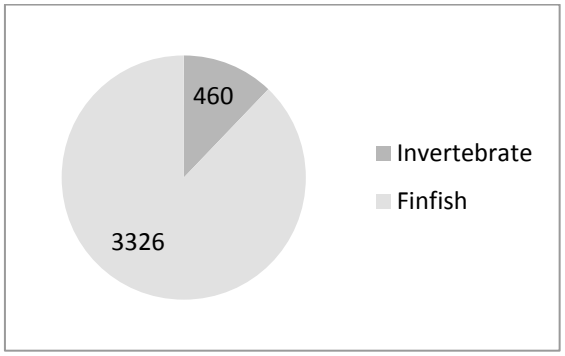
- Increasing frequency of El Niño/Southern Oscillation (ENSO) events;
- More years with a weaker Leeuwin Current;
- Increase in water temperature off the west coast of WA, particularly the lower west coast;
- Increase in salinity, which includes some large annual fluctuations;
- Change in the frequency 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 South 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. Changes in the distribution of key species are monitored in a national citizen-science program (www.redmap.org.au) in which the Department is a collaborator.

Commercial Fishing

The major commercial fisheries of the South Coast Bioregion are the abalone fishery (which achieved Marine Stewardship Council certification in 2017), a trap fishery targeting southern rock lobsters and deep-water crabs, 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 the intermittent scallop trawl fishery. There is also a commercial net fishery for finfish operating in a number of South Coast estuaries. Commercial fishers also target demersal scalefish offshore with droplines and handlines under general commercial 'wetline' provisions which are currently under review. South Coast commercial fishing vessel operators often hold a number of licences to create a viable year-round fishing operation.

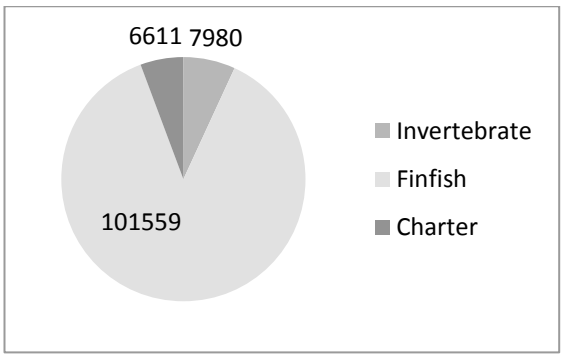


SOUTH COAST OVERVIEW FIGURE 2

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 major population and holiday centres. The major target species for beach and rock anglers are West Australian salmon, Australian herring, whiting and trevally, while boat anglers target snapper, queen snapper, Bight redfish and King George whiting. The third major component of the recreational fishery is the dinghy and shoreline fishing in 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. There is a current South Coast Aquaculture Project aiming to identify a network of suitable areas for aquaculture development, mostly focussed on shellfish including edible oysters. In addition, an offshore abalone farm near Augusta is growing-out abalone 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 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

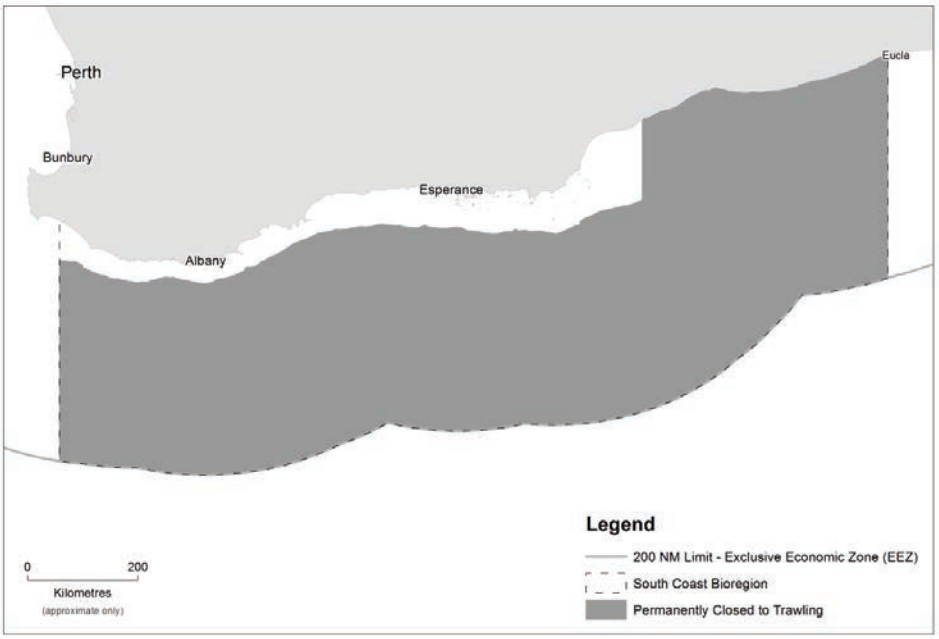
bioregion include closures under s.43 of the Fish Resources Management Act 1994 surrounding the wreck of the 'Perth' (Albany), wreck of the 'Sanko Harvest' (east of Esperance) and Esperance Jetty.

The Commonwealth Government's Marine Bioregional Planning process for the South-West marine region (between Kangaroo Island, South Australia and Shark Bay), is likely to result in increased zoning arrangements for Marine Protected Areas off the South Coast of WA (South Coast Overview Figure 5).

SOUTH COAST ECOSYSTEM MANAGEMENT TABLE 1

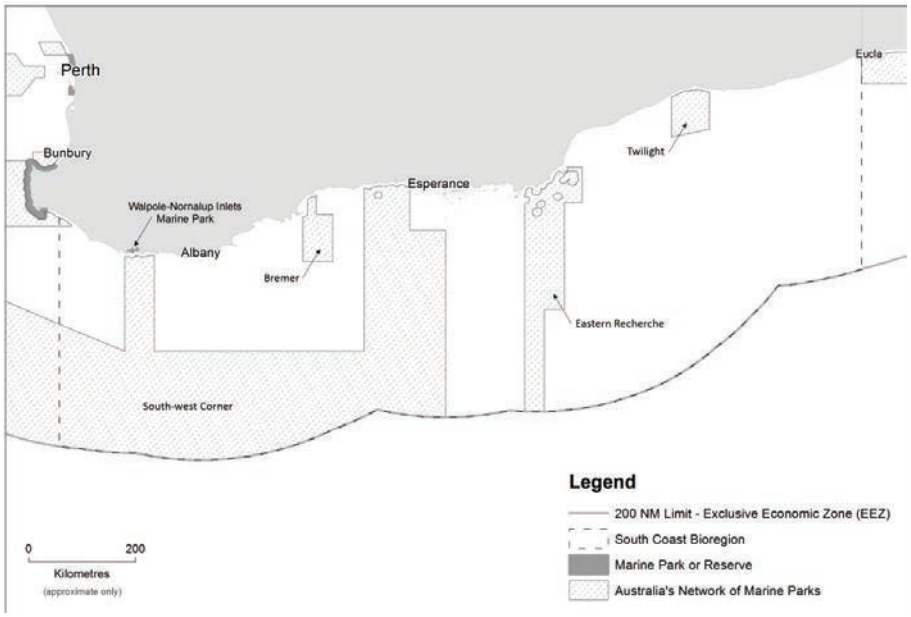
The areas and proportions of the South Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which meet the IUCN criteria for classification as marine protected areas. This table does not yet include the closures that may be implemented by the Commonwealth as part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

IUCN category or equivalent	State Waters only (17,116 km2)				All Waters (534,016 km2 (including State Waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km2	%	km2	%	km2	%	km2	%
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.

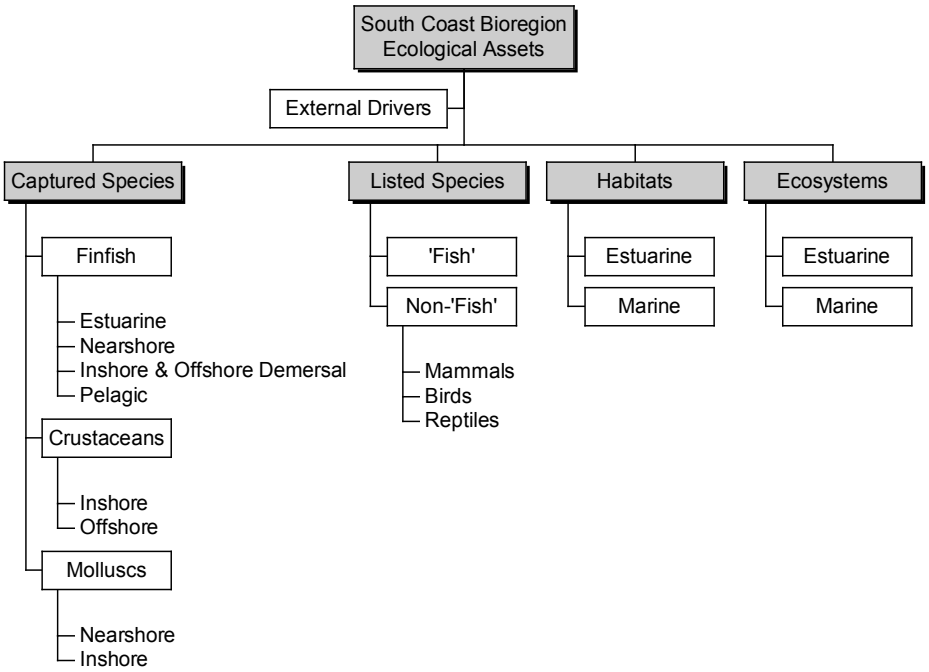


SOUTH COAST OVERVIEW FIGURE 5

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[1]) 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.



SOUTH COAST ECOSYSTEM MANAGEMENT FIGURE 6

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

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, 1226–1238.

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. However, this species is under management and risk of further spread is regarded as low.

Captured Species

FINFISH

Estuarine

Captured Species	Aquatic zone	Ecological Risk
Finfish	Estuarine	HIGH

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 of many nearshore indicator species (e.g. Australian salmon) have been declining since the mid-late 1990s mainly as a result of reduced market demand. A new assessment of Australian herring and Australian salmon is planned for September 2017.

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 moderate (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, however western rock lobster catches in Augusta/Windy Harbour have improved since 2014/15.

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[1] (ETP) species can be found within the South Coast Bioregion, including cetaceans, pinnipeds, 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 (*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 2). 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 2) following 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. Further monitoring was undertaken using observers in 2017.

Habitats and Ecosystems

The South Coast Bioregion, extends from 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 is 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 exposed to ocean swells. Seagrasses perform the following important ecosystem functions: primary production, nutrient cycling, stabilising sediments and habitat provision.

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.

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, historical eutrophication 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)[1] 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 (potentially due to climate change) and changes in tidal exchange due to opening and closing of sand-bars at river mouths.

SOUTH COAST CRUSTACEAN RESOURCE STATUS REPORT 2017

J. How and M. Yerman

OVERVIEW

The South Coast Crustacean Managed Fishery (SCCMF) 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*).

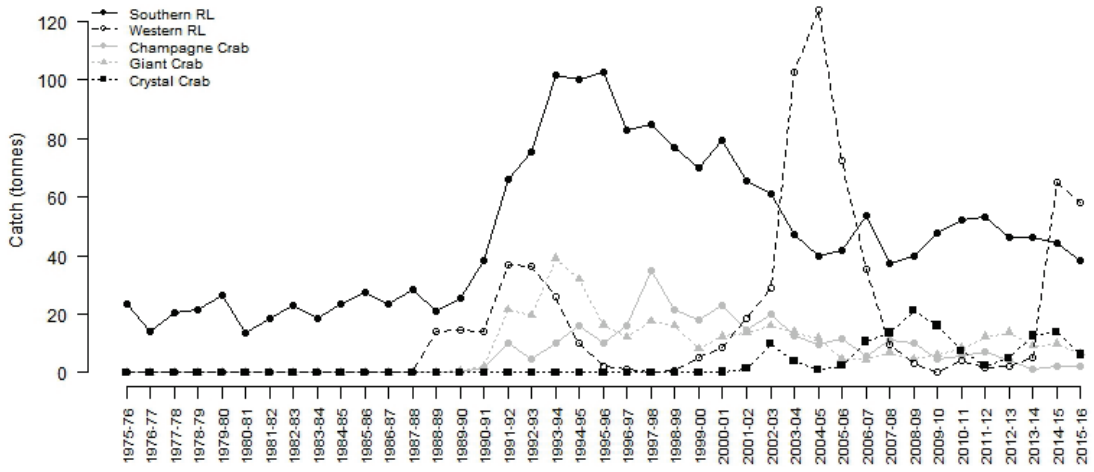
SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2015/16	112 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 -$6.9 mill Moderate Risk
Governance	Stable	External Drivers	Moderate Risk

CATCH AND LANDINGS

The total landings of crustacean from this resource in 2015/16 accessed by the SCCMF was 111.5 t, comprising 38.2 t of southern rock lobster, 58.2 t of western rock lobster, and 6.2 t of crystal, 6.7 t giant and 2.1 t of champagne crabs retained (South Coast Crustacean Figure 1).



SOUTH COAST CRUSTACEAN FIGURE 1.

Total landings in the South Coast Crustacean Fishery by species.

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. 112pp.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Zone 1 – Augusta / Windy Harbour (Western rock lobster-Sustainable-Adequate)

The dominant species retained in the catch from this zone is western rock lobster. The western rock lobster in this zone represents the southern edge of the distribution of the stock. The catches and catch rates in 2014/15 and 2015/16 have been above the historic average catch (South Coast Crustacean Figure 1 and 2a). Evidence suggests that the source of recruitment for western rock lobsters in the SCCMF is the West Coast Rock Lobster Managed Fishery (WCRLMF), which is assessed as **sustainable-adequate**.

Zone 2 – Albany (Crystal Crab- Sustainable-Adequate)

Crystal crab, which is found on the west and south coasts of Western Australia (WA), 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).

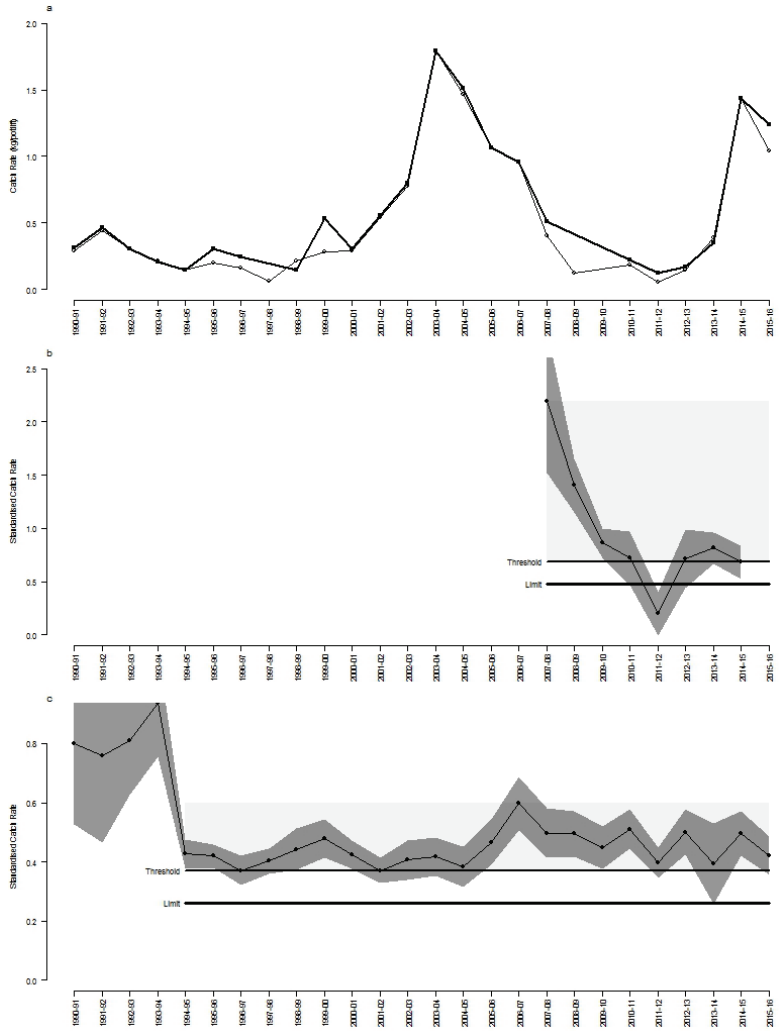
Landings of crystal crabs decreased from 13.9 tonnes in 2014/15 to 6.1 tonnes in 2015/16 (South Coast Crustacean Figure 1). It was not possible to calculate a standardised catch rate for crystal crabs in this region for the 2015/16 season from the monthly returns due to a lack of targeted effort. Effort associated with catch of crystal crab also contained significant catches of other deep sea crab and rock lobster species.

Volunteer daily logbook which provides targeted effort information, was available for the last two seasons (2014/15 and 2015/16). It showed catch rates remaining steady between these seasons, with logbook catch accounting for about 50% of the total catch of crystal crabs in these seasons. As the 2013/14 and 2014/15 seasons were assessed as being above the threshold level (South Coast Crustacean Figure 2b), the stock status for 2015/16 was assessed as **sustainable-adequate.**

Zone 3 – Esperance and Zone 4 – Bight (Southern Rock Lobster- Sustainable-Adequate)

The assessment for these zones is determined using southern rock lobster as the indicator species. Southern rock lobster 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 that 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 SCCMF have declined in recent seasons, with catch landings outside of the target catch range of 50-80 tonnes (South Coast Crustacean Figure 1). This is due to in part to reduced targeted effort for southern rock lobsters, particularly in Zone 4. 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-moderate sustainability risk) and the SCCMF stock biomass is above its threshold level and is therefore **sustainable-adequate**.



SOUTH COAST CRUSTACEAN FIGURE 2.

Annual nominal catch rate (grey line open circles), targeted catch rate (heavy line solid circles) or standardised catch rate (line and open circles with grey 95CI) for a) western rock lobster in Zone 1 (Windy Harbour-Augusta), b) crystal crab in Zone 2 (Albany) and c) southern rock lobster in Zones 2-4. Target region (light grey), threshold (thin horizontal line) and limit (heavy horizontal line) reference points are presented when applicable.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch (Low risk): 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 (Moderate risk): The SCCMF operates in areas adjacent to Australian Sea Lion (ASL) colonies. Pots fished in areas potentially frequented by juvenile ASLs are required to be fitted with a Sea Lion Exclusion Device (SLED). These devices are designed to stop the entrance and accidental drowning of ASLs. 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 Primary Industries and Regional Development, Fisheries Division (Fisheries) to establish suitable mitigation measures to reduce potential ASL interactions and minimise any impact on fisher catches.

In the 2015/16 season there were no whale entanglements attributed to the SCCMF.

Turtles can also get caught in the float rigs of lobster pots. In 2015/16 no turtles were reported to have been entangled in lobster fishing gear.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat (Low risk): Potting is considered to have a low impact on the habitat over which the SCCMF operates.

Ecosystem (Low risk): The effect of the removal of lobster and deep sea crabs has been assessed for the West Coast Deep Sea Crustacean Fishery and WCRLMF 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

The SCCMF 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 WA. **Moderate** risk.

Economic

The beach value of the fishery was about $6.9 million in 2015/16 with the majority of the catch sold live to Asian markets both locally and internationally. **Moderate** risk.

GOVERNANCE SYSTEM

Annual Catch Tolerances

Southern Rock Lobster – 50-80 t

Current fishing level – Acceptable

Under the SCCF Management Plan, the SCCMF 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 SCCMF, the large amount of latent effort which existed in Zones 2 and 4 was dramatically reduced. The re-structuring which occurred as part of the SCCMF's establishment has also seen a reduction in effort in Zone 4 which may have in part contributed to the catch of 38 t for 2015/15 being below the level of 50-80 t of southern rock lobster.

Harvest Strategy (Under Development)

A preliminary harvest strategy has been developed 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 Fisheries website.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

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

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. **Moderate** risk.

REFERENCES

de Lestang S, Caputi N, and How J. 2016. Resource Assessment Report: Western Rock Lobster Resource of Western Australia. Department of Fisheries, Western Australia.

How JR, Webster FJ, Travaille KL, Nardi K, and Harry AV. 2015. West Coast Deep Sea Crustacean Managed Fishery, Western Australian Marine Stewardship Council Report Series No. 4. Department of Fisheries, Western Australia.

Linnane A, Gardner C, Reilly D, How J. 2014. Southern Rock Lobster, *Jasus edwardsii,* in: Status of Key Australian Fish Stock Reports. Fisheries Research and Development Corporation (http://fish.gov.au/Pages/SAFS_Report.aspx).

Ovenden JR, Brasher DJ, and White R. 1992. *Mitochondrial DNA analyses of the Red Rock Lobster Jasus edwardsii supports an apparent absence of population subdivision throughout Australasia*. Marine Biology, 112: 319–326.

SOUTH COAST GREENLIP/BROWNLIP ABALONE RESOURCE STATUS REPORT 2017

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).

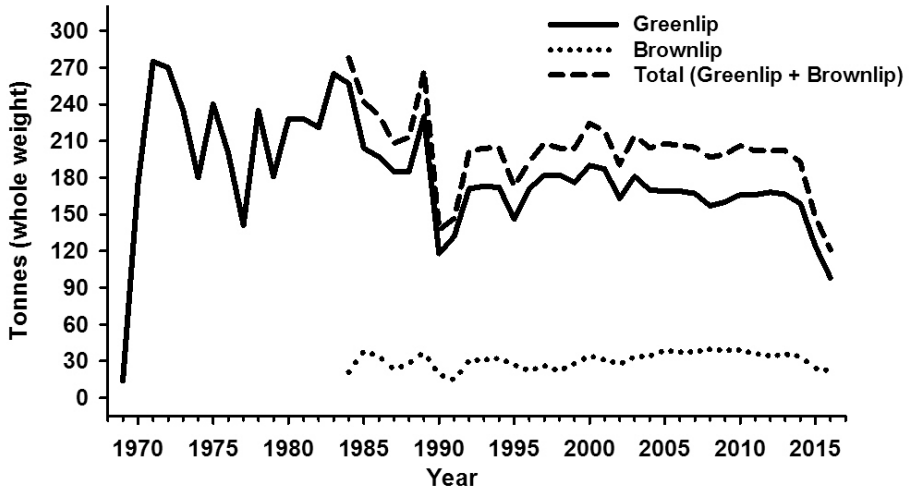
SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	121 t	8 t
Fishing Level	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 Low Risk	Economic	GVP Level 3 - $5.1 mill Moderate Risk
Governance	MSC full assessment complete	External Drivers	Moderate Risk

CATCH AND LANDINGS

In 2016 the total commercial Greenlip/Brownlip abalone catch was 121 t whole weight (Greenlip 99 t and Brownlip 22 t), which was 83% of the combined TACC (145 t whole weight) and represents the lowest catch in over 40 years (Greenlip/Brownlip Abalone Figure 1). The lower catch in 2016 was due to reductions in TACC (Greenlip 25 t) and a commercial industry decision to not fish a proportion of the quota (17 t of Greenlip abalone in 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.

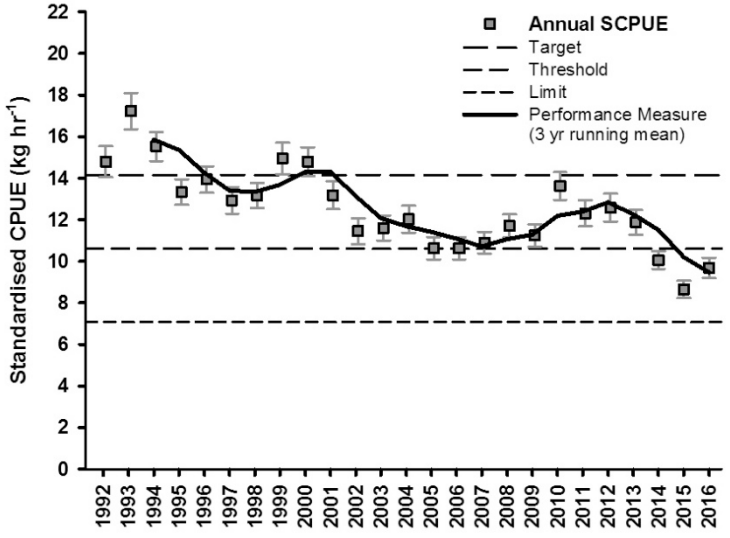
INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Greenlip abalone (Sustainable-Adequate)

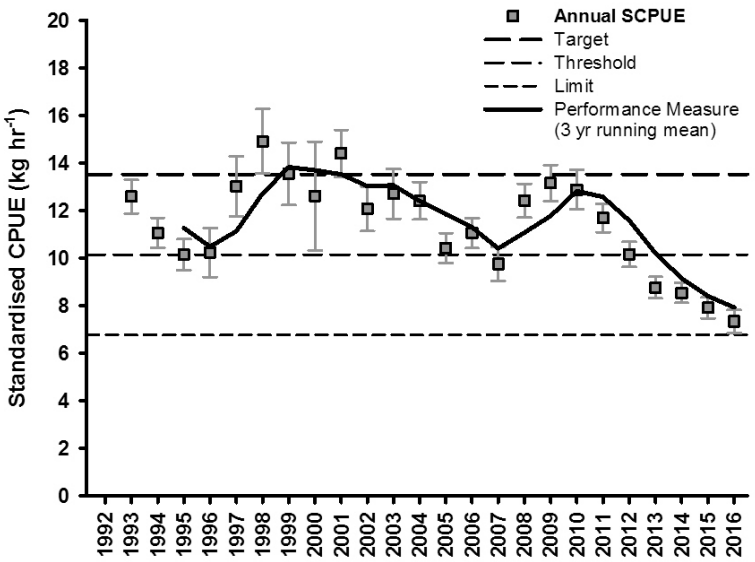
Greenlip abalone are distributed from south-west WA across southern Australia to Victoria and northern Tasmania. A recent genomic study suggests the existence of one single Greenlip abalone population along the WA coast but with five adaptive populations (Sandoval-Castillo *et al*. 2015). The fishery 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 performance indicator (PI) of standardised catch per unit effort (SCPUE) as a 3 year mean which uses commercial catch and effort statistics, and other measures such as fisheries-independent sampling. In Management Area 2 (Esperance) there has been a declining trend in annual SCPUE since 2010, until a slight increase occurred in 2016. The PI is still below the threshold but above the limit reference level (Greenlip/Brownlip Abalone Figure 2a). In Management Area 3 (Albany), since 2013 the annual SCPUE and PI have declined to below the threshold but remain 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. 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. Stock status of Greenlip abalone is considered **sustainable-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) and reference levels (target, threshold and limit) 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 Brownlip abalone 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 performance indicator (3 year mean of SCPUE) were used for the assessment of the 2017 TACC for each management area. In Management Area 2 (Esperance) the annual SCPUE and PI for Brownlip abalone were relatively stable above the target reference level between 1999 and 2012, however over the last four years they have declined markedly and are now below the threshold but above the limit reference level. In Management Area 3 (Albany) the SCPUE and PI for Brownlip abalone fluctuated greatly during 1999 to 2010 (above the target), before remaining relatively stable from 2011 to 2016 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 2016 as above the target reference level. Consequently the stock status of Brownlip abalone is considered to be **sustainable-adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

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. **Negligible** risk.

HABITAT AND ECOSYSTEM INTERACTIONS

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. **Negligible** risk.

SOCIAL AND ECONOMIC OUTCOMES

Social (Low Risk)

There are 17 vessels operating in the Commercial Greenlip/Brownlip Abalone Fishery, employing approximately 35 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 18,002 recreational abalone licenses issued in 2016 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 2016 was $5.1 million, based on the estimated average price received by commercial fishers of $117/kg meat weight ($44/kg whole weight) for Greenlip abalone and $92/kg meat weight ($37/kg whole weight) for Brownlip abalone. Greenlip abalone prices in 2016 were higher than prices in 2015 ($107/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 - Acceptable; Recreational - Acceptable)

Commercial: 145 t (TACC) (3,440 – 5,270 fishing hours)

Recreational: Not formal

Commercial effort (4411 hours) was within tolerance range following TACC reductions. Non-achievement of TACC was due to commercial Industry decisions. Recreational catch not considered a risk to these stocks.

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 both species in each management area. A recent review (2015) of the harvest control rules 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 2017/18 season using the harvest strategy, for Greenlip abalone they are 3 t in Area 1, 48 t in Area 2 and 65 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. 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. Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

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 has undergone full MSC assessment and achieved certification (https://fisheries.msc.org/en/fisheries/western-australia-abalone-fishery/@@view).

EXTERNAL DRIVERS

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. 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. **Moderate** risk.

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SOUTH COAST NEARSHORE AND ESTUARINE FINFISH RESOURCE STATUS REPORT 2017

K. Smith, G. Baudains, M. Holtz and E. Bunbury

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 gill net, haul net and beach seine. 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 mainly comprised of western Australian salmon (*Arripis truttaceus*), southern school whiting (*Sillago bassensis*), Australian herring (*Arripis georgianus*) and King George whiting (*Sillaginodes punctatus*). Landings of estuarine finfish are mainly comprised of sea mullet (*Mugil cephalus*), estuary cobbler (*Cnidoglanis macrocephalus*) and black bream (*Acanthopagrus butcheri*).

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2016	279 t	13–21 t (2015/16 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 (Cobbler)	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 mill) Moderate Risk
Governance	Recovery Plan for Wilson Inlet Cobbler under development	External Drivers	High Risk (Environment)

CATCH AND LANDINGS

In 2016, the total commercial catch of nearshore and estuarine finfish in the SCB was 279 t, comprising 23 t from ocean waters and 256 t from estuaries (South Coast Nearshore and Estuarine Finfish Table 1). The commercial catch was taken by the SCEMF (256 t), 'open access' commercial fishers (20 t) and the SCSMF (3 t).

The top 10 nearshore and estuarine species (or species groupings) in the South Coast represented 95% of the total boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range for the top 10 nearshore and estuarine species in the South Coast was steady in 2015/16 compared with estimates from previous statewide surveys (95% CI 13–21 tonnes compared with 20–31 in 2013/14, but lower than 37–52 in 2011/12) (Ryan *et al*. 2017). No recent estimates of shore-based recreational catches are available.

SOUTH COAST NEARSHORE AND ESTUARINE FINFISH TABLE 1.

Total catches (tonnes) of finfish by commercial fisheries in nearshore and estuarine waters in the South Coast Bioregion in previous five years.

Species	Scientific name	2012	2013	2014	2015	2016
Black bream	*Acanthopagrus butcheri*	42.7	42.1	31.2	29.7	71.9
Estuary cobbler	*Cnidoglanis macrocephalus*	53.1	67.2	57.0	53.3	70.2
Sea mullet	*Mugil cephalus*	30.6	25.5	27.9	17.7	27.8
Australian herring	*Arripis georgianus*	134.4	250.6	104.0	23.7	20.9
King George whiting	*SIllaginodes punctatus*	9.9	11.5	13.3	22.5	17.2
Tarwhine	*Rhabdosargus sarba*	3.9	4.6	6.0	7.5	12.1
Pink snapper	*Chrysophrys auratus*	2.1	0.6	2.2	4.4	10.3
Leatherjackets	Monocanthidae	11.1	11.2	11.7	8.7	10.1
Western Australian salmon	*Arripis truttaceus*	75.0	139.4	303.4	119.3	5.0
Southern garfish	*Hyporamphus melanochir*	5.4	14.0	6.7	7.2	6.9
Flatheads	Platycephalidae	3.1	4.9	3.0	5.3	6.9
Yelloweye mullet	*Aldrichetta forsteri*	4.9	3.4	5.2	4.4	3.5
Snook	*Sphyraena novaehollandiae*	1.7	1.9	1.5	3.4	2.2
Other finfish		11.6	13.0	15.5	13.5	14.3
Total		389.6	589.9	588.6	320.5	279.5

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)

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 2016 commercial catch was 103 t, with 86% taken by the South West Coast Salmon Managed Fishery, 3% by the SCSMF and 11% by other fisheries.

The estimated boat-based recreational harvest range for Western Australian Salmon in the SCB was steady in 2015/16 (95% CI 1–5 tonnes compared with 2–6 in 2013/14 and 4–11 in 2011/12, but shore-based recreational catches are believed to be substantial for this species (Ryan *et al*. 2017).

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 **sustainable-adequate**.

Australian herring (Sustainable-Recovering)

(see West Coast Nearshore and Estuarine Finfish Resource Status Report)

Sea mullet (Sustainable-Adequate)

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 2016 was 27.8 t. The 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 1). On the basis of this evidence, the SCB sea mullet stock is classified as **sustainable-adequate.**

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 from populations in adjacent ocean waters.

Since 2000, 95% of commercial landings of cobbler have been caught in the SCB, with the remainder in the WCB. From 2000 to 2016, the total SCB catch ranged from 40 to 98 t (South Coast Nearshore and Estuarine Figure 2). Over this period, 79% 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 70 t in 2016, including 61 t from Wilson Inlet.

Annual fishery-independent surveys since 2007 indicate that juvenile recruitment and adult abundance has been steadily declining in Wilson Inlet. Currently, the SPR for the Wilson Inlet stock is estimated to be below the limit reference level of 20%. On the basis of this evidence, the Wilson Inlet stock is classified as **inadequate**.

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. In 2016, the SCB catch was 72 t, mainly from Beaufort Inlet (52% of landings), Wilson Inlet (14%), Stokes Inlet (9%), Oyster Harbour (7%), Princess Royal Harbour (7%), and six other estuaries. In 2016, a record high catch of 38 t was taken from Beaufort Inlet (the previous highest was 26 t in 2005) and the 3rd highest catch (10 t) was taken in Wilson Inlet.

The estimated boat-based recreational harvest range for black bream in the SCB was steady in 2015/16 (95% CI 1–6 tonnes compared with 1–3 in 2013/14 and 3–11 in 2011/12 (Ryan *et al*. 2017). 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 recreational fishing in SCB estuaries indicated that the highest recreational catches of black bream were taken in Walpole-Nornalup Inlet (Smallwood and Sumner 2007). The current stock status in Walpole-Nornalup Inlet cannot be assessed due to lack of recent data.

Catch rate trends suggest abundance is stable in Wilson Inlet and Oyster Harbour, increasing in Beaufort Inlet and decreasing in Stokes Inlet (South Coast Nearshore and Estuarine Figure 3).

The catch and catch rate in each estuary is within the historical range. On the basis of this evidence, the black bream stocks in these four estuaries are classified as **sustainable-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 appropriate size ranges. 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 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 have lower risks of barotrauma-related injuries than deep water oceanic 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, 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 2016, there were approximately 8 commercial fishers employed in the South Coast Salmon Fishery and 32 in the South Coast Estuarine Managed Fishery. Additional employment is created by these fisheries in 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. 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 2016:

South Coast Estuarine Managed Fishery
Level 2: $1 to 5 million (finfish + invertebrates)

South Coast Salmon Managed Fishery
Level 1: <$1 million

Moderate Risk

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

South Coast Estuarine Managed Fishery: 200 – 500 tonnes (finfish only).

Finfish catch was 256 t in 2016. This fishery has traditionally targeted finfish, but in recent years has harvested significant quantities of blue swimmer crabs (24 t in 2016), which have partly replaced finfish in the overall catch. The total catch by this fishery in 2016 is considered **adequate**.

Australian Salmon Fisheries (all WA commercial fisheries): 0 - 1200 tonnes.

Catch was 103 t in 2016. This is the lowest catch since the fishery commenced in the 1940s. Recent catches continue to be low relative to historic levels, due to low effort from limited market demand.

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. Indicator species are assessed annually based on catch and/or catch rate trends, where data are 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 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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives/Outlook Status

Australian herring workshop: The Department is convening a workshop in 2017 that will undertake a formal assessment of the most recent herring data using the Weight of Evidence approach to update herring stock status. It is the Department's intention that workshop involve Department staff (research and management) as well as external scientists and representatives from WAFIC and Recfishwest. The workshop will also direct some focus towards salmon and utilise the opportunity to identify knowledge gaps and research opportunities relating to salmon assessment.

WAFIC Review: WAFIC commissioned an independent review of minor commercial fisheries on the south and lower west coasts in relation to the potential establishment of an industry representative association. The review was undertaken by Dr Peter Rogers. His report "The Case for Establishing the Southern Seafood Producers (WA) Association" sets out his findings and makes recommendations including reforms/development for many SC and SW fisheries. The Department will work with WAFIC during 2017 and 2018 to address the recommendations as appropriate.

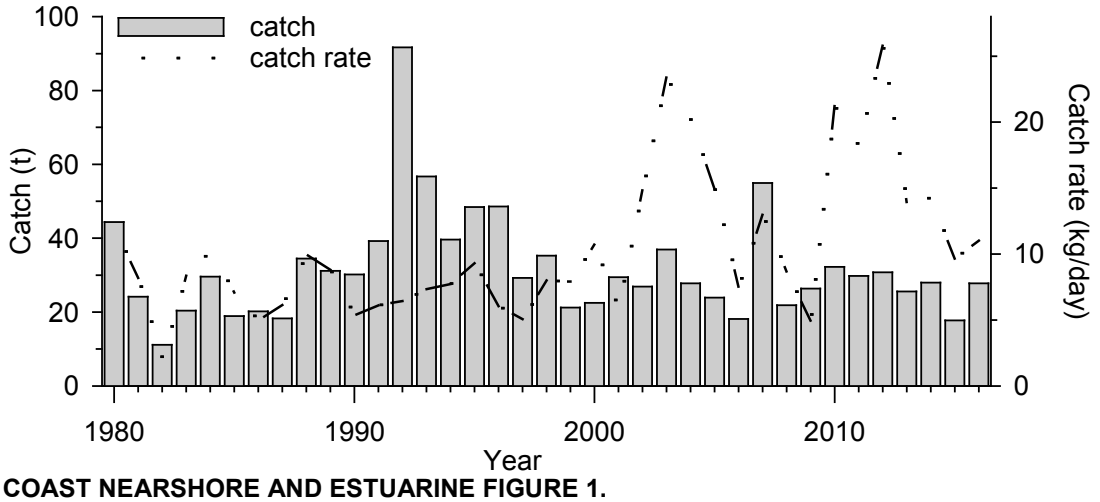
Wilson Inlet cobbler sustainability: Consultation with stakeholders is underway to determine the most appropriate management response to address the sustainability concerns for cobbler in Wilson Inlet. Management measures should be implemented in late 2017 and will take into account the possibility of future changes to the SCEMF as recommended by the WAFIC review and consistent with the resource based approach adopted under the (impending) Aquatic Resources Management Act.

EXTERNAL DRIVERS

The abundance of fish species in SCB estuaries are strongly influenced by climatic and other environmental factors, independent of fishing. Catchment processes (e.g. runoff) can have major effects on estuary condition and fishery production. Annual variations in coastal currents (particularly the Leeuwin and Capes Currents) influence spawning, recruitment, distribution and catchability of species such as Australian herring and western Australian salmon. Cool inshore temperatures due to a strong Capes Current appear to have provided a favourable 'corridor' for fish to migrate northwards in 2016, with exceptionally high numbers of salmon observed along the west coast during the autumn spawning period, and some fish travelling as far north as Exmouth

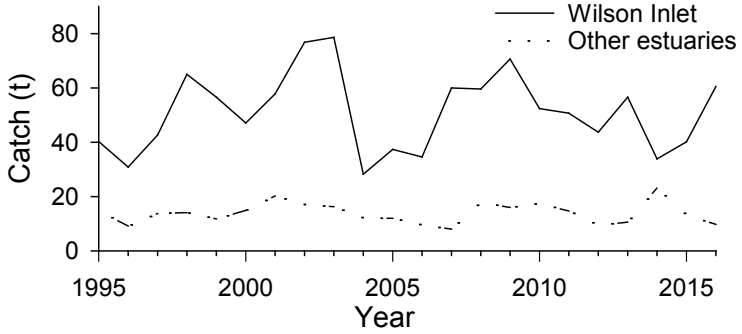
Fluctuating market demand is a significant factor affecting the annual commercial catch level of many species. On the basis of market demand and price commercial fishers sometimes elect not to capture a school of fish, or release part of their catch, when a market is not available. This is particularly relevant to Western Australian salmon.

High risk.



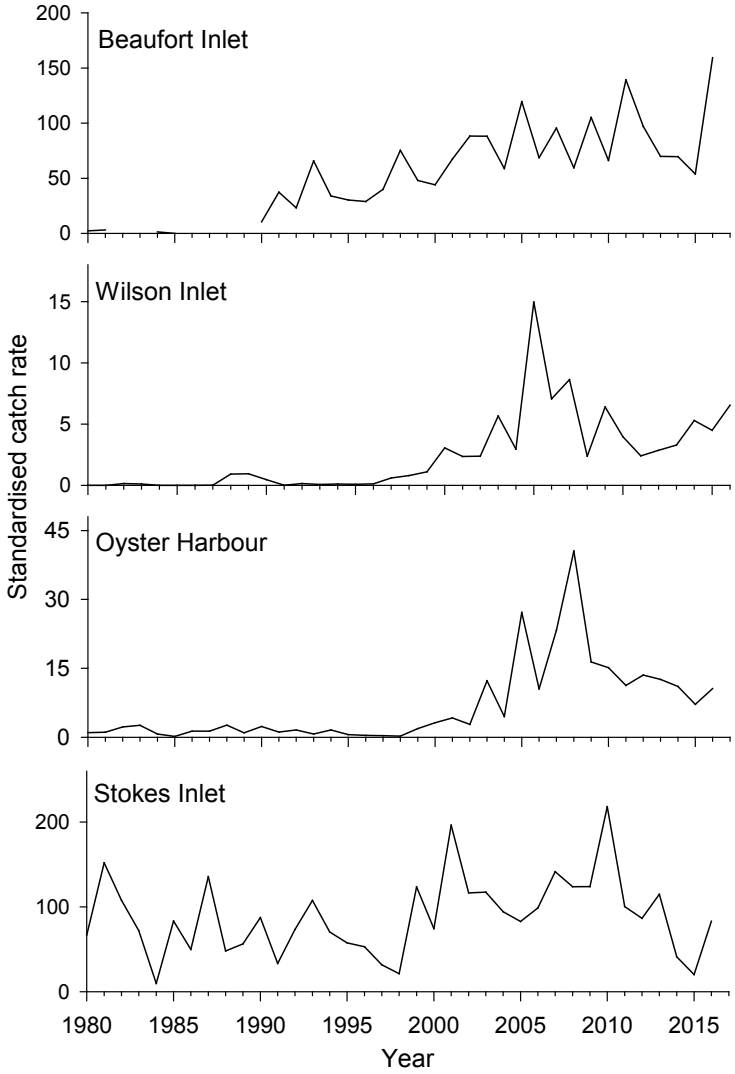
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 1.

Sea mullet i) total commercial catch in the South Coast Bioregion, and ii) nominal annual commercial catch rate in Oyster Harbour, 1980 to 2016.



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 2016.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 3.

Annual commercial catch rates of black bream in key South Coast Bioregion estuaries, 1980 to 2016.

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SOUTH COAST SMALL PELAGIC SCALEFISH RESOURCE STATUS REPORT 2017

J. Norriss and E. Bunbury

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, however this catch is very small and infrequent. The SCPSMF has five management zones, centred on King George Sound (Zone 1) , Albany (Zone 2), Bremer Bay (Zone 3), Esperance (Zone 4) and a developmental zone near Augusta (Zone 5) where very minor catch has been recorded in recent years. 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 strong recovery by 2005 catches have remained well below the total allowable catch (TAC), which was conservatively set at 5,683 t. The SCPSMF underwent pre-assessment for Marine Stewardship Council certification in 2014.

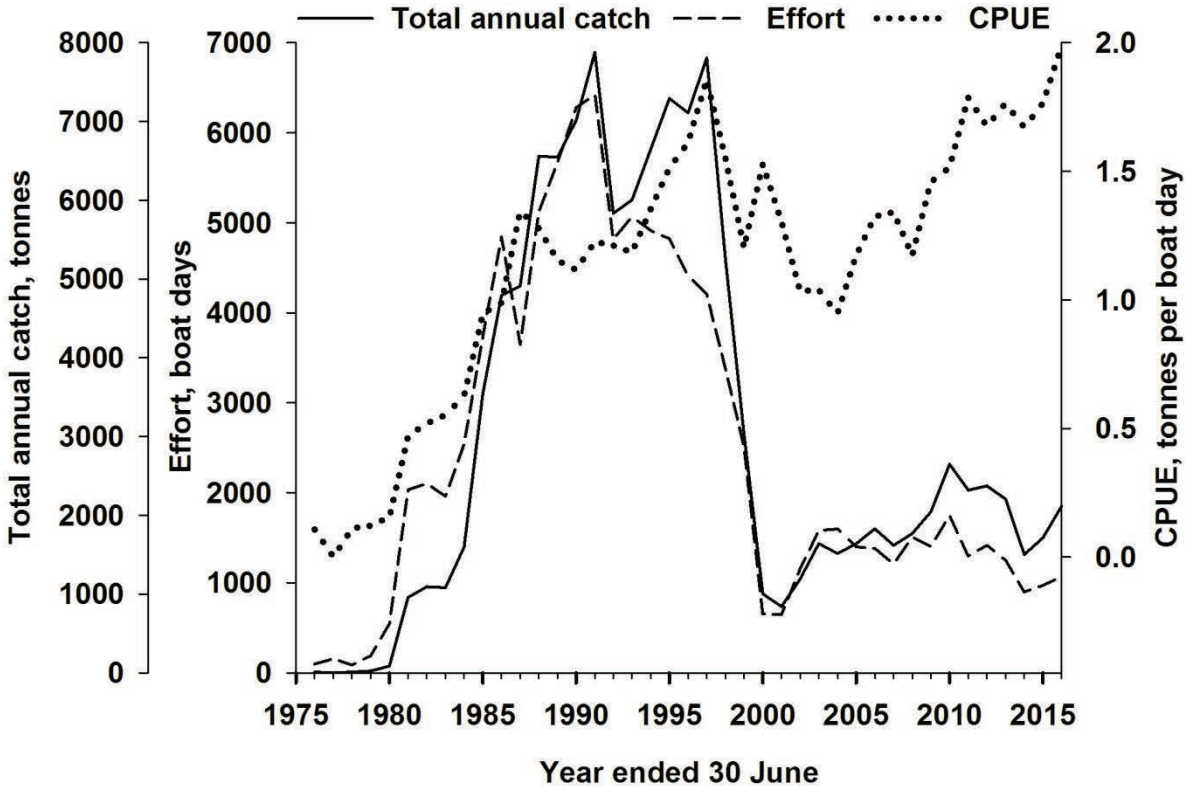
SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2015/16	2,149 t	<1 t (2015/16 boat-based only)
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	Moderate-high Risk
Habitat	Negligible Risk	Ecosystem	Low Risk
Social	Low Amenity Low Risk	Economic	GVP $1-5 mill Moderate Risk
Governance	Stable	External Drivers	Moderate Risk

CATCH AND LANDINGS

The SCPSMF total catch of 2,149 t in the 2015/16 quota year was comprised of 1,515 t for the Albany region (zones 1 and 2 combined) and 632 t for Bremer and Esperance (zones 3 and 4) combined. The large majority (99%) was pilchards (2,118 t), a 24% increase from the previous year (South Coast Small Pelagic Figure 1). The remainder of the catch was comprised mostly of yellowtail scad (20 t), the highest annual catch for this species since 1998/99. Fishing effort in the 2015/16 quota year was 1,065 boat days by 9 active vessels, an increase of 10% from the previous year.



SOUTH COAST SMALL PELAGIC FIGURE 1.

Time series of total annual catch, effort and nominal catch per unit effort (CPUE) for pilchards in the SCPSMF from 1975/76 to 2015/16.

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 management units 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 relatively high, and for 2015/16 is the highest on record (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 **sustainable-adequate**.

Yellowtail scad (Sustainable-Adequate)

Yellowtail scad is a schooling species common in temperate Australian waters. The population structure in WA is unknown but assumed to be a single stock. 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, and the biological stock is considered **sustainable-adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

The SCPSMF is a species-restricted fishery and accordingly landing any species not listed in the management plan is prohibited. Small quantities of fish bycatch species are sometimes captured incidentally, but this occurs infrequently and the majority are released from the net unharmed. **Negligible** risk.

All interactions with endangered, threatened and protected species are required to be recorded on Department of Fisheries Catch and Disposal Records for each fishing trip and on statutory monthly Catch and Effort Statistics returns. Bycatch of Flesh-footed Shearwaters (FFS) have consistently been recorded. FFS opportunistically feed on fish trapped during purse seine net operations and may drown if caught in the net. Low capture rates of dolphins, sea lions and seals have also been recorded, which are usually released unharmed. Interactions with protected species are

mitigated and managed through the implementation of a voluntary SCPSMF Code of Practice which industry reviews and sometimes refines annually. Measures applied include an annual Special Management Period (SMP, from 15 March to 30 April) when the risk of FFS interactions is highest. During the SMP fishers avoid fishing at dawn and dusk to minimise interactions. **Moderate** risk.

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 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. 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 9 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. **Low** risk.

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 2015/16 was level 2 ($1-5 million). **Moderate** risk

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

The SCPSMF total annual catch for all species combined in the 2015/16 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

The SCPSMF is managed under a constant catch harvest strategy, with catches limited up to zonal TACs. Any proposed changes to the TAC are made with regard to total catches and nominal catch rates, in consultation with stakeholders.

Compliance

Licensees are allocated individual transferable quotas and catches are assessed against quotas through the lodgement by fishers of trip Catch and Disposal Records to the Department of Fisheries. Compliance is monitored via aerial patrols and both at-sea and land based inspections.

Consultation

Consultation with licensees on operational issues occurs on an as needs basis, and more formally via industry Management Meetings convened by the West Australian Fishing Industry Council (WAFIC) pursuant to a Service Level Agreement with the Department of Fisheries.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives/Outlook Status

The south coast small pelagic scalefish resource will continue to be monitored using catch and catch rates.

In 2017 staff from the Fisheries Division will conduct an independent observer program to record FFS interactions during the SMP. Results will inform future bycatch mitigation strategies.

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 no fishing in these waters was identified in 2015/16, the last year reported for that fishery (Moore and Mazur 2016). **Moderate** risk.

SOUTH COAST SMALL PELAGIC TABLE 1.

2015/16 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)	2015/16 catch (t)	Active vessels	2015/16 catch as per cent of TAC
Albany (Zones 1 and 2)	2,683	1,515	6	56.5%
Bremer Bay (Zone 3)*	1,500	632	2	21.1%
Esperance (Zone 4)*	1,500		1	
Total for Fishery	5,683	2,149	9	37.8%

* Insufficient vessels operated in 2015/16 so catch cannot be reported.

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TEMPERATE DEMERSAL GILLNET AND DEMERSAL LONGLINE FISHERIES RESOURCE STATUS REPORT 2017

M. Braccini & 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 fishers employ demersal gillnets to target mainly 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' as 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 2017

Fishery Performance	Commercial	Recreational
Total Catch 2015-16		
Sharks and rays*	994 t	< 5% of commercial catch
Scalefish*	143 t	
Fishing Level	Acceptable	Acceptable

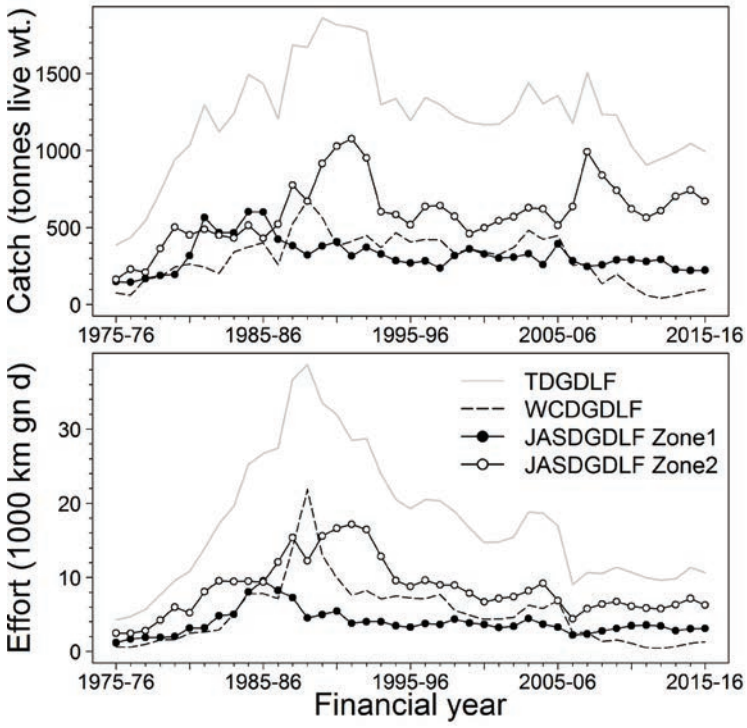
Stock/Resource Performance	Stock Status	Assessment Indicators
Sharks South & West	Sustainable - Recovering	Annual: Catch, standardised catch rates; Periodic: Total biomass

EBFM Performance Asset	Level	Asset	Level
Bycatch	Low Risk	Listed Species	Negligible- Low Risk
Habitat	Negligible Risk	Ecosystem	Low Risk
Social	Moderate Social Amenity Significant Social Risk	Economic	GVP Level 2. ($1-5 mill)
Governance	Moderate Risk	External Drivers	Moderate Risk

*All reported weights are live weight

CATCH AND LANDINGS

For the TDGDLF, reported catches of elasmobranchs 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, boat-based recreational fishers retain very small numbers of sharks in WA (Ryan *et al*. 2017). 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^{-1}). 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

Gummy shark (Sustainable - Adequate)

The most recent stock assessment for gummy shark estimated the 1997-98 biomass at 42% unfished levels, which is above the 40% target. Standardised catch rates peaked in the mid/late 2000s and have been stable at lower levels ever since (Temperate Demersal Figure 2). This trend will be further examined in a new stock assessment, which will be completed in 2017. On the basis of the above, the current status of gummy sharks is **sustainable-adequate.**

Dusky shark (Sustainable - Recovering)

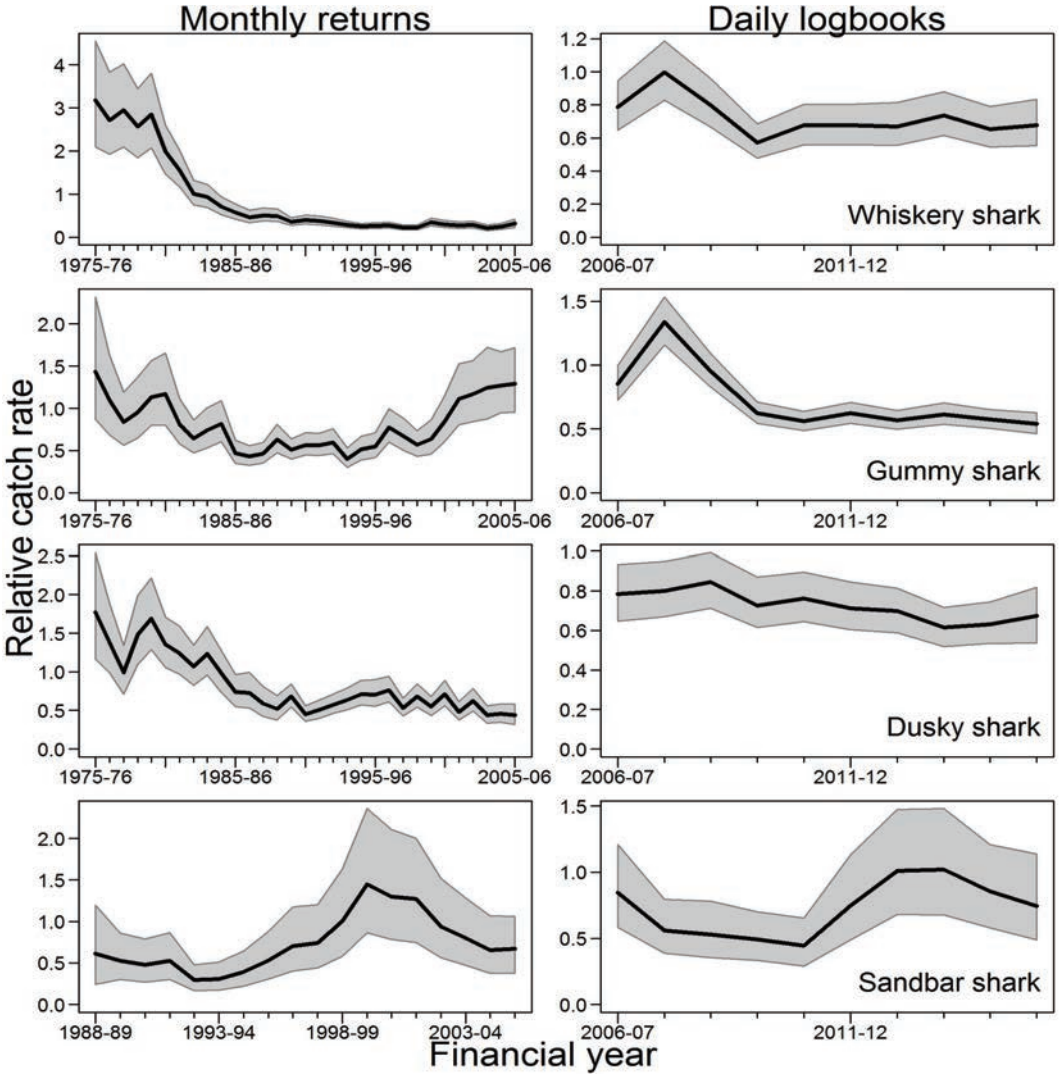
Catches of dusky shark comprise mostly of neonates and one to two year old fish. Recent catches (which include catches of bronze whaler, *C. brachyurus*, that cannot be accurately separated in catch returns data prior to 2006/07) have been reduced to approximately half of the quantity determined to be sustainable in 1994-95 and 1995-96 and comprehensive measures to mitigate cryptic mortality of older dusky sharks have been introduced since 2006. In addition, risk ratings for the issues identified through risk assessments are at acceptable levels (Braccini *et al*. 2017). Hence, current management arrangements are considered suitable to allow gradual recovery of the breeding stock. The recent stable trends in standardised catch rates (Temperate Demersal Figure 2) will be considered in more detail during development of the new stock assessment models in 2017. On the basis of the above, the current status of dusky sharks is **sustainable-recovering.**

Whiskery shark (Sustainable - Adequate)

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 standardised catch rates in the early 1980s (Temperate Demersal Figure 2) is likely a result of changes in targeting practices (Simpfendorfer *et al*. 2000). Since the 1990s, standardised catch rates have remained stable, with a moderate increase in recent years. A new stock assessment will be completed in 2017. On the basis of the above, the current status of whiskery sharks is **sustainable-adequate.**

Sandbar shark (Sustainable - Recovering)

For sandbar shark, standardised catch rates have shown an increasing trend between mid 1980s and early 2000s and have fluctuated subsequently at relatively high levels ever since. Sandbar shark catches in the TDGDLF since 2008/09 have been at levels that would allow a recovery of the breeding stock. In addition, risk ratings for the issues identified through risk assessments are at acceptable levels (Braccini *et al*. 2017). On the basis of the above, the current status of sandbar sharks is **sustainable-recovering.**



TEMPERATE DEMERSAL FIGURE 2.

Standardised catch rates by species (shaded areas indicate 95% confidence intervals).

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 finfish, all fishery impacts on stocks of bycatch species impose a **low risk** to their ongoing sustainability.

Protected Species: The TDGDLF has low interactions with listed species (McAuley & Simpfendorfer 2003). For 2015-16, fishers reported catching and releasing 15 dead and 11 alive grey nurse sharks, 1 alive turtle, and 3 dead and 11 alive white sharks (Appendix 3) 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 51 and 60 skippers and crew were employed in the JASDGDLF and between 17 and 20 skippers and crew were employed in the WCDGDLF during 2015-16. 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 sharks generate a high level of community interest and debate, creating **moderate** social amenity and **significant** 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 2015-16 is $4.3 and $0.5 million for JASDGDLF and WCDGDLF, respectively (GVP level 2).

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels

The 2015-16 total catch of sharks and rays was 994 t (419 t, 220 t, 41 t, and 143 t for gummy, dusky, sandbar and whiskery sharks, respectively), similar to previous years and within the acceptable catch ranges (725–1,095 t for the four key species and 350–450 t, 200–300 t, < 120 t, and 175–225 t for gummy, dusky, sandbar and whiskery sharks, respectively). Whiskery catch was maintained below historical allowable levels due to reductions in targeted effort.

The catch levels of both the commercial and recreational sectors indicate that the fishery performance for both sectors is considered **acceptable**.

Harvest Strategy

The TDGDLF is managed under a constant catch harvest strategy. Although the harvest strategy has not been formally developed, 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}). The 2015-16 effort levels were maintained within these ranges (49,600 km gn.hr^{-1} or 3,081.9 km gn.d^{-1} for Zones 1 & 3 of the JASDGDLF; 114,200 km gn.hr^{-1} or 6,263.6 km gn.d^{-1} for Zone 2 of the JASDGDLF; 27,100 km gn.hr^{-1} or 1,296 km gn.d^{-1} for WCDGDLF).

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 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 non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

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 is proposed that closures 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. **Moderate** risk.

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SOUTH COAST DEMERSAL SCALEFISH RESOURCE STATUS REPORT 2017

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*). Commercial fishers take these species predominantly by hook and line, however some demersal scalefish are taken by demersal gillnet as part of the the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLMF) (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 2017

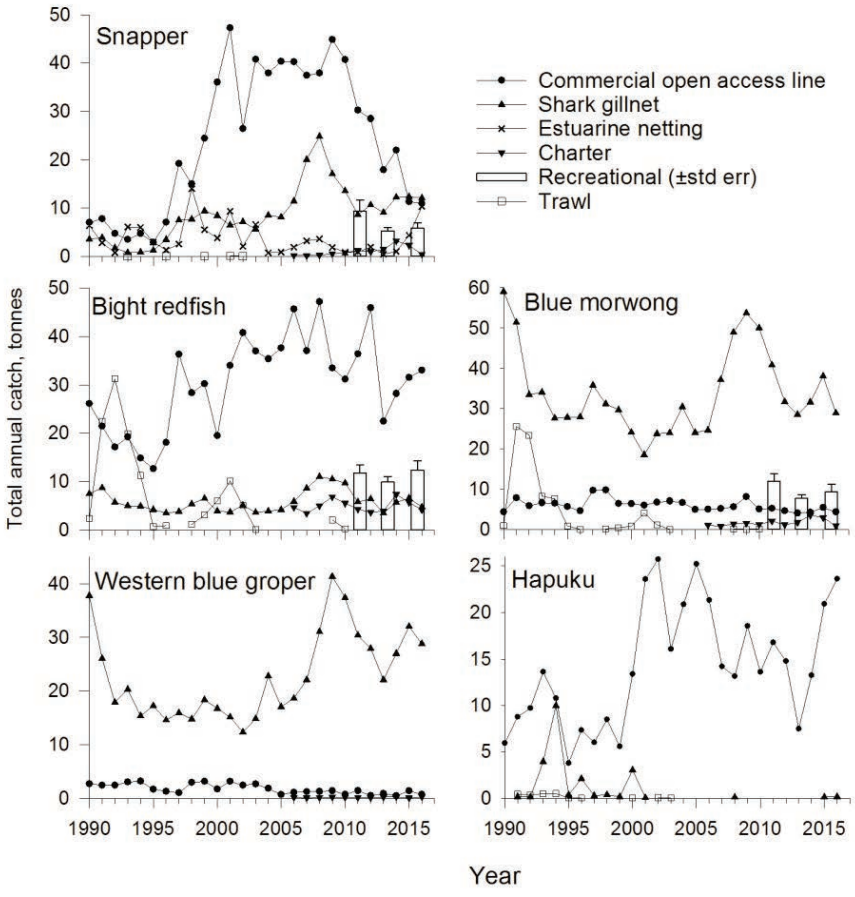
Fishery Performance	Commercial	Recreational
Total Catch 2016	180 t	38–51 t (2015/16 boat-based only)
Fishing Level	Acceptable	Acceptable
Stock/Resource Performance	Stock Status	Assessment Indicators
Demersal	Sustainable - Adequate	Annual: Catch, Fishing Mortality, SPR

EBFM Performance Asset	Level	Asset	Level
Bycatch	Low Risk	Listed Species	Negligible Risk
Habitat	Negligible Risk	Ecosystem	Low Risk
Social	Moderate Amenity High Risk	Economic	GVP $1-5 mill 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).

The top 10 demersal species in the South Coast represented 96% of the total boat-based recreational catch (kept by numbers) in 2015/16. The estimated boat-based recreational harvest range for the top 15 demersal species in the South Coast was steady in 2015/16 (95% CI 38–51 tonnes compared with 30–38 in 2013/14 and 47–63 in 2011/12), with steady estimated recreational harvests for Bight Redfish, Blue Morwong, Breaksea Cod, Foxfish, Harlequin Fish, Pink Snapper, Sea Sweep, West Australian Dhufish and Swallowtail (Ryan *et al*. 2017).



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 **moderate** for snapper, Bight redfish and blue morwong, and low for western blue groper, i.e. the levels of breeding stocks for these species were therefore considered **sustainable-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 catches beyond recent historical levels would constitute an unacceptable risk. A historically high catch of snapper by estuarine netting in 2016 has been offset by a decline in the commercial wetline catch over recent years.

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.

Hapuku (Sustainable-Adequate)

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).

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. **Low** risk. 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). **Low** risk.

SOCIAL AND ECONOMIC OUTCOMES

Social

The annual estimated boat-based recreational fishing effort in the SCB was steady in 2015/16 (24,444 boat days, SE=2,042) compared with 2013/14 (28,277, SE=2,323), but lower than 2011/12 (40,073, SE=3,354) (Ryan *et al*. 2017). In recent years approximately 50 to 60 commercial wetline vessels have each employed up to three crew. Several seafood processors in the SCB and in Perth have also provided employment. **High** risk.

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 South Coast commercial line fishery currently operates under open-access arrangements (as opposed to a 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 a number of SC open access and other fishing activities (see Management Initiatives/Outlook Status below). Consultation occurs with commercial fishers and the West Australian Fishing Industry Council on management issues and initiatives. 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.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives (Under Review)

South Coast commercial fish trap, G-net and open-access line, net and squid jig fisheries are currently under review. 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 comments the IAP submitted their final report to the Department in late 2016. The Department is currently providing advice (including the IAP's final report) to the Minister for Fisheries for his consideration and in-principle decisions regarding matters of access and allocation 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 Curtotti 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

Climate Change

The Northern Inland Bioregion is expected to be affected similarly to the North and Gascoyne Coast Bioregions.

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*) increased after 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, 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 2015/16 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 10 fish in 2015)

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. Biennial integrated recreational surveys of boat-based fishers (iSurvey) provide regular bioregional-wide estimates of boat-based catches of all species.

Aquaculture

Aquaculture development operations in the region have previously included the production of barramundi from cage operations 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

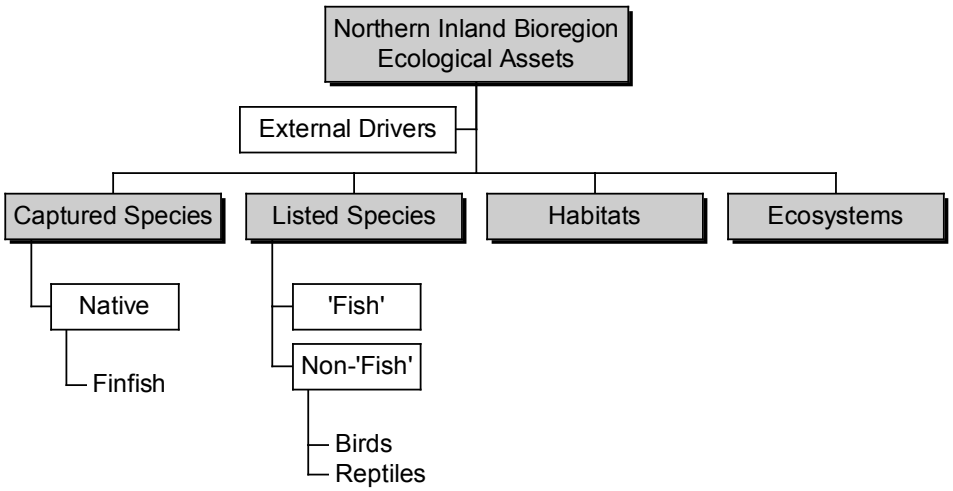
Within each Bioregion there are a range of management measures that have been implemented to manage the potential impact of activities (See the Ecosystem Management Section for an overview).

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 moderate 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 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 small 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 fishes 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 that do not impact the ongoing sustainability of the species.

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 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 2017

S. Newman, G. Mitsopoulos and E. Smith

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).

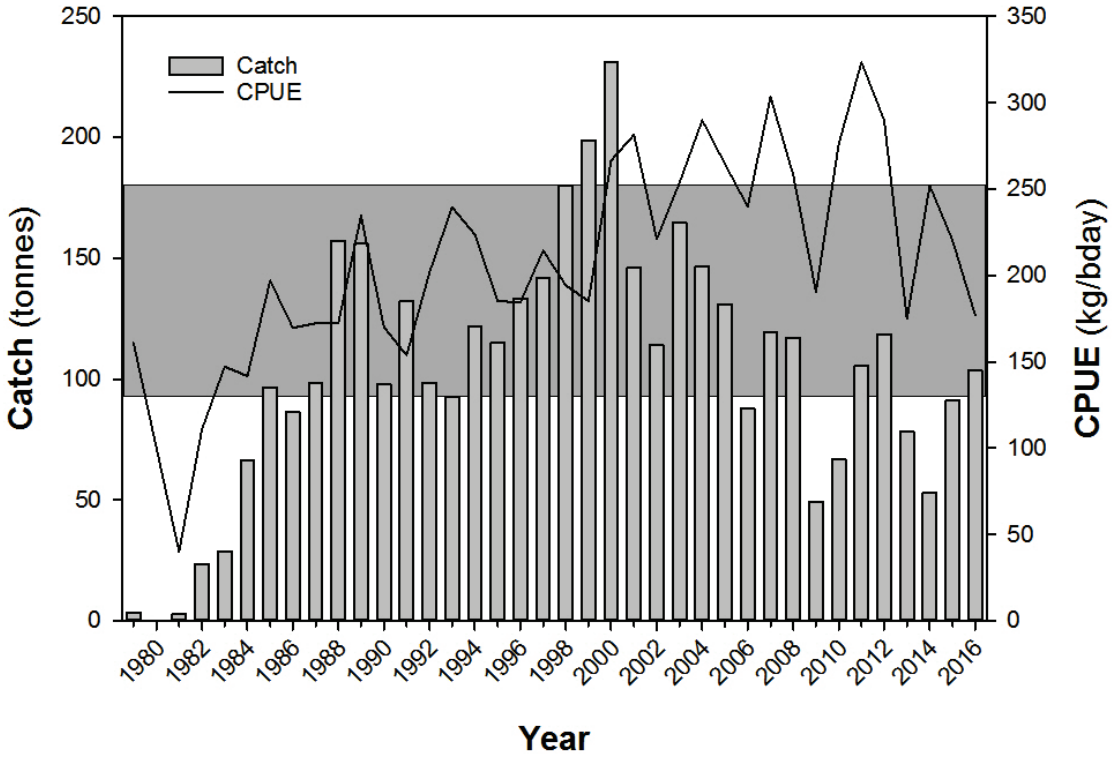
In addition to the waters of Lake Argyle, recreational anglers can fish in all creeks and tributaries that feed into the Ord River and Lake Argyle.

SUMMARY FEATURES 2017

Fishery Performance	Commercial		Recreational
Total Catch 2016	103 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 mill)
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 (Lake Argyle Silver Cobbler Figure 1). 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 (Lake Argyle Silver Cobbler Figure 1). Catches from 2008 to 2016 have fluctuated between 49 t and 119 t. In 2016, the catch of silver cobbler was 103 t.



LAKE ARGYLE SILVER COBBLER FIGURE 1.

The annual catch and catch per unit effort (CPUE, kg/block day) for silver cobbler in the Lake Argyle Silver Cobbler Fishery over the period from 1979 to 2016. The upper and lower bounds of the target commercial catch range are shown by the shaded catch area between 93 and 180 tonnes.

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 2016 is within 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 **sustainable-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. **Negligible** risk.

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 2016, five vessels fished in the LASCF, with an average crew of 1.8 people per vessel, indicating that nine people were directly employed in the fishery, which operates from 1 January to 31 October each year. Additional employment occurs throughout the fish processing and distribution networks. **Low** risk.

Economic

The fishery's score value in 2016 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 2016 is within the target acceptable catch range. 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 Fisheries Division of the Department of Primary Industries and Regional Development (Fisheries) 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 Fisheries. Consultation processes for the recreational fishing sector are facilitated by Recfishwest under a Service Level Agreement, although Fisheries undertakes direct consultation with the community on specific issues.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives (Stable)

The next management review for the Fishery is scheduled for 2018/2019.

EXTERNAL DRIVERS

A number of external factors may impact on silver cobbler biomass. These include the introduced cane toad (*Rhinella marina*) which has been observed in Lake Argyle and may affect prey and predators of silver cobbler.

The population of the freshwater crocodile (*Crocodylus johnstoni*) 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 winter, 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

Climate Change

The Southern Inland Bioregion is expected to be affected similarly to the West and South Coast Bioregions.

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 into public dams and rivers, and feral redfin perch, an introduced, self-perpetuating stock. The native freshwater cobbler is also taken in small numbers.

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 some potential to expand.

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 region's lakes and 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. Most of these species are only found in WA, all have had major contractions in their distribution, many species now only consist of small vulnerable fragmented populations, and half are now listed as threatened. They are under pressure from feral fish populations, migration barriers (bridges and dams) and urban land-use development, particularly in the form of unfiltered storm water discharge from roads into natural waterbodies.

The Department works with representatives from the Department of Water and Environmental Regulation, the Department of Biodiversity, Conservation and Attraction, and other stakeholders, to facilitate information exchange, identify research projects and apply for funding to manage freshwater native fish

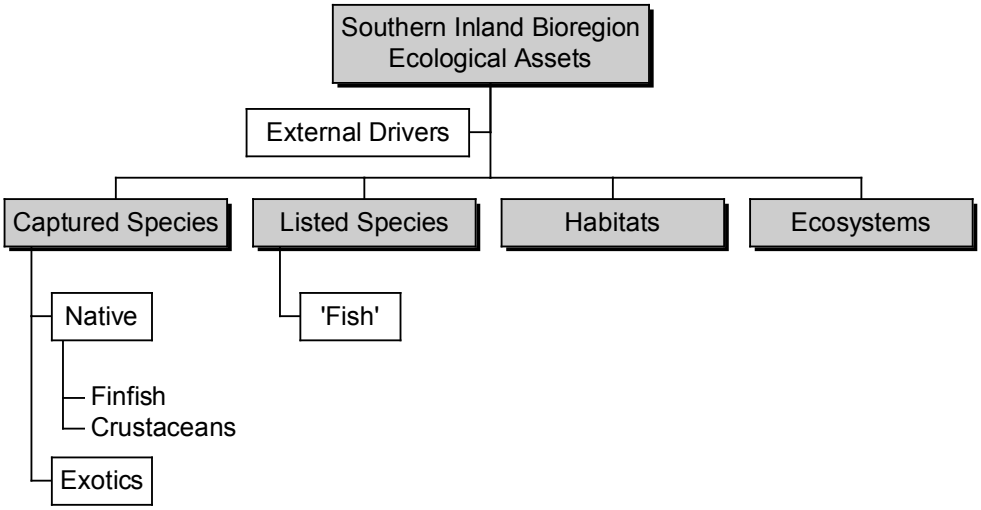
species. This is being facilitated by the Freshwater Ecosystem Working Group which aims to coordinate a whole-of -Government approach to the management of freshwater ecosystems in the State.

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 IN LAND 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 a 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), habitat loss 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 land and water 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, especially due to reduced rainfall and habitat loss.

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 Freshwater Research Centre and are tolerant of warmer water temperatures. Research activities are aimed at improving growth rate by increasing the number of sterile fish produced at the Centre.

Listed Species

Fish *Crustaceans are classified as fish under the FRMA 1994

Listed species	Ecological Risks
Western trout minnow	SIGNIFICANT (non-fishing)
Hairy marron*	SIGNIFICANT (fishing)
Hairy marron*	SIGNIFICANT (non-fishing)
Balstons Perch	SIGNIFICANT (non-fishing)
Little Pygmy Perch	SIGNIFICANT (non-fishing)
Black-stripe Minnow	SIGNIFICANT (non-fishing)
Salamanderfish	SIGNIFICANT (non-fishing)

Western trout minnow (*G. truttaceus*) 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 is being 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 collaboration 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 that found that 24% no longer have any fish and less than 5% have native fish populations, the rest contain feral species.

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. Given that these lakes are predominantly groundwater fed, a significant contributing factor is the over-extraction of water to supply Perth's increasing human population. This is causing the ground water levels to drop and is recognised as being unsustainable for either fish or people.

SOUTH-WEST RECREATIONAL FRESHWATER RESOURCE STATUS REPORT 2017

R. Duffy, F. Trinnie, K. Ryan and M. Yerman

OVERVIEW

The Southern Inland Freshwater Fishery (SIFF) Resource incorporates the Recreational Marron Fishery and the South West Recreational Freshwater Angling (SWRFA) fishery. Both fisheries have separate recreational licenses and are managed with rules around seasons, gear, bag limits, size limits and area closures.

SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch	NA	Marron: 52,669 (±4,801 s.e.) Marron SWRFA: 69,231(± 9,447 s.e.) Fish
Fishing Level	NA	Acceptable
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
Marron	Sustainable - Adequate	Annual: Recreational Catch, Effort; Fishery Independent Stock Assessment
Trout	Sustainable - Adequate	Annual: Number Stocked

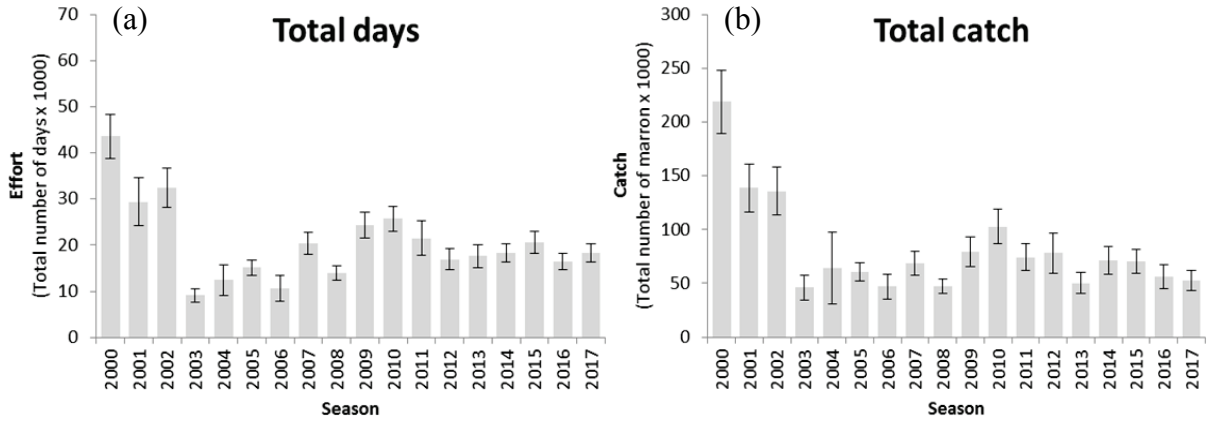
EBFM Performance Asset	Level	Asset	Level
Bycatch	Low Risk	Listed Species	Significant Risk
Habitat	Moderate Risk	Ecosystem	Low Risk
Social	High Amenity Moderate Risk	Economic	NA
Governance	Stable	External Drivers	Significant Risk

CATCH AND LANDINGS

Marron (*Cherax cainii*): The total estimated fishing effort was higher in 2017 compared to 2016 (18,386 (± 999 s.e.) days vs 16,433 (± 949) days). Total estimated recreational catch for the 2017 season was 52,669 (±4,801 s.e.) marron, similar to the 2016 catch of 56,155 (±5,817) (Recreational Fishery Figure 1). The number of licensed fishers was down (12,896 in 2017 vs 14,006 in 2016), however the number of active fishers was slightly higher (6,057 in 2017 vs 5,688 in 2016), an increase in participation rate in 2017 compared to 2016 (46% vs 39%). Choices around fishing effort in 2017 were based mainly on social reasons, and less related to access, cost or fishing quality, whereas in 2016, limited access rated highly in the reason for the lower participation.

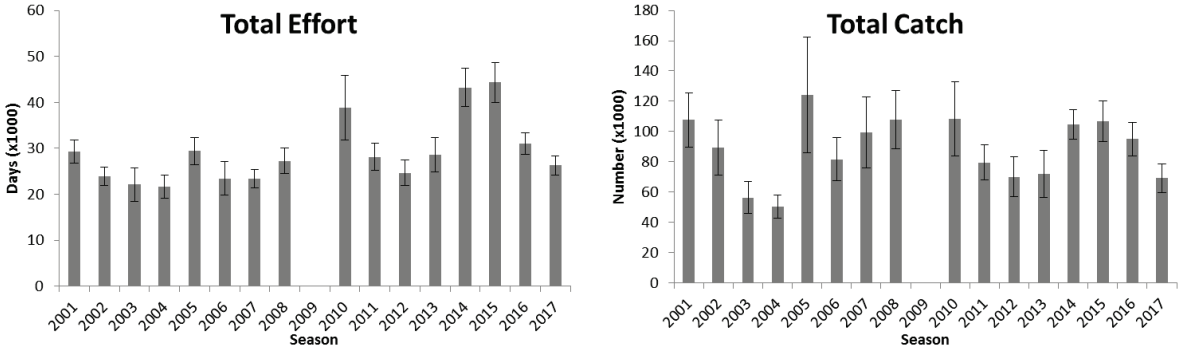
SWRFA: Children under the age of 16 were no longer required to hold a Freshwater Angling licence after March 2016. Survey design does not permit portioning of the contribution of this age group to historical surveys. Therefore, the 2017 survey is not directly comparable to previous surveys.

The total estimated fishing effort was lower in 2017 compared to 2016 (26,258 days in 2017 vs. 31,106 days in 2016). The estimated total recreational catch from SWRFA across all species for 2017 was 69,231 (±9,447 s.e.) fish of which 43,984 (±8,325 s.e.) were kept and 25,247 (±4,441 s.e.) were released. This was a decrease from 2016, where the estimated total recreational catch was 94,972 fish (±11,043 s.e.) (Recreational Fishery Figure 2). The estimated number of licensed fishers in 2017 (9,447) was down slightly on 2016 (9,918), however it remained around the long-term average.



RECREATIONAL FISHERY FIGURE 1.

Estimated (a) total days people went marroning and (b) total number of marron caught, from 2000 to 2017 for marron licence holders in the SIFF marron fishery.



RECREATIONAL FISHERY FIGURE 2.

Estimated (a) total days fished and (b) total number of finfish caught, from 2001 to 2017 for licence holders in 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) (in prep.) for further information.

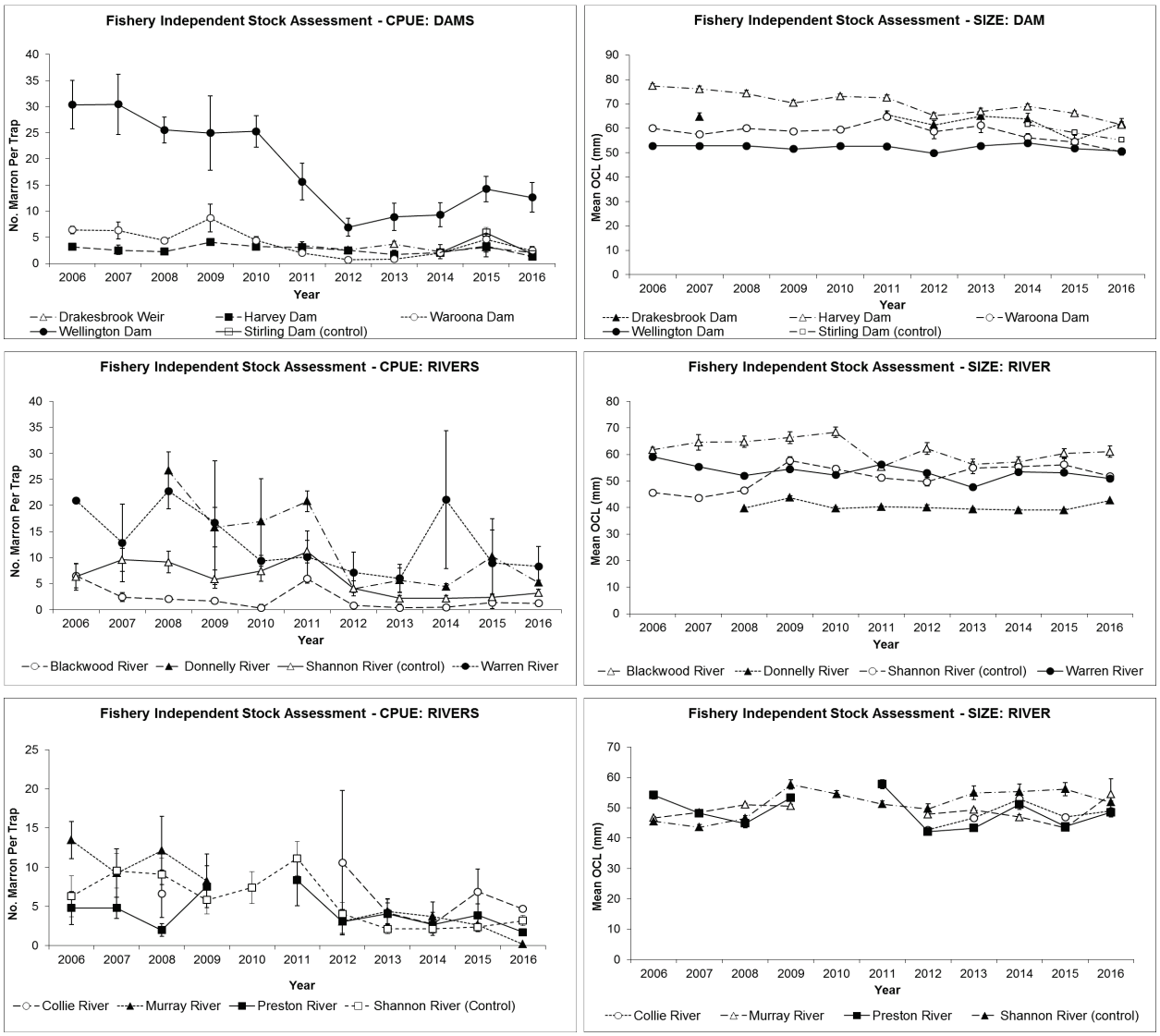
Total effort was higher in 2017 (18,386 days ± 999 s.e.) compared to 2016 (16,433 days ± 949 s.e.) but similar to effort levels since 2011. The number of days fished per fisher was similar between 2017 (3.04 days ±0.16 s.e.) and 2016 (2.89 days ±0.17 s.e.). The reduced catch of marron, despite a higher number of participants and an increase in the average number of days fished, may indicate marron stocks are under pressure. Marron catch has been correlated with rainfall (de Graaf *et al*., 2010), rainfall for the last three years has been similar, but below average, potentially placing ongoing pressure on marron populations and recruitment.

Distribution of fishing effort between dams and rivers has remained consistent with historic patterns (approximately 35% in dams and 65% in rivers). The distribution of fishing effort across particular rivers and dams is largely consistent across years, although some fluctuations occur. (Refer to RAR (in prep) for further information.)

Fishery independent survey data showed relative abundance of marron varied greatly among indicator sites (Recreational Fishery Figure 3). Patterns in size data vary between systems. Of concern is a decline in mean size in a number of systems. Interpretation of this data is confounded by control sites where no fishing is allowed showing conflicting trends; mean size of marron in Shannon River has increased; mean size in Stirling Dam has decreased. Therefore, while fishing may have impacted the mean size of animals, it is also likely be driven by environmental factors.

Overall marron stocks are considered **sustainable-adequate** due to stable recreational catch, 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. In addition, there is some evidence of site-specific reductions in abundance from fishery independent CPUE data. For more information refer to RAR (in prep.).



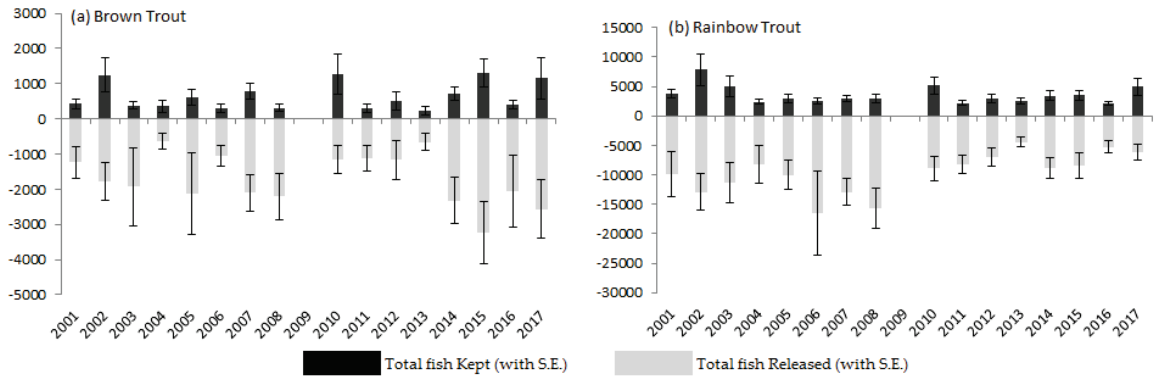
RECREATIONAL FISHERY FIGURE 3.

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. Numbers stocked in 2016 were similar to 2015. Stocking numbers for rainbow trout were: 570,000 fry, 35,000 yearlings and 2,500 ex-broodstock. Stocking numbers for brown trout were 20,000 fry and 300 brown trout ex-brood stock.

The total estimated recreational catch of each species in 2017, was slightly lower than 2016, due in part to reduced effort, however it could also be a result of the absence of fishers under 16 years old that cannot be included in the phone surveys as they no longer require a licence. 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 2017 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 of Primary Industries and Regional Development, Fisheries Division (Fisheries), and combined with the small population size is considered a **significant risk**.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat: The major habitat impacts of the Marron Fishery and the SWRFA are litter in surrounding areas, and fishers trampling 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 **moderate 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 (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 examining the social drivers of the Marron Fishery.

The effect of reduced rainfall in the future 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. Fisheries is investigating how these situations can be managed in the future. Social aspects are identified as having **high amenity** and a **moderate risk**.

Economic

The SIFF is likely to support tourism to regional towns in the South-West. 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 has largely fluctuated between 50,000 and 100,000 animals since 2001. Fishery independent surveys indicate negative impacts of fishing on stocks, therefore, although catch is considered **acceptable** it should be reviewed.

SWRFA: There are no allowable catch and tolerance levels specified as trout are stocked annually.

Harvest Strategy

The marron fishery is managed under a constant catch harvest strategy, although the Harvest strategy has not been formalised. The SWRFA fishery is based on stocking (inputs). While a stocking committee determines numbers and locations to be stocked, there is currently no formal harvest strategy for this 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, Recfishwest, Freshwater Fisheries Reference Group and freshwater fishers are held regularly.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives (Stable)

Children under the age of 16 are no longer required to hold a licence after March 2016.

EXTERNAL DRIVERS

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. **Significant** risk.

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STATEWIDE BIOREGION

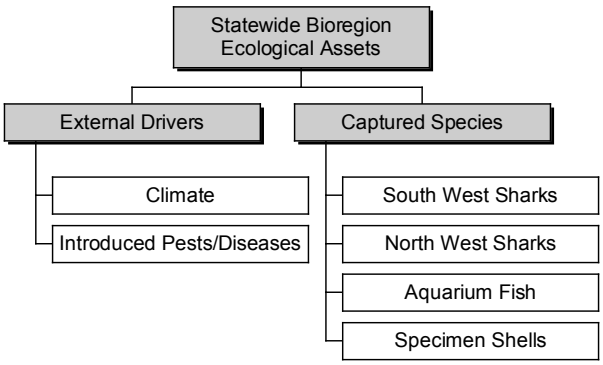
ECOSYSTEM BASED FISHERIES MANAGEMENT

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 levels. The risks to each of the individual stocks 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. These risk levels are 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

Marine pest surveillance programs are being implemented at key locations throughout the State. These include: Broome, Dampier, Port Hedland, Cape Preston, Cape Lambert, Geraldton, Fremantle, Garden Island, Albany and Esperance. Further targeted surveillance activities occur within metropolitan waters of Swan River and Cockburn Sound.

Captured Species

FINFISH

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 recovering at acceptable rates following management intervention.

The stocks levels of sharks in the mid west and north regions are considered to be recovering with some more productive species having recovered.

Captured Species	Aquatic zone	Ecological Risk
Aquarium Fish	Marine	MODERATE

The level of capture is low and the management arrangements ensure that species are not at risk.

INVERTEBRATES

Captured Species	Aquatic zone	Ecological Risk
Specimen Shells	Marine	MODERATE

The level of capture is low and the management arrangements are such that these species are not at risk.

STATEWIDE MARINE AQUARIUM FISH AND HERMIT CRAB RESOURCES STATUS REPORT 2017

S. Newman, R. Ferridge, 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 south of 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 one of two land-based commercial fisheries in Western Australia. The HCF operates under Ministerial Exemptions and 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.

SUMMARY FEATURES 2017

Fishery Performance	Commercial (n = numbers; kg = kilograms; l = litres)	Recreational
Total Catch 2016	Fish (n) – 15,424; Syngnathid (n) – 215; Invertebrates (other than hermit crabs) (n) - 29,487; Hard coral (kg) - 3,514; Soft coral (kg) – 4,298; Living rock & Living sand (kg) - 8,621; Sponges (n) - 3,972; Algae/Seagrasses (l) - 75; Hermit crabs (n) - 79,437	NA
Fishing Level	MAFMF: Acceptable HCF: Acceptable	NA

Stock/Resource Performance	Stock Status	Assessment Indicators
Statewide MAFMF & HCF	Sustainable - Adequate	Annual: 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 mill)
Governance	Stable	External Drivers	Negligible Risk

CATCH AND LANDINGS

Eight licences were active in the MAFMF and 3 in the HCF during 2016. The total catch in the MAFMF and the HCF in 2016 was 128,610 fishes, 16.4 t of coral, live rock & living sand and 75 L of marine plants. MAFMF fish catches were dominated by glassfish (*Ambassis vachelli*, n = 3,200), scribbled angelfish (*Chaetodontoplus duboulayi*, n = 2,670), black-axil chromis (*Chromis atripectoralis*, n =2,106), spotted blenny (*Istiblennius meleagris*, n = 1,222) and margined coralfish (*Chelmon marginalis*, n = 943) (Marine Aquarium Table 1), with more than 120 other fish taxa also reported. In addition, more than 160 invertebrate taxa were also landed in the MAFMF dominated by crabs, gastropods and soft coral. The

main coral species landed in 2016 were the coral like anemones of the *Corallimorphus* genus (Marine Aquarium Fish Table 2).

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 risk assessment was undertaken with industry and other marine management groups in 2014 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, and therefore catches, 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. **Negligible** risk. 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*). **Low** risk.

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

Eleven licences were active in 2016. Collections by the MAFMF are usually undertaken on SCUBA or surface supplied air (hookah) from small vessels, typically in small teams of 2 – 3 people. Operators in the HCF use four-wheel drive vehicles to access remote beaches where collection occurs on foot. **Low** risk.

Economic

The value per individual aquarium fish and hermit crab licence is relatively high but difficult to estimate as operators can sell direct to the public, to wholesalers or they 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 economic risk to these values.

GOVERNANCE SYSTEM

The current effort level in these fisheries is low and relatively consistent from year to year. The impact of these fisheries is very low relative to the widespread distribution of the numerous species targeted. No other fisheries exploit the majority of the species targeted and therefore there is extremely limited potential for any impact on breeding stocks. Therefore the current level of fishing activity is considered **adequate**.

There are specific performance measures for CITES species taken by the MAFMF as part of its WTO conditions. Catches of CITES species in 2016 were well below the WTO limits for hard corals (3,515 kg; limit of 6,000 kg), *Tridacnid* clams (336 individuals; limit of 700) and syngnathids (215 individuals; limit of 704).

Harvest Strategy

A harvest strategy was developed for the MAFMF in 2016 as a condition on the fisheries WTO approval. The draft MAFMF Harvest Strategy is due for release for public consultation in 2017.

An updated risk assessment was completed in 2014 for the MAFMF. The outcomes of the risk assessment are scheduled to be published in 2017.

Compliance

Operators in the MAFMF and the HCF are required to complete statutory catch and effort returns on a monthly basis. The MAFMF is also required to submit a more detailed daily logbook. 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 Management

Meetings convened by the West Australian Fishing Industry Council (WAFIC) under a Service Level Agreement with the Fisheries Division of the Department of Pirmay industries and Regional Dveleopment (Fisheries). The most recent Management Meeting occurred in December 2016.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives/Outlook Status

A major management review of the MAFMF commenced in 2014. As a result of the review, a new Management Plan is due to be implemented in 2017/18 which will replace the *Marine Aquarium Managed Fishery Management Plan 1995* and other subsidiary legislative tools currently used to manage this fishery. The new management plan will introduce formal quota management arrangements for coral, *Tridacnid* clams, 'live rock' and syngnathiformes. A new electronic reporting system will also be introduced to support the quota management system.

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 **negligible** risk to these fisheries.

MARINE AQUARIUM FISH TABLE 1

Summary of the reported catch (number of individuals) of the main fish (excluding Syngnathids) species landed from the Marine Aquarium Fish Managed Fishery for 2016, and catches over the previous four years. This table in previous Status Reports may vary among years due to varying catch levels of the species being landed.

Species	Common Name	2012	2013	2014	2015	2016
Ambassis vachellii	Vachell's Glassfish				5,245	3,200
Chaetodontoplus duboulayi	Scribbled Angelfish	2,527	1,938	1,333	1,668	2,670
Chromis atripectoralis	Black-axil Chromis	1,010	1,200	2,778	2,400	2,106
Istiblennius meleagris	Spotted Blenny	1,468	1,075	1,669	1,680	1,222
Chelmon marginalis	Margined Coralfish	1,048	1,429	1,082	827	943
Valenciennea muralis	Mural Glidergoby	345	288	262	1,458	714
Chromis viridis	Blue-green Chromis	109	126	52	108	545
Trachinops noarlungae	Yellow-headed Hulafish	580	230	380	100	307
Amphiprion clarkii	Clark's Anemonefish	326	280	299	359	240
Chromis klunzingeri	Black-headed Chromis	421	150	310	14	238

MARINE AQUARIUM FISH TABLE 2

Summary of the reported catch (kg) of the main coral species landed from the Marine Aquarium Fish Managed Fishery for 2016, and catches over the previous four years.

Species	Common Name	2012	2013	2014	2015	2016
Corallimorphus spp.	Corallimorphus Coral-like Anemones	72.50	1,869.00	2,318.00	2,319.00	1,708.00
Zoanthidae - undifferentiated	Zoanthidae Anemones	527.50	1,712.00	1,576.00	1,976.00	748.50
Order Alcyonacea - undifferentiated	General Soft Coral & Sea Fans	10.80	243.00	197.00	712.00	471.00
Sarcophyton spp.	Toadstool Soft Corals	118.80	314.60	448.00	430.00	455.70
Euphyllia ancora	Hammer Hard Coral	491.80	344.76	330.90	535.10	417.80
Duncanopsammia axifuga	Whisker Hard Coral	456.40	326.52	318.80	505.99	375.70
Order Corallimorpharia - undifferentiated	General Coral-like Anemones	3,815.00	1,009.00	418.00	282.00	369.00
Order Zoantharia - undifferentiated	General Zoanthid Anemones	736.60	404.00	632.00	609.00	340.00
Euphyllia glabrescens	Torch Hard Coral	504.60	246.58	277.40	362.52	290.10
Trachyphyllia geoffroyi	Trachyphyllia Hard Coral	266.30	230.00	180.15	279.30	272.90
Goniopora spp.	Goniopora Hard Corals	145.10	235.85	225.80	251.22	234.65
Order Scleractinia - undifferentiated	General Hard Corals	18.15	222.40	290.00	218.00	231.00
Symphyllia spp.	Symphyllia Hard Corals	189.90	74.80	296.00	208.60	178.00
Acropora spp.	Acropora Staghorn Hard Corals	186.20	98.40	165.60	198.37	173.20
Catalaphyllia jardinei	Elegant Hard Coral	265.20		154.10	229.50	164.70
Dipsastraea spp.	Dipsastraea Hard Corals	140.60	136.40	44.00	127.00	151.30
Lobophyllia spp.	Lobophyllia Hard Corals	293.20	555.90	333.50	439.82	145.40
Zoanthus spp.	Zoanthus Anemone	513.00	395.00	109.00	182.00	110.00
Euphyllia paraancora	Branching Hammer Hard Coral	29.00	269.00	330.00	48.50	106.60
Turbinaria spp.	Turbinaria Hard Corals	94.20	149.05	41.00	131.50	89.20

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STATEWIDE SPECIMEN SHELL RESOURCES STATUS REPORT 2017

A. Hart, R. Ferridge, C. Syers and P. Kalinowski

OVERVIEW

The Specimen Shell Managed Fishery (SSMF) is based on the collection of individual shells for the purposes of display, collection, cataloguing, classification and sale.

Just over 200 (224) different Specimen Shell species were collected in 2016, using a variety of methods. The main methods are by hand by a small group of divers operating from small boats in shallow coastal waters or by wading along coastal beaches below the high water mark. A current Exemption permits the use of a remote controlled underwater vehicle at depths of up to 300 m. While the fishery covers the entire Western Australian coastline, there is some concentration of effort in areas adjacent to population centres such as Broome, Exmouth, Perth, Mandurah, the Capes area and Albany.

This fishery is managed through input controls in the form of limited entry, gear restrictions and permanent closed areas. The primary controls in the fishery are operational limitations – depth, time and tide. This is a limited entry fishery with 31 licences in the fishery, with 23 of the licences being active in 2016. A maximum of 2 divers are allowed in the water per licence at any one time and specimens may only be collected by hand. Remotely operated vehicles are currently also being trialled under exemption instruments; these are limited to one per licence.

There are a number of closed areas where the SSMF is not permitted to operate. This includes within various marine parks and aquatic reserves and other closed waters such as Reef Observation Areas and Fish Habitat Protection Areas. Much of the west side of North-West Cape and the Ningaloo Marine Park are prohibited areas for the fishery. The exclusion of Marmion Marine Park in the Perth metropolitan area is also important because of its populations of 2 rare cowrie species.

SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	Commercial landings: 8,531 shells	NA
Fishing Level	Acceptable	NA
Stock/Resource Performance	Stock Status	Assessment Indicators
	Sustainable - Adequate	Catch: 10,000 to 25,000 shells Catch rate: 10 – 40 shells per day

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 mill)
Governance	Stable	External Drivers	Negligible Risk

CATCH AND LANDINGS

In 2016, the total number of specimen shells collected was 8,531 distributed over a wide range of species. This is based on 100% of submitted catch returns. In the past 5 years, more than 300 separate species of molluscs have been collected, with an average of more than 200 species per year – the majority in low numbers.

There is some focus of effort on mollusc families most popular with shell collectors, such as cowries, cones, murexes and volutes. Cypraeidae or cowries are noted for their localised variations in both shape and colour, making them attractive to collectors.

Although there are 31 licences in the fishery, about 7 of these are regularly active. Effort in 2016 was 585 days, which was similar to the effort reported in 2015 (633 days). Over the past 5 years, there was an annual average of around 671 days fished.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

During the 2016 season the catch rate was approximately 14 shells per day.

Ponder and Grayson (1998) examined the specimen shell industry on a nationwide basis, rating vulnerability to over-exploitation on the basis of species biology, accessibility to collection, and rarity. Species collected in Western Australia which were identified by Ponder and Grayson as potentially vulnerable comprised of 6 cowries (Cypraea (Austrocypraea) reevei, Cypraea (Zoila) friendii vercoi, Cypraea (Zoila) marginata (albanyensis), Cypraea (Zoila) marginata (consueta), Cypraea (Zoila) rosselli and Cypraea (Zoila) venusta) and 2 volutes (Amoria damoni (keatsiana) and Amoria damoni (reevei)).

Shell sighting is the abundance category used to monitor the 8 vulnerable species. Of the 8 vulnerable species an overall average of approximately 49 % of the shells sighted were not harvested in 2016. The measure of the number of shells sighted is reported correctly in about 87 % of the cases where one of the vulnerable species is reported. It is anticipated that current sightings are an under estimate of the available populations.

Sustainable-Adequate.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

There is no bycatch in this fishery owing to the highly selective fishing methods. **Negligible** risk.

The fishery reported no interactions with listed protected species during 2016. Reports of interactions with listed protected species are required to be recorded on monthly catch and effort returns. **Low** risk.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat and ecosystem impacts are considered **negligible**. This is due to the small scale of the fishery and the hand collection methods. While the fisheries can potentially operate over large areas catches are relatively low due to the special handling requirements. For example, collectors will ignore any specimens with slight visual imperfections, but their reproductive potential in the population remains undiminished. This results in a **negligible risk** to the overall ecosystem from the fishery.

SOCIAL AND ECONOMIC OUTCOMES

Social

In 2016 there were 31 authorisation holders in this fishery with around 7 licences recording consistent activity, the number of people employed regularly in the fishery is likely to be around 11. There were also around 17 people that operated occasionally in this fishery. **Low** risk.

Economic

The value per individual specimen shell can be relatively high but difficult to estimate as operators can sell direct to the public, to wholesalers or they have vertically integrated businesses including export. Estimated annual economic value of this fishery is currently not assessed. **Negligible** risk.

GOVERNANCE SYSTEM

The performance measures for the fishery relate to the maintenance of breeding stocks, as indicated by catch levels and catch rates. In 2016, the catch level of approximately 8,513 shells is below the range set, i.e. 10,000 – 25,000 shells and the catch rate of 14 shells/day is within the range set, i.e. 10 – 40 shells/day.

Harvest Strategy

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of specimen shell species. This is reported under the 'Governance System' section of this report.

Compliance

Operators in the SSMF are required to complete statutory catch and effort returns on a monthly basis. The low risks to the sustainability of the stocks imposed by these fisheries results in a **low compliance risk.**

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 with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives/Outlook Status

A review of the Exemption based remote controlled underwater vehicle trial will be carried out at the end of the 3 year trial.

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 **negligible risk** to these fisheries.

APPENDICES

APPENDIX 1
Science and Resource Assessment staff publications 2016/17

Scientific Papers

Ashworth, E.C., Hall, N.G., Hesp, S.A., Coulson, P.G., and Potter, I.C. (2017). Age and growth rate variation influence the functional relationship between somatic and otolith size. *Canadian Journal of Fisheries and Aquatic Sciences.* 74: 680–692

Ashworth, E.C., Hesp, S.A. and Hall, N.G. (2017) A new proportionality-based back-calculation approach, which employs traditional forms of growth equations, improves estimates of length at age. *Canadian Journal of Fisheries and Aquatic Sciences.* 74: 1088–1099

Braccini, M. (2016) Temporal patterns in the size of the main commercial shark species of Western Australia. *Marine and Freshwater Research* https://doi.org/10.1071/MF16117

Braccini, M. & Taylor, S. (2016) The spatial segregation patterns of sharks from Western Australia. *Royal Society Open Science* 3**:** 160306.

Caputi, N., Kangas, M., Denham, A., Feng, M., Pearce, A., Hetzel, Y. & Chandrapavan, A. (2016) Management adaptation of invertebrate fisheries to an extreme marine heat wave event at a global warming hotspot. *Ecology and Evolution.* doi: 10.1002/ece3.2137 http://onlinelibrary.wiley.com/doi/10.1002/ece3.2137/full

Coulson, P.G., Hall, N.G., and Potter, I.C. (2017). Variations in biological characteristics of temperate gonochoristic species of Platycephalidae and their implications: A review. *Estuarine, Coastal and Shelf Science*, 190: 50–68.

Coulson, P.G., Hall, N.G., and Potter, I.C. (2016). Biological characteristics of three co-occurring species of armorhead from different genera vary markedly from previous results for the Pentacerotidae. *Journal of Fish Biology*, 89: 1393–1418.

Dias, P.J., Fotedar, S., Munoz, J., Hewitt, M.J., Lukehurst, S., Hourston, M., Wellington, C., Duggan, R., Bridgwood, S., Massam, M., Aitken, V., de Lestang, P., McKirdy, S., Willan, R., Kirkendale, L., Giannetta, J., Corsini-Foka, M., Pothoven, S., Gower, F., Viard, F., Buschbaum, C., Scarcella, G., Strafella, P., Bishop, M.J., Sullivan, T., Buttino, I., Madduppa, H., Huhn, M., Zabin, C.J., Bacela-Spychalska, K., Wójcik-Fudalewska, D., Markert, A., Maximov, A., Kautsky, L., Jaspers, C., Kotta, J., Pärnoja, M., Robledo, D., Tsiamis, K., Küpper, F.C., Žuljević, A., McDonald, J.I. and Snow, M. (2017) Establishment of a taxonomic and molecular reference collection to support the identification of species regulated by the Western Australia Prevention List for Introduced Marine Pests. *Management of Biological Invasions,* 8(2): 215–225. DOI: 10.3391/mbi.2017.8.2.09

Fletcher, W.J. (2016). Changes in fisheries production following large scale expansion of no-take closures within the Great Barrier Reef, Australia: the results, the debate and implications for policies related to food security. In: Marine Protected Areas: Interactions with Fishery Livelihoods and Food Security. *FAO Fisheries and Aquaculture Technical Paper. No. 603*. pp 51-56.

Gardner, M.J., Chaplin, J.A., Potter, I., Fairclough, D.V. and Jackson, G. (2017). The genetic structure of a marine teleost, *Chrysophrys auratus*, in a large marine embayment. *Environmental Biology of Fishes* https://doi.org/10.1007/s10641-017-0652-8

Hastings, K. and Ryan, K.L. (2017). Differences in perception of a newly created Marine Park in south-west Western Australia by boat-based recreational fishers and the broader community. *Marine Policy* 77, 65–77.

Jaiteh, V., Hordyk, A.R, Braccini, M., Warren, C., & Loneragan, N.R. (2016) Shark finning in eastern Indonesia: Assessing the sustainability of a data-poor fishery. *ICES Journal of Marine Science* doi:10.1093/icesjms/fsw170

Lenanton, R.C.J., Dowling, C.E., Smith, K.A., Fairclough, D. and Jackson, G. (2017). Potential influence of a marine heatwave on range extensions of tropical fishes in the eastern Indian Ocean - invaluable contributions from amateur observers. *Regional Studies in Marine Science* https://doi.org/10.1016/j.rsma.2017.03.005

Lukehurst, S.S., Dias, P.J., Huhn, M., Madduppa, H.H., Lee, S.S.C., Teo, S., Gardner, M.G. and McDonald, J.I. (2017) Isolation and characterization of 16 polymorphic microsatellite loci for the Asian green mussel *Perna viridis* (Mollusca, Mytilidae). *Management of Biological Invasions*, 8(1):85–88.

Newman, S.J., Wakefield, C.B., Williams, A.J., O'Malley, J.M., Taylor, B.M., Nicol, S.J., Nichols, R.S., Hesp, S.A., Hall, N.G., Hill, N., Ong, J.J.L., Andrewse, A.H., Wellington, C.M., Harvey, E.S., Mous, P., Oyafusol, Z.S., Pardee, C., Bunce, M., DiBattista, J.D. and Moore, B.R. (2017) International workshop on advancing methods to overcome challenges associated with

life history and stock assessments of data-poor deep-water snappers and groupers. *Marine Policy* 79:78-83

Partridge, G.J., Ginbey, B.M., Woolley, L.D., Fairclough, D.V., Crisafulli, B., Chaplin, J., Prokop, N., Dias, J., Bertram, A. and Jenkins, G.I. (2017) Development of techniques for the collection and culture of wild-caught fertilised snapper (*Chrysophrys auratus*) eggs for stock enhancement purposes. *Fisheries Research*. Vol 186 p 524-530 Elsevier

Pitcher, C.R., Ellis, N., Jennings, S., Hiddink, J.G., Mazor, T., Kaiser, M.J., Kangas, M.I., McConnaughey, R.A., Parma, A.M., Rijnsdorp, A.D., Suuronen, P., Collie, J.S., Amoroso, R, Hughes, K.M. and Hilborn, R. (2017). Estimating the sustainability of towed fishing-gear impacts on seabed habitats: a simple quantitative risk assessment method applicable to data-limited fisheries. *Methods in Ecology and Evolution* 8: 472-480. Doi:10.111/2041-210X.12705.

Simpson, T.J.S., Dias, P.J., Snow, M., Muñoz, J. and Berry, T. (2016) Real-time PCR detection of *Didemnum perlucidum* (Monniot, 1983) and *Didemnum vexillum* (Kott, 2002) in an applied routine marine biosecurity context .*Molecular Ecology Resources*, 17 (3) 443-453

Simpson, T.S., Smale, D.A., McDonald, J.I. and Wernberg, T. (2017) Large scale variability in the structure of sessile invertebrate assemblages in artificial habitats reveals the importance of local-scale processes. *Journal of Experimental Marine Biology and Ecology*, 494: 10-19.

Wakefield, C. B., Potter, I. C., Hall, N. G., Lenanton, R. C. J., and Hesp, S. A. (2016) Timing of growth zone formations in otoliths of the snapper, Chrysophrys auratus, in subtropical and temperate waters differ and growth follows a parabolic relationship with latitude. – *ICES Journal of Marine Science*, doi:10.1093/icesjms/fsw137.

Wellington, C., Wakefield, C. and White, W. (2017) First record of *Odontaspis ferox* (Risso, 1810) in the temperate south-eastern Indian Ocean from in situ observations in a deep-water canyon using baited video. *Journal of Applied Ichthyology* 33:133-135

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Braccini, M., McAuley R. & A. Harry. (2017) Spatial and temporal dynamics of Western Australia's commercially important sharks. FRDC Project No 2010/003. *Fisheries Research Report No. 282*. Department of Fisheries, Western Australia. 160pp.

Harris, D., Johnston, D., Baker, J. and Foster, M. (2017). Adopting a Citizen Science approach to develop cost-efficient methods that will deliver annual information for managing small-scale recreational fisheries: The Southwest Recreational Crabbing Project. Fisheries Research Report No. 281, Department of Fisheries, Western Australia. 121pp.

Hart, A., Strain, L., Hesp, A., Fisher, E., Webster, F., Brand-Gardner, S. and Walters, S. (2017). Marine Stewardship Council Full Assessment Report Western Australian Abalone Managed Fishery. Marine Stewardship Council Series No. 8. Department of Fisheries, Western Australia. 288pp.

Hobday, A.J., Ling, S.D., Holbrook, N.J., Caputi, N., McDonald Madden, E., McDonald, J. & Munday, P. (2017). National Climate Change Adaptation Research Plan Marine Biodiversity and Resources: Update 2017. National Climate Change Adaptation Research Facility, Gold Coast, 75 pp. Available at https://www.nccarf.edu.au/content/narp-marine-biodiversity-resources/

Price, E., Melville-Smith, R., King, D., Green, T., Dixon, W., Lambert, S. and Spencer, T. (2016). Measurement of Fisheries Compliance Outcomes: A Preliminary National Study Project No. 2014/206. Fisheries Research Report No. 275, Department of Fisheries, Western Australia, 113pp.

Strain, L.W.S., Hesp, S.A., Fabris, F. and Hart, A.M. (2017). Demographic performance of Brownlip abalone: exploration of wild and cultured harvest potential. FRDC Project No. 2012/016. Fisheries Research Report No. 280, Department of Fisheries, Western Australia, 100pp.

Stewardson, C., Andrews, J., Ashby, C., Haddon, M., Hartmann, K., Hone, P., Horvat, P., Mayfield, S., Roelofs, A., Sainsbury, K., Saunders, T., Stewart, J., Stobutzki, I. and Wise, B. (eds) 2016, Status of Australian fish stocks reports 2016, Fisheries Research and Development Corporation, Canberra. Contributors – Braccini, M., de Lestang, S., Fairclough, D., Hart, A., How, J., Jackson, G., Johnston, D., Kangas, M., Lewis, P., Molony, B., Newman, S., Norriss, J., Smith, K., Strain, L., Wakefield, C.

Popular Articles

Caputi, N, Wahle, R. and Moore, J. 2017 (Ed.) The Lobster Newsletter. 30(1). Department of Fisheries, Western Australia. January 2017

http://www.fish.wa.gov.au/Documents/rock_lobster/the_lobster_newsletter/lobster_newsletter_v30_no1.pdf.

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 2015/16

This table contains the estimated live weight[1] 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 Primary Industries and Regional Development. 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.

Category Family Scientific Name	Common Name	Scientific Name	Live Weight (tonnes)
FISH			
SCALEFISH			
Acropomatidae, Percichthyidae, Serranidae, Polyprionidae, Moronidae, Callanthiidae, Centrogeniidae, Ostracoberycidae	Temperate Basses & Rockcods	*Percichthyidae, Serranidae - undifferentiated*	59
Ariidae	Forktail Catfishes	*Ariidae - undifferentiated*	17
	Silver Cobbler	*Neoarius midgleyi*	112
Arripidae	Australian Herring	*Arripis georgianus*	81
	Western Australian Salmon	*Arripis truttaceus*	104
Balistidae, Monacanthidae	Triggerfishes & Leatherjackets	*Balistidae, Monacanthidae - undifferentiated*	23
Berycidae	Bight Redfish	*Centroberyx gerrardi*	55
	Redfishes	*Berycidae - undifferentiated*	7
	Yelloweye Redfish	*Centroberyx australis*	3
Caesiondae, Lutjanidae, Symphysanodontidae	Fusiliers, Tropical Snappers & Slopefishes	*Caesionidae, Lutjanidae, Symphysanodontidae - undifferentiated*	2
Carangidae	Amberjack	*Seriola dumerili*	17
	Golden Trevally	*Gnathanodon speciosus*	5
	Samsonfish	*Seriola hippos*	29
	Silver Trevallies	*Pseudocaranx georgianus, Pseudocaranx sp. "dentex" & Pseudocaranx wrighti*	2

Category Family Scientific Name	Common Name	Scientific Name	Live Weight (tonnes)
	Trevallies	*Carangidae - undifferentiated*	167
	Yellowtail Kingfish	*Seriola lalandi*	1
	Yellowtail Scad	*Trachurus novaezelandiae*	23
Centrolophidae	Blue-Eye Trevalla	*Hyperoglyphe antarctica*	5
Cheilodactylidae	Blue Morwong	*Nemadactylus valenciennesi*	39
Clupeidae	Australian Sardine	*Sardinops sagax*	2,161
	Perth Herring	*Nematalosa vlaminghi*	2
	Sandy Sprat	*Hyperlophus vittatus*	34
	Scaly Mackerel	*Sardinella lemuru*	1,242
Flat Fishes (multi-family groups)	Flounders	*Bothidae, Psettodidae & Pleuronectidae*	7
Glaucosomatidae	Northern Pearl Perch	*Glaucosoma buergeri*	27
	West Australian Dhufish	*Glaucosoma hebraicum*	46
Haemulidae	Grunter Breams	*Haemulidae - undifferentiated*	45
	Javelinfishes	*Pomadasys spp.*	31
	Painted Sweetlips	*Diagramma labiosum*	53
Hemiramphidae	Southern Garfish	*Hyporhamphus melanochir*	10
Labridae	Baldchin Groper	*Choerodon rubescens*	9
	Pigfishes	*Bodianus spp.*	2
	Tuskfishes	*Choerodon spp.*	9
	Western Blue Groper	*Achoerodus gouldii*	43
	Wrasses	*Labridae - undifferentiated*	1
Latidae	Barramundi	*Lates calcarifer*	51
Lethrinidae	Bluespotted Emperor	*Lethrinus punctulatus*	305
	Drab Emperor	*Lethrinus ravus*	3
	Grass Emperor	*Lethrinus laticaudis*	4
	Longnose Emperor	*Lethrinus olivaceus*	15
	Mozambique Seabream	*Wattsia mossambica*	6
	Redspot Emperor	*Lethrinus lentjan*	25
	Redthroat Emperor	*Lethrinus miniatus*	51
	Robinson's Seabream	*Gymnocranius grandoculis*	30
	Spangled Emperor	*Lethrinus nebulosus*	83
	Yellowtail Emperor	*Lethrinus atkinsoni*	8
Lutjanidae	Brownstripe Snapper	*Lutjanus vitta*	92
	Chinamanfish	*Symphorus nematophorus*	7
	Crimson Snapper	*Lutjanus erythropterus*	230
	Darktail Snapper	*Lutjanus lemniscatus*	13
	Goldband Snapper	*Pristipomoides multidens*	627
	Golden Snapper	*Lutjanus johnii*	1
	Indonesian Snapper	*Lutjanus bitaeniatus*	6
	Mangrove Jack	*Lutjanus argentimaculatus*	13
	Moses' Snapper	*Lutjanus russellii*	49
	Red Emperor	*Lutjanus sebae*	281
	Rosy Snapper	*Pristipomoides filamentosus*	12
	Ruby Snapper	*Etelis carbunculus*	23
	Saddletail Snapper	*Lutjanus malabaricus*	188
	Sharptooth Snapper	*Pristipomoides typus*	20

Category Family Scientific Name	Common Name	Scientific Name	Live Weight (tonnes)
	Stripey Snapper	*Lutjanus carponotatus*	1
	Tropical Snappers	*Lutjanus spp.*	50
Mugilidae	Sea Mullet	*Mugil cephalus*	218
	Yelloweye Mullet	*Aldrichetta forsteri*	9
Mullidae	Goatfishes	*Mullidae - undifferentiated*	24
Nemipteridae	Rainbow Monocle Bream	*Scolopsis monogramma*	10
	Threadfin Breams	*Nemipteridae - undifferentiated*	119
Oplegnathidae	Knifejaw	*Oplegnathus woodwardi*	1
Pentacerotidae	Boarfishes	*Pentacerotidae - undifferentiated*	5
Platycephalidae	Flatheads	*Platycephalidae - undifferentiated*	23
Plotosidae	Estuary Cobbler	*Cnidoglanis macrocephalus*	70
Polynemidae	King Threadfin	*Polydactylus macrochir*	20
	Threadfin Salmons	*Polynemidae - undifferentiated*	1
Polyprionidae	Bass Groper	*Polyprion americanus*	2
	Hapuku	*Polyprion oxygeneios*	30
Pomatomidae	Tailor	*Pomatomus saltatrix*	18
Pricanthidae	Bigeyes	*Priacanthidae - undifferentiated*	53
Rachycentridae	Cobia	*Rachycentron canadum*	14
Scaridae	Parrotfishes	*Scaridae - undifferentiated*	5
Sciaenidae	Black Jewfish	*Protonibea diacanthus*	2
	Mulloway	*Argyrosomus japonicas*	25
Scombridae	Australian Bonito	*Sarda australia*	8
	Blue Mackerel	*Scomber australasicus*	1
	Grey Mackerel	*Scomberomorus semifasciatus*	8
	Spanish Mackerel	*Scomberomorus commerson*	311
Scorpididae	Sea Sweep	*Scorpis aequipinnis*	1
Serranidae	Banded Grouper	*Epinephelus amblycephalus*	6
	Barcheek Coral Trout	*Plectropomus maculatus*	20
	Birdwire Rockcod	*Epinephelus merra*	1
	Blackspotted Rockcod	*Epinephelus malabaricus*	21
	Breaksea Cod	*Epinephelides armatus*	5
	Chinaman Rockcod	*Epinephelus rivulatus*	1
	Common Coral Trout	*Plectropomus leopardus*	2
	Duskytail Grouper	*Epinephelus bleekeri*	19
	Eightbar Grouper	*Hyporthodus octofasciatus*	14
	Goldspotted Rockcod	*Epinephelus coioides*	39
	Radiant Rockcod	*Epinephelus radiatus*	1
	Rankin Cod	*Epinephelus multinotatus*	169
	Spotted Cod	*Epinephelus Microdon/Areolatus/Bilobatus*	67
	Tomato Rockcod	*Cephalopholis sonnerati*	2
	Yellowspotted Rockcod	*Epinephelus areolatus*	1
Sillaginidae	King George Whiting	*Sillaginodes punctata*	20
	Whitings	*Sillaginidae - undifferentiated*	91
	Yellowfin Whiting	*Sillago schomburgkii*	68
Sparidae	Black Bream	*Acanthopagrus butcheri*	44
	Frypan Bream	*Argyrops spinifer*	40

Category Family Scientific Name	Common Name	Scientific Name	Live Weight (tonnes)
	Pink Snapper	*Chrysophrys auratus*	279
	Tarwhine	*Rhabdosargus sarba*	9
	Western Yellowfin Bream	*Acanthopagrus morrisoni*	17
Sphyraenidae	Pikes	*Sphyraenidae - undifferentiated*	8
	Snook	*Sphyraena novaehollandiae*	5
Terapontidae	Striped Grunters	*Terapontidae - undifferentiated*	2
TOTAL SCALEFISH			8,596
SHARKS & RAYS			
Carcharhinidae	Bronze Whaler	*Carcharhinus brachyurus*	57
	Dusky Whaler	*Carcharhinus obscurus*	162
	Sandbar Shark	*Carcharhinus plumbeus*	42
	Spinner Shark	*Carcharhinus brevipinna*	48
	Tiger Shark	*Galeocerdo cuvier*	4
Lamnidae	Shortfin Mako	*Isurus oxyrinchus*	3
Orectolobidae	Wobbegong	*Orectolobidae - undifferentiated*	29
Pristiophoridae	Common Sawshark	*Pristiophorus cirratus*	6
Rajidae	Skates	*Rajidae, Arhynchobatidae - undifferentiated*	16
Rhinobatidae	Guitarfishes	*Rhinobatidae - undifferentiated*	1
Sphyrnidae	Hammerhead Sharks	*Sphyrnidae - undifferentiated*	48
Triakidae	Gummy Shark	*Mustelus antarcticus*	419
	Pencil Shark	*Hypogaleus hyugaensis*	1
	Whiskery Shark	*Furgaleus macki*	143
	Other Sharks	*Sharks - undifferentiated*	8
TOTAL SHARKS & RAYS			987
OTHER FISH	Other Fish		137
TOTAL FISH			9,720
INVERTEBRATES			
CRABS			
Geryonidae	Crystal Crab	*Chaceon bicolor*	161
Hypothalassiidae	Champagne Crab	*Hypothalassia spp.*	3
Menippidae	Giant Crab	*Pseudocarcinus gigas*	7
Portunidae	Blue Swimmer Crab	*Portunus armatus*	494
TOTAL CRABS			665
LOBSTERS			
Palinuridae	Southern Rock Lobster	*Jasus edwardsii*	38
	Western Rock Lobster	*Panulirus cygnus*	5,674
Scyllaridae	Bug	*Ibacus & Thenus spp.*	13
TOTAL LOBSTERS			5,725

Category Family Scientific Name	Common Name	Scientific Name	Live Weight (tonnes)
MOLLUSCS			
Cephalopoda	Squid	*Order Teuthoidea - undifferentiated*	35
Haliotidae	Brownlip Abalone	*Haliotis rubra conicopora*	22
	Greenlip Abalone	*Haliotis laevigata*	99
	Roe's Abalone	*Haliotis roei*	46
Octopodidae	Octopuses	*Octopodidae - undifferentiated*	270
Sepiidae	Cuttlefish	*Sepia spp.*	59
Veneridae	Ballot's Saucer Scallop	*Amusium balloti*	601
TOTAL MOLLUSCS			1,132
PRAWNS			
Penaeidae	Banana Prawn	*Penaeus merguiensis*	166
	Blue Endeavour Prawn	*Metapenaeus endeavouri*	345
	Brown Tiger Prawn	*Penaeus esculentus*	1,071
	Velvet Prawn	*Metapenaeopsis spp.*	131
	Western King Prawn	*Melicertus latisulcatus*	1,496
Stomatopoda	Mantis Shrimps	*Order Stomatopoda - undifferentiated*	17
TOTAL PRAWNS			3,226
OTHER INVERTEBRATES	Other Invertebrates		46
TOTAL INVERTEBRATES			10,794
GRAND TOTAL			20,514

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. Live weight has to be derived and this is usually done by applying a conversion factor to the landed weight. *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. Weight figures are round off to the nearest tonnage.
3. 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 2015/16

Common Name	Quantity (numbers)	Weight (kg)	Volume (litres)
MARINE AQUARIUM FISH FISHERY			
Fish	18,293		
Syngnathidae (not included in Fish)	257		
Invertebrates (not including Corals)	45,845		
Hard Coral		4,802.17	
Soft Coral[1]		6,471.00	
Living Rock & Living Sand		13,139.00	
Sponges	4,104		
Algae/Seagrasses			197
SPECIMEN SHELL FISHERY			
Specimen Shells - Mollusca	9,806		
HERMIT CRAB FISHERY			
Land Hermit Crabs only - *Coenobita variabilis*	92,982		

1 The 'Soft coral' category for the Marine Aquarium Fish Fishery includes 5,154 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.

Table of catches from boat-based recreational fishers and charter returns for 2015/16

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 2015/16 (1 September 2015 – 31 August 2016). 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, otherwise species were grouped to general or 'other' categories within each class. Uncertainty around estimates from the state-wide survey is not included in this table (refer to Ryan *et al*. 2017 for this information). Estimates of shore-based recreational catches are not available. The table represents the latest year for which a complete set of data is available.

Category Family	Common Name	Scientific Name	Est Kept Catch (number)	Est Kept Catch (tonnes)	Charter Kept Catch (number)	Charter Est Kept Catch (tonnes)
FISH						
SCALEFISH						
Acropomatidae, Percichthyidae, Serranidae, Polyprionidae, Moronidae, Callanthiidae, Centrogeniidae, Ostracoberycidae	Temperate Basses & Rockcods	Percichthyidae, Serranidae - undifferentiated	3,991	N/A	1,375	N/A
Apistidae, Neosebastidae, Pteroidae, Scorpaenidae, Sebastidae, Setarchidae, Synanceiidae, Tetrarogidae	Scorpionfishes	Apistidae, Neosebastidae, Pteroidae, Scorpaenidae, Sebastidae, Setarchidae, Synanceiidae & Tetrarogidae - undifferentiated	id	id	93	N/A
Ariidae	Forktail Catfishes	Ariidae - undifferentiated	130	N/A	78	N/A
Arripidae	Australian Herring	*Arripis georgianus*	104,468	19	32	Neg
	Western Australian Salmon	*Arripis truttaceus*	4,568	18	41	< 0.5
Aulopidae	Sergeant Baker	*Latropiscis purpurissatus*	2,784	3	171	< 0.5
Berycidae	Bight Redfish	*Centroberyx gerrardi*	11,592	15	3,910	5
	Swallowtail	*Centroberyx lineatus*	2,402	2	1,042	< 1
Caesiondae, Lutjanidae, Symphysanodontidae	Fusiliers, Tropical Snappers & Slopefishes	Caesionidae, Lutjanidae, Symphysanodontidae - undifferentiated	id	id	389	N/A
Carangidae	Amberjack	*Seriola dumerili*	id	id	38	< 0.5
	Golden Trevally	*Gnathanodon speciosus*	1,205	6	167	< 1
	Queenfish	*Scomberoides spp.*	202	N/A	201	N/A
	Samsonfish	*Seriola hippos*	1,962	15	425	3
	Silver Trevally	*Pseudocaranx georgianus*	32,776	29	1,172	1

Category Family	Common Name	Scientific Name	Est Kept Catch (number)	Est Kept Catch (tonnes)	Charter Kept Catch (number)	Charter Est Kept Catch (tonnes)
	Trevallies	Carangidae - undifferentiated	3,955	N/A	679	N/A
	Yellowtail Kingfish	*Seriola lalandi*	1,167	7	101	< 1
Cheilodactylidae	Blue Morwong	*Nemadactylus valenciennesi*	5,308	17	773	2
Clupeidae & Pristigasteridae	Herrings & Ilishas	Clupeidae, Pristigasteridae - undifferentiated	id	id	220	N/A
Glaucosomatidae	Northern Pearl Perch	*Glaucosoma buergeri*	681	1	767	2
	West Australian Dhufish	*Glaucosoma hebraicum*	23,818	137	2,650	15
Haemulidae	Grunter Breams	Haemulidae - undifferentiated	id	id	76	< 0.5
	Painted Sweetlips	*Diagramma labiosum*	733	2	322	1
Hemiramphidae	Garfishes	Hemiramphidae - undifferentiated	id	id	140	Neg
Labridae	Baldchin Groper	*Choerodon rubescens*	16,612	52	4,314	13
	Blackspot Tuskfish	*Choerodon schoenleinii*	1,584	5	202	< 1
	Blue Tuskfish	*Choerodon cyanodus*	1,563	5	0	N/A
	Brownspotted Wrasse	*Notolabrus parilus*	4,431	3	8	Neg
	Foxfish	*Bodianus frenchii*	1,777	2	395	< 0.5
	Western King Wrasse	*Coris auricularis*	6,317	3	63	Neg
	Wrasses	Labridae - undifferentiated	2,860	N/A	391	N/A
Latidae	Barramundi	*Lates calcarifer*	1,425	6	700	3
Lethrinidae	Bluespotted Emperor	*Lethrinus punctulatus*	id	id	842	< 0.5
	Emperors	Lethrinidae - undifferentiated	id	id	159	< 0.5
	Grass Emperor	*Lethrinus laticaudis*	9,659	12	3,794	5
	Longnose Emperor	*Lethrinus olivaceus*	id	id	968	N/A
	Redthroat Emperor	*Lethrinus miniatus*	5,412	6	4,585	5
	Robinson's Seabream	*Gymnocranius grandoculis*	id	id	722	2
	Spangled Emperor	*Lethrinus nebulosus*	8,310	20	3,641	9
Lutjanidae	Chinamanfish	*Symphorus nematophorus*	id	id	379	2
	Crimson Snapper	*Lutjanus erythropterus*	1,065	2	968	2
	Goldband Snapper	*Pristipomoides multidens*	3,716	15	2,205	9
	Golden Snapper	*Lutjanus johnii*	2,133	3	3,314	5
	Mangrove Jack	*Lutjanus argentimaculatus*	2,336	2	1,324	1

Category Family	Common Name	Scientific Name	Est Kept Catch (number)	Est Kept Catch (tonnes)	Charter Kept Catch (number)	Charter Est Kept Catch (tonnes)
	Moses' Snapper	*Lutjanus russellii*	id	id	296	N/A
	Red Emperor	*Lutjanus sebae*	5,831	21	2,304	8
	Rosy Snapper	*Pristipomoides filamentosus*	id	id	1,210	2
	Ruby Snapper	*Etelis carbunculus*	id	id	24	< 0.5
	Saddletail Snapper	*Lutjanus malabaricus*	id	id	1,491	3
	Sharptooth Snapper	*Pristipomoides typus*	id	id	672	1
	Stripey Snapper	*Lutjanus carponotatus*	4,965	4	1,284	1
Mullidae	Goatfishes	Mullidae - undifferentiated	id	id	177	N/A
Nemipteridae	Threadfin Breams	Nemipteridae - undifferentiated	id	id	8	N/A
	Western Butterfish	*Pentapodus vitta*	6,660	3	0	N/A
Platycephalidae	Flatheads	Platycephalidae - undifferentiated	6,333	N/A	166	N/A
Polynemidae	Threadfin Salmons	Polynemidae - undifferentiated	3,562	13	869	N/A
Pomatomidae	Tailor	*Pomatomus saltatrix*	8,215	6	16	Neg
Rachycentridae	Cobia	*Rachycentron canadum*	1,644	11	500	3
Scaridae	Parrotfishes	Scaridae - undifferentiated	id	id	7	N/A
Sciaenidae	Black Jewfish	*Protonibea diacanthus*	id	id	62	< 0.5
	Mulloway	*Argyrosomus japonicas*	709	3	552	2
Scombridae	Bonitos	*Sarda australis & Cybiosarda elegans*	id	id	17	N/A
	Longtail Tuna	*Thunnus tonggol*	id	id	128	< 1
	Mackerel Tuna	*Euthynnus affinis*	583	3	59	< 0.5
	Mackerels	Scombridae - undifferentiated	1,749	N/A	289	N/A
	School Mackerel	*Scomberomorus queenslandicus*	1,853	4	163	< 0.5
	Shark Mackerel	*Grammatorcynus bicarinatus*	470	4	24	< 0.5
	Southern Bluefin Tuna	*Thunnus maccoyii*	2,009	9	65	< 0.5
	Spanish Mackerel	*Scomberomorus commerson*	4,788	44	1,614	15
	Spotted Mackerel	*Scomberomorus munroi*	id	id	100	< 0.5
	Yellowfin Tuna	*Thunnus albacares*	442	4	162	2
Scorpididae	Sea Sweep	*Scorpis aequipinnis*	2,069	3	484	< 1
	Sweep	Scorpididae - undifferentiated	803	< 1	74	N/A
Serranidae	Breaksea Cod	*Epinephelides armatus*	16,963	22	3,236	4
	Chinaman Rockcod	*Epinephelus rivulatus*	6,092	4	647	< 0.5

Category Family	Common Name	Scientific Name	Est Kept Catch (number)	Est Kept Catch (tonnes)	Charter Kept Catch (number)	Charter Est Kept Catch (tonnes)
	Coral Trout	*Plectropomus maculatus & P leopardus*	4,827	13	2,063	6
	Goldspotted Rockcod	*Epinephelus coioides*	2,697	13	323	2
	Harlequin Fish	*Othos dentex*	2,246	5	126	< 0.5
	Rankin Cod	*Epinephelus multinotatus*	4,479	18	3,351	13
Sillaginidae	King George Whiting	*Sillaginodes punctata*	35,820	25	342	< 0.5
	School Whiting	*Sillago bassensis, vittata and schomburgkii*	173,989	22	0	N/A
	Whitings	Sillaginidae - undifferentiated	752	N/A	512	Neg
Sparidae	Black Bream	*Acanthopagrus butcheri*	15,979	9	id	id
	Breams	Sparidae - undifferentiated	152	N/A	311	N/A
	Pink Snapper	*Chrysophrys auratus*	28,030	67	10,715	26
	Tarwhine	*Rhabdosargus sarba*	1,624	1	35	Neg
	Western Yellowfin Bream	*Acanthopagrus morrisoni*	id	id	4	Neg
Sphyraenidae	Pikes	Sphyraenidae - undifferentiated	1,117	N/A	5	N/A
	Snook	*Sphyraena novaehollandiae*	1,820	2	17	Neg
SHARKS & RAYS						
Carcharhinidae, Hemigaleidae	Whaler & Weasel Sharks	Carcharhinidae, Hemigaleidae - undifferentiated	900	N/A	164	N/A
	Sharks	Sharks - undifferentiated	1,278	N/A	94	N/A
INVERTEBRATES						
CRABS						
Portunidae	Blue Swimmer Crab	*Portunus armatus*	197,050	46	0	N/A
	Mud Crab	*Scylla spp.*	4,876	4	1,278	N/A
LOBSTERS						
Palinuridae	Tropical Rock Lobster	*Panulirus spp. except P. cygnus*	Id	Id	20	N/A
	Western Rock Lobster	*Panulirus cygnus*	250,337	156	2,912	2
MOLLUSCS						
Cephalopoda	Squid	Order Teuthoidea - undifferentiated	62,173	N/A	122	N/A

Category Family	Common Name	Scientific Name	Est Kept Catch (number)	Est Kept Catch (tonnes)	Charter Kept Catch (number)	Charter Est Kept Catch (tonnes)
Octopodidae	Octopuses	Octopodidae - undifferentiated	1,159	N/A	id	id
Sepiidae	Cuttlefish	*Sepia spp.*	1,963	N/A	20	N/A

Kept catch (number): refers to the estimated number of retained fish in the state-wide survey of boat-based recreational fishing (Ryan *et al,* 2017), 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 for the state-wide survey, or <3 licensees for the Tour Operator Returns.

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.

Table of growout production for the Western Australian aquaculture industry in 2015/16

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	422	Tonnes	$11.14	$4,697,015
Marron	190	51	Tonnes	$31.64	$1,608,565
Mussels	3	198	Tonnes	$4.02	$796,325
Yabbies	8	11	Tonnes	$28.57	$326,731
Silver Perch	10	25	Tonnes	$21.35	$525,136
Goldfish & Koi carp	4	83,383	No.	n/a	$188,928
Ornamental Invertebrates	10	11,177	No.	n/a	$112,127
Ornamental Fish	6	17,441	No.	n/a	$80,581
Rainbow Trout	5	8	Tonnes	$8.74	$73,918
Other Species**	< 3	87	Tonnes	n/a	$2,435,798
Algae	< 3	**			**
Total (not including algae or pearls)					$10,845,124

* Tonnes refer to whole weight.

** Industry figures have not been included to protect the confidentiality of individual producers, as there are less than three productive licensees.

Table of reported bycatch of protected and listed species from commercial fisheries for 2016

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 2016[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 that are listed 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.

Class	Common Name	Scientific Name	Release Condition		
			ALIVE (number)	DEAD (number)	UNKNOWN (number)
Birds	Shearwater (unspecified)		374	48	-
Fishes	Devilray (unspecified)	Family Mobulidae	6	-	-
	Sawfish (unspecified)	Family Pristidae	19	1	24
	Green Sawfish	*Pristis zijsron*	41	10	-
	Narrow Sawfish	*Anoxypristis cuspidata*	10	2	-
	White Shark	*Carcharodon carcharias*	13	2	-
	Grey Nurse Shark	*Carcharias taurus*	13	11	-
	Seahorses, Seadragons & Pipefish	Family Syngnathidae	287	43	16
Reptiles	Crocodile (unspecified)	*Crocodylus* spp.	18	1	-
	Freshwater Crocodile	*Crocodylus johnstoni*	3	1	-
	Sea Snake (unspecified)	Family Hydrophiidae or Laticaudidae	6,180	888	11
	Turtle (unspecified)		8	2	65
	Green Turtle	*Chelonia mydas*	6	1	17
	Loggerhead Turtle	*Caretta caretta*	-	-	14
Mammals	Dolphin (unspecified)	Family Delphinidae	3	28	1
	Australian humpbacked dolphin	*Sousa sahulensis*	-	2	-
	Total all species		6,981	1,040	148

1. Reports by other sources (eg. members of public and Government officials) 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 ancillary interaction records are reported in Annual Reports to Parliament and elsewhere, they are inconsistent with the more-detailed information from statutory fishing records and are therefore not included here.
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 or as Threatened species under EPBC, these include: listed migratory and marine 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.

Table of Fish Prices for 2015/16

This table contains the average price per kilogram paid for each marine species caught in Western Australia in 2015/16. The prices are based on prices reported by WA land based processors; the average prices reported are weighted and are based on whole weight. Where prices aren't available for a financial year a default price, based on the average of prices reported in previous years, is used. The prices have been adjusted to reflect the beach price paid. That is, the 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.

Category Family	Common Name	Scientific Name	Price per Kilogram
FISH			
SCALEFISH			
Acanthuridae, Zanclidae	Surgeonfishes & Moorish Idols	*Acanthuridae, Zanclidae - undifferentiated*	$4.49
Acropomatidae, Percichthyidae, Serranidae, Polyprionidae, Moronidae, Callanthiidae, Centrogeniidae, Ostracoberycidae	Temperate Basses & Rockcods	*Percichthyidae, Serranidae - undifferentiated*	$6.81
Apistidae, Neosebastidae, Pteroidae, Scorpaenidae, Sebastidae, Setarchidae, Synanceiidae, Tetrarogidae	Scorpionfishes	*Apistidae, Neosebastidae, Pteroidae, Scorpaenidae, Sebastidae, Setarchidae, Synanceiidae & Tetrarogidae - undifferentiated*	$10.32
Ariidae	Forktail Catfishes	*Ariidae - undifferentiated*	$2.35
	Silver Cobbler	*Neoarius midgleyi*	$4.46
Arripidae	Australian Herring	*Arripis georgianus*	$2.44
	Western Australian Salmon	*Arripis truttaceus*	$0.91
Balistidae, Monacanthidae	Triggerfishes & Leatherjackets	*Balistidae, Monacanthidae - undifferentiated*	$3.94
Belonidae	Longtoms	*Belonidae - undifferentiated*	$4.49
Berycidae	Bight Redfish	*Centroberyx gerrardi*	$6.20
	Redfishes	*Berycidae - undifferentiated*	$7.55
	Swallowtail	*Centroberyx lineatus*	$3.40
	Yelloweye Redfish	*Centroberyx australis*	$4.25
Caesiondae, Lutjanidae, Symphysanodontidae	Fusiliers, Tropical Snappers & Slopefishes	*Caesionidae, Lutjanidae, Symphysanodontidae - undifferentiated*	$3.80
Carangidae	Amberjack	*Seriola dumerili*	$1.82
	Black Pomfret	*Parastromateus niger*	$8.79
	Bludger Trevally	*Carangoides gymnostethus*	$3.37
	Common Dart	*Trachinotus botla*	$4.49
	Giant Queenfish	*Scomberoides commersonnianus*	$8.07
	Golden Trevally	*Gnathanodon speciosus*	$2.79
	Samsonfish	*Seriola hippos*	$2.82
	Silver Trevallies	*Pseudocaranx georgianus, Pseudocaranx sp. "dentex" & Pseudocaranx wrighti*	$2.78
	Trevallies	*Carangidae - undifferentiated*	$3.37

Category Family	Common Name	Scientific Name	Price per Kilogram
	Turrum	*Carangoides fulvoguttatus*	$1.49
	Yellowtail Kingfish	*Seriola lalandi*	$3.96
	Yellowtail Scad	*Trachurus novaezelandiae*	$0.71
Centrolophidae	Blue-Eye Trevalla	*Hyperoglyphe antarctica*	$7.73
Cheilodactylidae	Blue Morwong	*Nemadactylus valenciennesi*	$3.82
	Morwongs	*Cheilodactylidae - undifferentiated*	$1.02
Clupeidae	Australian Sardine	*Sardinops sagax*	$0.93
	Blue Sprat	*Spratelloides robustus*	$5.95
	Perth Herring	*Nematalosa vlaminghi*	$2.98
	Sandy Sprat	*Hyperlophus vittatus*	$2.76
	Scaly Mackerel	*Sardinella lemuru*	$1.05
Coryphaenidae	Mahi Mahi	*Coryphaena hippurus*	$4.64
Elopidae	Hawaiian Giant Herring	*Elops hawaiensis*	$4.49
Engraulidae	Australian Anchovy	*Engraulis australis*	$0.54
Fishes (multi-family groups)	Flounders	*Bothidae, Psettodidae & Pleuronectidae*	$13.43
Gempylidae	Gemfish	*Rexea solandri*	$3.30
Gerreidae	Common Silverbiddy	*Gerres subfasciatus*	$4.49
Glaucosomatidae	Northern Pearl Perch	*Glaucosoma buergeri*	$6.82
	West Australian Dhufish	*Glaucosoma hebraicum*	$14.84
Haemulidae	Grunter Breams	*Haemulidae - undifferentiated*	$4.88
	Javelinfishes	*Pomadasys spp.*	$4.13
	Painted Sweetlips	*Diagramma labiosum*	$4.88
Hemiramphidae	Southern Garfish	*Hyporhamphus melanochir*	$7.85
Labridae	Baldchin Groper	*Choerodon rubescens*	$12.20
	Pigfishes	*Bodianus spp.*	$6.82
	Tuskfishes	*Choerodon spp.*	$7.10
	Western Blue Groper	*Achoerodus gouldii*	$4.84
	Wrasses	*Labridae - undifferentiated*	$5.52
Latidae	Barramundi	*Lates calcarifer*	$8.64
Lethrinidae	Bluespotted Emperor	*Lethrinus punctulatus*	$4.16
	Drab Emperor	*Lethrinus ravus*	$4.49
	Emperors	*Lethrinidae - undifferentiated*	$4.49
	Grass Emperor	*Lethrinus laticaudis*	$6.66
	Longnose Emperor	*Lethrinus olivaceus*	$5.73
	Mozambique Seabream	*Wattsia mossambica*	$6.38
	Redspot Emperor	*Lethrinus lentjan*	$4.93
	Redthroat Emperor	*Lethrinus miniatus*	$7.34
	Robinson's Seabream	*Gymnocranius grandoculis*	$4.15
	Seabreams	*Gymnocranius spp.*	$4.49
	Spangled Emperor	*Lethrinus nebulosus*	$5.73
	Spotcheek Emperor	*Lethrinus rubrioperculatus*	$4.49
	Yellowtail Emperor	*Lethrinus atkinsoni*	$4.42
Lobotidae	Tripletail	*Lobotes surinamensis*	$4.49
Lutjanidae	Brownstripe Snapper	*Lutjanus vitta*	$3.67
	Chinamanfish	*Symphorus nematophorus*	$5.68

Category Family	Common Name	Scientific Name	Price per Kilogram
	Crimson Snapper	*Lutjanus erythropterus*	$5.19
	Darktail Snapper	*Lutjanus lemniscatus*	$5.42
	Fiveline Snapper	*Lutjanus quinquelineatus*	$3.67
	Goldband Snapper	*Pristipomoides multidens*	$8.92
	Golden Snapper	*Lutjanus johnii*	$6.66
	Indonesian Snapper	*Lutjanus bitaeniatus*	$3.80
	King Snappers	*Pristipomoides spp.*	$8.50
	Mangrove Jack	*Lutjanus argentimaculatus*	$5.49
	Maori Snapper	*Lutjanus rivulatus*	$4.49
	Moses' Snapper	*Lutjanus russellii*	$5.69
	Red Emperor	*Lutjanus sebae*	$11.02
	Rosy Snapper	*Pristipomoides filamentosus*	$8.57
	Ruby Snapper	*Etelis carbunculus*	$6.66
	Saddletail Snapper	*Lutjanus malabaricus*	$5.33
	Sharptooth Snapper	*Pristipomoides typus*	$8.51
	Stripey Snapper	*Lutjanus carponotatus*	$3.67
	Tang's Snapper	*Lipocheilus carnolabrum*	$6.07
	Tropical Snappers	*Lutjanus spp.*	$3.67
Mugilidae	Bluetail Mullet	*Valamugil buchanani*	$4.49
	Mullets	*Mugilidae - undifferentiated*	$4.69
	Sea Mullet	*Mugil cephalus*	$2.14
	Yelloweye Mullet	*Aldrichetta forsteri*	$1.58
Mullidae	Goatfishes	*Mullidae - undifferentiated*	$3.34
Nemipteridae	Rainbow Monocle Bream	*Scolopsis monogramma*	$2.09
	Rosy Threadfin Bream	*Nemipterus furcosus*	$4.04
	Threadfin Breams	*Nemipteridae - undifferentiated*	$4.04
Neosebastidae	Bighead Gurnard Perch	*Neosebastes pandus*	$4.62
Ophidiidae	Pink Ling	*Genypterus blacodes*	$4.49
Oplegnathidae	Knifejaw	*Oplegnathus woodwardi*	$1.91
Pentacerotidae	Boarfishes	*Pentacerotidae - undifferentiated*	$4.05
Platycephalidae	Flatheads	*Platycephalidae - undifferentiated*	$5.84
	Rock Flathead	*Platycephalus laevigatus*	$8.66
Plotosidae	Estuary Cobbler	*Cnidoglanis macrocephalus*	$3.99
Polynemidae	Blue Threadfin	*Eleutheronema tetradactylum*	$5.51
	King Threadfin	*Polydactylus macrochir*	$5.51
	Threadfin Salmons	*Polynemidae - undifferentiated*	$5.51
Polyprionidae	Bass Groper	*Polyprion americanus*	$8.51
	Hapuku	*Polyprion oxygeneios*	$7.37
Pomatomidae	Tailor	*Pomatomus saltatrix*	$3.99
Pricanthidae	Bigeyes	*Priacanthidae - undifferentiated*	$1.79
Psettodidae	Australian Halibut	*Psettodes erumei*	$5.65
Rachycentridae	Cobia	*Rachycentron canadum*	$3.71
Salmonidae	Trout	*Oncorhynchus mykiss & Salmo trutta*	$4.49
Scaridae	Parrotfishes	*Scaridae - undifferentiated*	$6.16
Scatophagidae	Striped Scat	*Selenotoca multifasciata*	$4.49
Sciaenidae	Black Jewfish	*Protonibea diacanthus*	$5.50

Category Family	Common Name	Scientific Name	Price per Kilogram
	Mulloway	*Argyrosomus japonicas*	$4.67
Scombridae	Australian Bonito	*Sarda australia*	$7.55
	Bigeye Tuna	*Thunnus obesus*	$10.89
	Blue Mackerel	*Scomber australasicus*	$8.50
	Grey Mackerel	*Scomberomorus semifasciatus*	$7.68
	Longtail Tuna	*Thunnus tonggol*	$2.69
	Mackerels	*Scombridae spp. (tribes Scomberomorini & Scombrini)*	$2.55
	Shark Mackerel	*Grammatorcynus bicarinatus*	$2.19
	Skipjack Tuna	*Katsuwonus pelamis*	$5.95
	Spanish Mackerel	*Scomberomorus commerson*	$8.08
	Spotted Mackerel	*Scomberomorus munroi*	$4.25
	Tunas	*Scombridae spp. (tribes Sardini & Thunnini)*	$2.97
	Wahoo	*Acanthocybium solandri*	$4.19
	Yellowfin Tuna	*Thunnus albacares*	$10.11
Scorpididae	Banded Sweep	*Scorpis georgiana*	$0.96
	Sea Sweep	*Scorpis aequipinnis*	$2.69
Serranidae	Banded Grouper	*Epinephelus amblycephalus*	$6.81
	Barcheek Coral Trout	*Plectropomus maculatus*	$15.28
	Birdwire Rockcod	*Epinephelus merra*	$6.81
	Blackspotted Rockcod	*Epinephelus malabaricus*	$7.11
	Breaksea Cod	*Epinephelides armatus*	$8.64
	Chinaman Rockcod	*Epinephelus rivulatus*	$5.58
	Common Coral Trout	*Plectropomus leopardus*	$15.28
	Coral Rockcod	*Cephalopholis miniata*	$6.81
	Coral Trout	*Plectropomus spp. & Variola spp.*	$15.28
	Duskytail Grouper	*Epinephelus bleekeri*	$6.90
	Eightbar Grouper	*Hyporthodus octofasciatus*	$8.34
	Flowery Rockcod	*Epinephelus fuscoguttatus*	$5.90
	Goldspotted Rockcod	*Epinephelus coioides*	$6.77
	Harlequin Fish	*Othos dentex*	$4.49
	Radiant Rockcod	*Epinephelus radiatus*	$7.27
	Radiant Rockcod/Comet Grouper	*Epinephelus Radiatus/Morrhua*	$7.27
	Rankin Cod	*Epinephelus multinotatus*	$8.18
	Spotted Cod	*Epinephelus Microdon/Areolatus/Bilobatus*	$5.90
	Striped Grouper	*Epinephelus latifasciatus*	$6.81
	Tomato Rockcod	*Cephalopholis sonnerati*	$7.00
	Yellowedge Coronation Trout	*Variola louti*	$6.81
	Yellowspotted Rockcod	*Epinephelus areolatus*	$5.90
Siganidae	Goldlined Rabbitfish	*Siganus lineatus*	$4.49
	Rabbitfish	*Siganus spp.*	$4.49
Sillaginidae	Goldenline Whiting	*Sillago analis*	$4.49
	King George Whiting	*Sillaginodes punctata*	$13.41
	Whitings	*Sillaginidae - undifferentiated*	$6.94

Category Family	Common Name	Scientific Name	Price per Kilogram
	Yellowfin Whiting	*Sillago schomburgkii*	$4.10
Sparidae	Black Bream	*Acanthopagrus butcheri*	$7.38
	Breams	*Sparidae - undifferentiated*	$4.49
	Frypan Bream	*Argyrops spinifer*	$5.16
	Pink Snapper	*Chrysophrys auratus*	$7.99
	Tarwhine	*Rhabdosargus sarba*	$4.79
	Western Yellowfin Bream	*Acanthopagrus morrisoni*	$4.47
	Yellowback Bream	*Dentex spariformis*	$6.80
Sphyraenidae	Pikes	*Sphyraenidae - undifferentiated*	$1.78
	Snook	*Sphyraena novaehollandiae*	$2.62
Terapontidae	Striped Grunters	*Terapontidae - undifferentiated*	$1.77
	Yellowtail Grunter	*Amniataba caudavittata*	$4.49
Zeidae	John Dory	*Zeus faber*	$8.24
SHARKS & RAYS			
Carcharhinidae	Bronze Whaler	*Carcharhinus brachyurus*	$2.36
	Dusky Whaler	*Carcharhinus obscurus*	$4.20
	Sandbar Shark	*Carcharhinus plumbeus*	$3.58
	Spinner Shark	*Carcharhinus brevipinna*	$1.09
	Tiger Shark	*Galeocerdo cuvier*	$0.65
Hexanchidae	Sevengill Sharks	*Heptranchias spp.*	$1.71
Lamnidae	Shortfin Mako	*Isurus oxyrinchus*	$0.52
Orectolobidae	Wobbegong	*Orectolobidae - undifferentiated*	$1.51
Pristiophoridae	Common Sawshark	*Pristiophorus cirratus*	$0.64
Rajidae	Skates	*Rajidae, Arhynchobatidae - undifferentiated*	$1.39
Rhinobatidae	Guitarfishes	*Rhinobatidae - undifferentiated*	$0.38
Sphyrnidae	Hammerhead Sharks	*Sphyrnidae - undifferentiated*	$0.99
Triakidae	Gummy Shark	*Mustelus antarcticus*	$4.49
	Pencil Shark	*Hypogaleus hyugaensis*	$1.33
	School Shark	*Galeorhinus galeus*	$4.49
	Whiskery Shark	*Furgaleus macki*	$3.84
	Shark Fins		$11.64
	Other Sharks	*Sharks - undifferentiated*	$1.71
OTHER FISH			
	Other Fish		$4.49
INVERTEBRATES			
CRABS			
Geryonidae	Crystal Crab	*Chaceon bicolor*	$31.05
Hypothalassiidae	Champagne Crab	*Hypothalassia spp.*	$8.50
Menippidae	Giant Crab	*Pseudocarcinus gigas*	$51.81
Portunidae	Blue Swimmer Crab	*Portunus armatus*	$5.41
	Brown Mud Crab	*Scylla olivacea*	$36.43

Category Family	Common Name	Scientific Name	Price per Kilogram
	Green Mud Crab	*Scylla serrata*	$36.43
LOBSTERS			
Palinuridae	Southern Rock Lobster	*Jasus edwardsii*	$60.00
	Western Rock Lobster	*Panulirus cygnus*	$69.06
Scyllaridae	Bug	*Ibacus & Thenus spp.*	$14.28
MOLLUSCS			
Cephalopoda	Squid	*Order Teuthoidea - undifferentiated*	$14.18
Haliotidae	Brownlip Abalone	*Haliotis rubra conicopora*	$36.68
	Greenlip Abalone	*Haliotis laevigata*	$43.81
	Roe's Abalone	*Haliotis roei*	$23.81
Octopodidae	Octopuses	*Octopodidae - undifferentiated*	$8.29
Sepiidae	Cuttlefish	*Sepia spp.*	$4.57
Veneridae	Ballot's Saucer Scallop	*Amusium balloti*	$7.77
PRAWNS			
Penaeidae	Banana Prawn	*Penaeus merguiensis*	$12.69
	Black Tiger Prawn	*Penaeus monodon*	$18.00
	Blue Endeavour Prawn	*Metapenaeus endeavouri*	$9.52
	Brown Tiger Prawn	*Penaeus esculentus*	$15.91
	Velvet Prawn	*Metapenaeopsis spp.*	$4.41
	Western King Prawn	*Melicertus latisulcatus*	$13.55
Stomatopoda	Mantis Shrimps	*Order Stomatopoda - undifferentiated*	$6.00
SEA CUCUMBERS			
Holothuriidae	Sandfish (Sea Cucumber)	*Holothuria scabra*	$5.00

APPENDIX 3
INDIAN OCEAN TERRITORIES RESOURCE STATUS REPORT 2017

S. Newman, L. Bellchambers, C. Skepper, S. Evans and P. Kalinowski

OVERVIEW

In November 2002, the territorial seas (out to 12 nautical miles) of the Cocos (Keeling) Islands and Christmas Island were declared as 'excepted waters' from the *Fisheries Management Act 1991*. Management responsibilities were transferred from the Australian Fisheries Management Authority to the Commonwealth Government, and the Government of Western Australia has now taken on management responsibilities for the marine territorial waters of the Indian Ocean Territories (IOT) on behalf of the Commonwealth Department of Infrastructure and Regional Development. The location of the Indian Ocean Territories and their proximity to the Western Australian coast are illustrated in Indian Ocean Territories Figure 1.

Under a Service Delivery Agreement with the Department of Infrastructure and Regional Development, the Western Australian Department of Primary Industries and Regional Development, Fisheries Division (Fisheries) manages commercial, recreational and aquaculture activities at Cocos (Keeling) Islands and Christmas Island, and also provides fish health diagnostic, biosecurity, fish pathology and licensing services. The Commonwealth Minister for the Department of Infrastructure and Regional Development holds responsibility for these excepted waters under the *Fish Resources Management Act 1994 (WA) (CI/CKI)* (the 'Applied Acts').

The commercial Christmas Island Line Fishery (CILF) primarily targets pelagic species, mainly wahoo (*Acanthocybium solandri*) and yellowfin tuna (*Thunnus albacares*). In addition, demersal fishing activities are also undertaken targeting deepwater demersal fish, mainly the deepwater snappers.

The Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) primarily targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge joculator*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*).

Recreational and artisanal fishing are undertaken around the Cocos (Keeling) and Christmas Islands targeting both finfish and invertebrate species. The Cocos (Keeling) Islands consist of a diverse range of aquatic environments that include a sheltered lagoon, fringing reefs and offshore 'blue water'. These environments support a range of demersal and pelagic finfish species, as well as various crustaceans (e.g. lobsters, crabs) and molluscs (e.g. gong gong, clams) that are highly sought after by fishers for both individual and community purposes. Christmas Island has no lagoon and a limited range of environments available for fishing; these are the fringing reef surrounding the island and offshore 'blue water', both of which primarily support pelagic fish species, a limited range of demersal finfish species and some invertebrates (e.g. lobster, clams).

SUMMARY FEATURES 2017

Fishery Performance	Commercial	Recreational
Total Catch 2016	4.6 t	NA
Fishing Level	Not Assessed	NA
Stock/Resource Performance	**Stock Status**	**Assessment Indicators**
IOT Finfish	Some species at risk	Annual: CILF Catch, CKIMAFF Catch Periodic: Independent surveys
IOT Invertebrate	Some species at risk	Periodic: Independent surveys

EBFM Performance Asset	Level	Asset	Level
Bycatch	Negligible Risk	Listed Species	Negligible Risk
Habitat	Negligible Risk	Ecosystem	Not assessed
Social	Low Risk	Economic	Not assessed
Governance	Stable	External Drivers	Negligible Risk

CATCH AND LANDINGS

Pelagic species dominate the catch of the CILF, comprising 97% of the total reported catch in 2016. Wahoo (*Acanthocybium solandri*) is the main target species of the CILF, comprising 88% of the total reported catch in 2016. Other pelagic species are also targeted during the trolling operations and primarily include yellowfin tuna (*Thunnus albacares*) and other tunas (except southern bluefin tuna *(Thunnus maccoyii),* which may not be taken), and to a lesser extent mahi mahi (*Coryphaena* spp.). Some commercial fishing activities are also undertaken for demersal fish species, mainly deep slope species such as ruby snapper (*Etelis* spp.) and these species comprised ~3% of the total reported catch in 2016. The commercial catch for Christmas Island usually consists of catch data from only two vessels and the exact catch data in many years is not reportable due to confidentiality provisions. The total reported catch for this fishery has been less than 10 tonnes per annum over the last ten years.

There is no commercial line fishery at the Cocos (Keeling) Islands.

The CKIMAFF targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge joculator*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*). As there is only one license in the CKIMAFF the catch data is not reportable due to confidentiality provisions.

Recreational and artisanal fishing vessels operate around the Cocos (Keeling) Islands and Christmas Island. The amount and magnitude of the recreational fishing catch and effort at these islands has not been assessed.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

IOT Finfish & IOT Invertebrate (Some species at risk)

Finfish:

Data on the abundance of finfish species is being collected and collated to determine changes over time.

The pelagic species that are targeted by the CILF (e.g. wahoo, yellowfin tuna) are likely to be part of a wider Indian Ocean stock. However, the demersal species are likely to be localised stocks that are reliant upon self-recruitment.

There is anecdotal evidence of localised depletion of some deep slope species like rosy snapper (*Pristipomoides filamentosus*) and ruby snapper (*Etelis carbunculus*) around Christmas Island. Recreational fishers use electric-powered lines to target deep-slope demersal finfish species at the Indian Ocean Territories, thereby increasing the fishing efficiency for these species.

The primary target of the CKIMAFF is *Centropyge joculator* which is endemic to the Cocos (Keeling) Islands and Christmas Island, inhabiting fringing reefs between 15 and 70 m. The biology of *C. joculator* has not been examined, although Allen *et al*. (2007) describe this species as being abundant on Christmas Island.

Invertebrates:

Holuthurians: The holothurian community is strongly influenced by habitat and although some species are wide-ranging and found in relatively high densities, they tend to be of low economic value. In contrast, species of moderate to high economic value were recorded at densities too low to support commercial fisheries and typically had very restricted distributions. The holothurian community found at the Cocos (Keeling) Islands is near to pristine due to a lack of historical fishing pressure. Holothurian stocks are sensitive to fishing exploitation and have been overexploited in other areas of the Indian and Pacific Oceans.

Gong Gong: The common spider conch or gong gong (*Lambis lambis*) is a recreationally-targeted gastropod inhabiting shallow waters of the lagoon of Cocos (Keeling) Islands. This species is vulnerable to over-fishing as it is highly accessible and presumably shares biological traits with other exploited conch species, including slow growth and late maturity. Monitoring data indicates that the current abundance of gong gong is lower than historically recorded. While heavy fishing pressure has presumably contributed to the reduction in gong gong numbers, further monitoring is required to determine the role of recruitment variability in maintaining gong gong populations at the Cocos (Keeling) Islands and changes in the lagoon system.

Giant Clams: Three species of giant clams (*Tridacna gigas*, *Tridacna derasa* and *Tridacna maxima*) have historically been reported at the Cocos (Keeling) Islands. Monitoring data indicates that currently only *T. maxima* occurs in sufficient numbers to be assessed. This data also shows a decline in relative stock abundance of *T. maxima* before they reach a size of sexual maturity. Heavy fishing pressure is presumed to contribute to this reduction, with further monitoring required to monitor sustainability of these stocks.

Reef Health: On-going reef monitoring has been established to monitor natural and anthropogenic impacts on the reef and lagoon communities at Cocos (Keeling) Islands and Christmas Island.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Fishing in the CILF for pelagic species such as wahoo uses specialised trolling gear to target the fish and involves limited discarding. Species occasionally caught but generally discarded include billfish, barracuda, shark and trevally. A high proportion of the

above species are expected to survive capture and release by the fishery. Consequently, it is considered likely that the pelagic fishery has a **negligible** impact on stocks of discarded species.

Fishing for demersal species in the CILF particularly those in the deep slope waters involves limited discarding as most species are retained for processing. However, catches can be lost to sharks (depredation).

The line fishing methods used in CILF are not known to interact with any listed species. However, there is some potential for low levels of seabird bycatch at Christmas Island.

The fishing techniques used to capture fish in the CKIMAFF involves using hand or scoop nets, or a small seine net of specific dimensions (the seine net cannot exceed 16 metres in length, must have a mesh of less than or equal to 28mm and a drop of not more than 3 metres) and fishers may use SCUBA equipment. Thus, the CKIMAFF has **negligible** bycatch due to the highly selective nature of fishing activities.

No listed species interactions have been reported for the CKIMAFF.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat impacts are considered **negligible**. The line fishing methods used in the CILF and the hand collection method used in the CKIMAFF are likely to have minimal impact on the habitat. Ecosystem impacts have not been assessed.

SOCIAL AND ECONOMIC OUTCOMES

Social

At least three people were employed in the CILF around Christmas Island during 2016. This estimate is based on the number of vessels reporting catches and the average number of crew on each boat.

At least two people were employed in the CKIMAFF around Cocos (Keeling) Islands during 2016.

Due to their sport fishing and eating qualities, wahoo and other pelagic species are popular target species for recreational anglers and fishing charter operators at the Indian Ocean Territories, particularly at Christmas Island. They are usually captured from small boats, although shore-based fishing is also undertaken.

A large variety of demersal and lagoon finfish and invertebrate species are caught by artisanal and recreational fishers at Cocos (Keeling) Islands involving the use of a large number of small vessels. Similarly, recreational fishers at Christmas Island undertake fishing activities from small vessels and also from the shore and catch a large variety of demersal finfish species, including a large number of deep slope species.

Economic

The value of the CILF is not known. The value of the CKIMAFF is also unknown, although *C. joculator* commands a high price on the international market (reported retail prices in excess of $1000.00 each in 2016).

GOVERNANCE SYSTEM

The potential recreational fishing effort for both pelagic and demersal fish species at both the Cocos (Keeling) Islands and at Christmas Island is high with a capacity to operate over the entire extent of the fishable area at each island group. Given the restricted amount of habitat and fishing area available it is expected that fishing pressure on some species at Cocos (Keeling) Islands or Christmas Island may be above sustainable levels.

The catch of the CKIMAFF has been small since its inception in 1993. There is little incentive for the single licensee to increase catch or effort since market viability and high prices are maintained by only having small numbers of fish available for sale. The current level of fishing activity has not been assessed.

Harvest Strategy

Recreational fishing rules and limitations have been developed using a constant catch strategy (maintaining but not increasing catches), although a formal harvest strategy is not currently in place for this resource.

Compliance

Operators in the CILF and CKIMAFF are required to complete statutory catch and effort returns on a monthly basis. The low risks to the sustainability of the stocks imposed by these fisheries results in a **low risk** and low level of compliance.

Consultation

Extensive community engagement and consultation has taken place to develop the first proposed set of dedicated recreational fishing arrangements for the IOTs. More recently community engagement has focussed on the development and agreement to the Cocos Malay Cultural Fishing Arrangements and commercial fishing policy and arrangements.

For the CILF and CKIMAFF consultation occurs directly with operators at Christmas Island and the Cocos (Keeling) Islands, with additional community consultation undertaken where applicable.

Direct community consultation is undertaken regularly at the Cocos (Keeling) Islands and Christmas Island in regard to fisheries science and resource assessment, recreational fishing rules and regulations.

Management Initiatives/Outlook Status

The key IOTs management initiative is the sustainable management of the aquatic resources at the IOTs for the benefit of the on-island communities.

Island-specific recreational fisheries management arrangements for the Indian Ocean Territories are currently being progressed and are expected to be legislated in 2018.

Cocos-Malay Cultural Fishing arrangements and a Commercial Fishing policy have also been finalised during 2016/17.

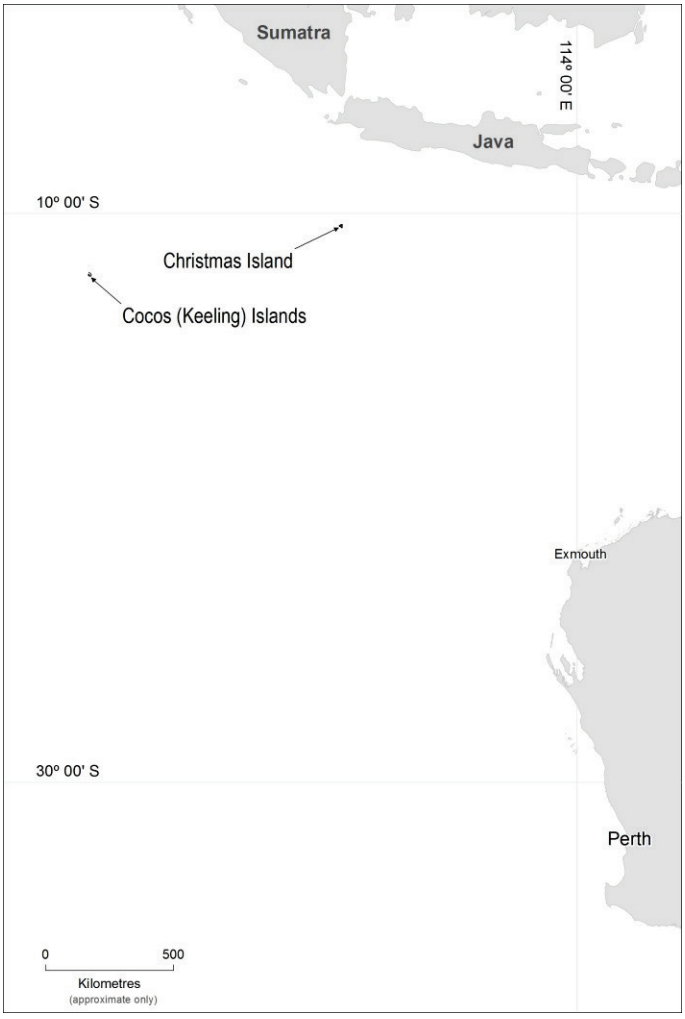
EXTERNAL DRIVERS

The demersal fish and invertebrate populations of Cocos (Keeling) Islands and Christmas Island are likely to consist of small, isolated populations that are expected to experience highly variable recruitment due to environmental fluctuations.

In February 2012, the MV Tycoon was grounded in Flying Fish cove on Christmas Island spilling phosphate and fuel oils into the Cove and surrounding areas.

In the summer of 2015/16 widespread thermal coral bleaching was recorded at Christmas Island. No coral bleaching was recorded at Cocos (Keeling) Islands over the same period. Monitoring is ongoing to assess the long-term impact of this event on the coral reef, finfish and invertebrate communities of Christmas Island.

Negligible risk.



INDIAN OCEAN TERRITORIES FIGURE 1

Location of the Cocos (Keeling) Islands and Christmas Island comprising the Indian Ocean Territories within the Indian Ocean, illustrating their proximity to the Western Australian coast.

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APPENDIX 4
Science and Resource Assessment staff adjunct positions and supervision of students

Staff Member	Position
Lynda Bellchambers	Adjunct Researcher, Faculty of Natural and Agricultural Sciences, University of Western Australia.
	PhD co-supervision, University of Western Australia, supervises Scott Evans - '' Understanding the relationships between fishery recruitment and essential benthic habitats within an ecosystem based fisheries management framework for prawn fisheries
Matias Braccini	PhD co-supervision, University of Mar del Plata, Argentina, supervises Marcelo Perez – 'Movement patterns of *Mustelus schmitti* in the coastal Bonaerense ecosystem based on the use of conventional mark recapture. Implications for management and sustainable exploitation'.
	PhD co-supervision, Murdoch University, supervises Brenton Pember -'A multi-disciplinary analysis of connectivity of the sandbar shark (*Carcharhinus plumbeus*) in the Indo-West Pacific'
	Adjunct Senior Lecturer, Murdoch University.
Cécile Dang	Adjunct Associate Professor, School of Veterinary and Life Sciences, Murdoch University.
	Adjunct Associate professor, School of Biological Sciences, UWA.
Simon de Lestang	Adjunct Research Fellow initially within the School of Biological Sciences, UWA
	PhD co- supervision, University of Western Australia, supervises Jean Dumas - 'Investigating sperm limitation in the Western Rock Lobster Fishery'.
	PhD co- supervision, University of Western Australia, supervises Emma Jade-Tuffley ' Determining variation in catchability of western rock lobsters (*Panulirus cygnus*)'.
	PhD co- supervision, University of Western Australia, supervises Michael Brooker - ' An investigation into unexpectedly low catch rates of *Panulirus cygnus* from an area of historical high catch rates'.
	Masters co- supervision, University of Western Australia, supervises Oscar Canon - Influence of environmental and spatial variables on population estimates and size structure of the western rock lobster *Panulirus cygnus* (George, 1962) within the centre of their biogeographic range in Western Australia'.
	Honours co- supervision, University of Western Australia, supervises Brock Keymer - Assessing gregariousness in juvenile western rock lobsters and its implications for stock assessment'.
	Honours co- supervision, University of Western Australia, supervises Dan Lindstedt - Will lobster wariness is a more sensitive indicator of fishing pressure than abundance, length or biomass?'.
David Fairclough	Adjunct Senior Lecturer. School of Veterinary and Life Sciences, Murdoch University.
	Adjunct Senior Lecturer. Department of Environment and Agriculture, Faculty of Science and Engineering. Curtin University.
	Honours co-supervision, Jake Daviot, Murdoch University, Has the composition and abundances of fishes changed in response to natural and human-induced events in Cockburn Sound?
	Masters co-supervision, Casper Avenant, Edith Cowan University, Dietary comparison of the tropical herbivore Siganus fuscescens and a range of temperate seagrass-associated omnivorous fishes

Staff Member	Position
Norman Hall	Emeritus Professor, Murdoch University.
Alastair Harry	Adjunct Research Associate, College of Science and Engineering, James Cook University.
Alex Hesp	PhD co-supervision, Murdoch University, Rachel Marks – "Key factors affecting the biology and population dynamics of the blue swimmer crab (*Portunus armatus*) in southwest Western Australia."
Danielle Johnston	PhD co-supervision, Murdoch University, Rachel Marks – "Key factors affecting the biology and population dynamics of the blue swimmer crab (*Portunus armatus*) in southwest Western Australia."
	Honours co-supervision, Murdoch University, Theodore Campbell – "Dietary composition of the Blue Swimmer Crab, *Portunus armatus*, and life history characteristics of related species."
Mervi Kangas	PhD co-supervision Murdoch University, supervises Inigo Koefoed – "The biology and life history of the endeavour prawn *Metapenaeus endeavouri*, and the influence of the environment on the life histories and stock dynamics of three species of Penaeid prawn in arid Western Australia.
Craig Lawrence	Adjunct Associate Professor, The University of Western Australia.
	Honours supervision, University of Western Australia. Jesse Wansbrough. The Reproduction and Early Development of the Western Pygmy Perch *Nannoperca vittata* Castelnau 1873 (Percichthyidae)
	MSc. supervision, University of Western Australia. Derik Aquary. An evaluation of three aquaponic techniques for growing lettuce (*Lactuca sativa*) using water from rainbow trout (*Oncorhynchus mykiss*) growth tanks
	MSc. supervision, University of Western Australia. Isobel Sewel. Insect meal as a dietary additive for rainbow trout.
Justin McDonald	Adjunct Professor – Murdoch University, Harry Butler Institute, School of Veterinary and Life Sciences.
	Adjunct Research Fellow – Curtin University, Department of Environment and Agriculture, Faculty of Science and Engineering.
	Adjunct Senior Lecturer – University of Western Australia, Faculty of Natural and Agricultural Sciences.
	Technical Advisor and committee member IMarEST Biofouling Expert Management Group.
	California State Lands Commission - Biofouling Technical Advisory Group member.
	Ministry for Primary Industries New Zealand - Biofouling Technical Advisory Group member.
	Associate Editor Management of Biological Invasions – International Journal.
Terry Miller	Adjunct Senior Lecturer, Centre for Sustainable Tropical Fisheries and Aquaculture, College of Marine and Environmental Sciences, James Cook University.
Brett Molony	Member of Marine and Freshwater Course Consultative Committee, Edith Cowan University.
Stephen Newman	Adjunct Associate Professor – Marine Ecology Group, School of Plant Biology, University of Western Australia.
	Adjunct Professor – Department of Environment and Agriculture, Fa.culty of Science and Engineering, Curtin University.
Karina Ryan	Adjunct Supervisor, Eric Aidoo "Spatial Modelling of Recreational Boat-Based Fishing in Western Australia". PhD, Edith Cowan University. Thesis Completed October 2016.
	Adjunct Supervisor, Eva Lai "Integrating multiple sources of data to construct a time series of recreational catch/effort for the West Coast Bioregion of Western Australia". PhD, Edith Cowan University.

Staff Member	Position
	Adjunct Supervisor, Alissa Tate “Assessing variability in standardised harvest rates from shore-based recreational fishing surveys”. Masters, Edith Cowan University.
	Adjunct Supervisor, Matthew Navarro “Evaluating the impacts of implementing marine protected areas on Western Australian marine recreators using integrated bio-economic modelling”. PhD, The University of Western Australia.
Lachlan Strain	Adjunct Research Fellow, Faculty of Science and Engineering, Department of Environment and Agriculture, Curtin University of Technology.
	PhD co-supervision, Curtin University of Technology, supervises Aisling Fontanini – ‘Impacts of marine climate change on two commercially and recreationally important Western Australian species: *Pagrus auratus* and *Haliotis roei*’.
Michael Travers	Adjunct Research Scientist, Australian Institute of Marine Science.
	Honours Co-supervision, University of Western Australia, supervises Elisabeth Myers. Day-night differences in temperate reef fish assemblages.
Corey Wakefield	Adjunct Senior Lecturer, Marine Ecology Group, School of Plant Biology, University of Western Australia.
	Honorary Research Fellow, Victoria University of Wellington, New Zealand.
	Adjunct Senior Lecturer, Curtin University of Technology.
	Masters co-supervision, Curtin University of Technology, supervises Claire Wellington – ‘Description and comparison of demersal fish ecology of the continental slope of Western Australia’.
	Masters co-supervision, Curtin University of Technology, supervises Dion Boddington – ‘Comparison of the life history characteristics, habitat partitioning and stock status of three groupers off the north-western coast of Australia’.
	Masters co-supervision, Victorian University of Wellington New Zealand, supervises Natalie Stewart – ‘The population structure of Polyprionidae from Australia and New Zealand’.
Brent Wise	Adjunct Associate Professor, School of Engineering, Faculty of Health, Engineering and Science, Edith Cowan University.

APPENDIX 5
GLOSSARY OF ACRONYMS

AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AIAWA	Abalone Industry Association of Western Australia
AIMS	Australian Institute of Marine Science
AIMWTMF	Abrolhos Islands and Mid West Trawl Managed Fishery
ALC	Automatic Location Communicator
ARMA	Aquatic Resources Management Act
ASL	Australian Sea Lion
BPMF	Broome Prawn Managed Fishery
BRD	Bycatch Reduction Device
BRUVS	Baited Remote Underwater Video System
CAES	Catch and Effort Statistics
CDR	Catch and disposal record
CI	Confidence Interval
CI/CKI	Christmas Island and Cocos (Keeling) Island
CILF	Christmas Island Line Fishery
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CKIMAFF	Cocos (Keeling) Islands Marine Aquarium Fish Fishery
CL	Confidence Limits
CPUE	Catch Per Unit Effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSLPMF	Cockburn Sound (Line and Pot) Managed Fishery
CW	Carapace Width
DBCA	Department of Biodiversity, Conservation and Attractions (formerly DPAW)
DFAC	Developing Fisheries Assessment Committee
DOTE	Department of the Environment (Commonwealth Government) (formerly Department of Sustainability, Environment, Water, Population and Communities)
DPAW	Department of Parks and Wildlife (formerly Department of Environment and Conservation)
EBFM	Ecosystem Based Fisheries Management
ECU	Edith Cowan University
EEZ	Exclusive Economic Zone
ENSO	El Niño/Southern Oscillation
EPBC	(Commonwealth Government) Environment Protection and Biodiversity Conservation (Act 1999)
ERLF	Esperance Rock Lobster Managed Fishery
ESD	Ecologically Sustainable Development
ETP	Endangered, Threatened and Protected
FAO	The Food and Agriculture Organisation of the United Nations
FED	Fish escapement device

FFS	Flesh-footed Shearwaters
FHPA	Fish Habitat Protection Area
FL	Fork Length
FMO	Fisheries and Marine Officer
FRDC	Fisheries Research and Development Corporation
FRMA	Fish Resources Management Act
FRR	Fisheries Research Report
GAB	Great Australian Bight
GCB	Gascoyne Coast Bioregion
GDSMF	Gascoyne Demersal Scalefish Managed Fishery
GVP	Gross Value of Product
HMAS	Her Majesty's Australian Ship
IBSS	Independent Breeding Stock Survey
IFM	Integrated Fisheries Management
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IMP	Introduced Marine Pests
IMS	Introduced Marine Species
ISO	International Organisation for Standardisation
ITQ	Individually Transferable Quota
IUCN	International Union for the Conservation of Nature
IVR	Integrated Voice Response
JANSF	Joint Authority Northern Shark Fishery
JASDGDLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery
KGBF	Kimberley Gillnet and Barramundi Managed Fishery
KPMF	Kimberley Prawn Managed Fishery
LASCF	Lake Argyle Silver Cobbler Fishery
MAFMF	Marine Aquarium Fish Managed Fishery
MBP	Marine Bioregional Plan
MFL	Managed Fishery Licence
MLL	Minimum Legal Length
MOP	Mother-of-Pearl
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NBPMF	Nickol Bay Prawn Managed Fishery
NCB	North Coast Bioregion
NDSMF	Northern Demersal Scalefish Managed Fishery
NPF	Northern Prawn Fishery
NRM	Natural Resource Management
NTAC	Notional Target Total Allowable Catch
OCL	Orbital Carapace Length
OIMF	Octopus Interim Managed Fishery
OPMF	Onslow Prawn Managed Fishery
PDSF	Pilbara Demersal Scalefish Fisheries
PFRC	Pemberton Freshwater Research Centre
PFTIMF	Pilbara Fish Trawl Interim Managed Fishery

RAP	Research Angler Program
RCL	Rostrum Carapace Length
RFBL	Recreational Fishing from Boat Licence
RFFSS	Recreational Freshwater Fisheries Stakeholder Subcommittee
RRAMF	Ranked Risk Assessment of Multiple Fisheries
SAFS	Status of Australian Fish Stocks
SBBSMNF	Shark Bay Beach Seine and Mesh Net Managed Fishery
SBCIMF	Shark Bay Crab Interim Managed Fishery
SBSF	Shark Bay Snapper Managed Fishery
SCB	South Coast Bioregion
SCCMF	South Coast Crustacean Managed Fishery
SCRIP	Strategic Criteria for Rural Investments in Productivity
SCTF	South Coast Trawl Fishery
SFD	Standard Fishing Day
SIEV	Suspected Illegal Entry Vessel
SLED	Sea Lion Exclusion Device
SMFG	Size Management Fish Ground
SSMF	Specimen Shell Managed Fishery
SST	Sea Surface Temperature
SWCC	South West Catchment Council
SWTMF	South West Trawl Managed Fishery
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TAE	Total Allowable Effort
TARC	Total Allowable Recreational Catch
TDGDLF	Western Australian Temperate Demersal Gillnet and Demersal Longline Fisheries
UWA	University of Western Australia
TPSA	Tiger Prawn Spawning Area
VFAS	Voluntary Fisheries Adjustment Schemes
VMS	Vessel Monitoring System
WAFIC	Western Australian Fishing Industry Council
WAFMRL	Western Australian Fisheries and Marine Research Laboratories
WAMSI	Western Australian Marine Science Institute
WANCSF	Western Australian North Coast Shark Fishery
WCB	West Coast Bioregion
WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery
WCDSF	West Coast Demersal Scalefish Fishery
WCDSIMF	West Coast Demersal Scalefish (Interim) Managed Fishery
WCEMF	West Coast Estuarine Managed Fishery
WCRLMF	West Coast Rock Lobster Managed Fishery
WDWTF	Western Deepwater Trawl Fishery
WTO	Wildlife Trade Operation