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Status reports of the fisheries and aquatic resources of Western Australia 2021/22

State of the fisheries

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CHIEF FISHERIES SCIENTIST STATEMENT

Aquatic resources within Western Australia (WA) are in good condition, and this has positioned WA as a global leader in sustainable fisheries management. The sustainable fisheries of WA continue to support our strong economy and regional communities. Nonetheless, the lack of a consistent approach to build in the knowledge of Traditional Owners remains a gap in our longer-term fisheries science in Western Australia.

Climate change and climate variability continues to impact fish stocks, challenging our ability to effectively monitor, assess, and manage fish stocks. We are continually working with our stakeholders, and the broader community to be adaptive, responsive, and innovative to derive updated scientific advice. A significant challenge is trying to predict what the future of our fish resources and the ecosystems that support them look like. In particular, we are aiming to explore innovative techniques within the burgeoning field of molecular genetics to better understand how regional distribution of key fish resources may be impacted and the resilience of key species to climate change. Aligned with this is the need to better evaluate how environmental change impacts the carrying capacity of the various habitat-types across our diverse array of regions.

As we explore new opportunities and new data streams, improve our assessment methodologies, and update stock assessments, this new information is expected to increase the efficacy of our assessments of the status of some stocks. This information underpins management advice and provides managers with appropriate resource specific measures to ensure sustainability.

Dr DAN GAUGHAN
Chief Fisheries Scientist

December 2022

EDITOR'S 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 Department's risk based EBFM framework is the State government's basis for management of all Western Australia's aquatic resources.

Assets examined in each bioregion include the meso-scale ecosystems and aquatic resources, along with the associated fisheries. A summary at the start of each chapter displays the stock and fishery performance levels, along with the current performance and risk levels for each of the other EBFM outcomes (bycatch, listed species interactions, habitat and ecosystem interactions, social and economics, governance). Major external drivers, such as COVID-19, climate change, coastal development and introduced pests/diseases, are examined to determine their impact on WA's aquatic resources.

The 2021/22 financial year saw a continuation of the outstanding results achieved in fisheries management to ensure the continued sustainability of WA's aquatic resources. The unique contribution that the State's fishing sectors and aquaculture industries make to Western Australia are acknowledged in the State's 2020 – 2024 Primary Industries Plan (the Plan). The Plan recognizes and responds to these times of significant disruptions to historical ways of doing business by providing a high-level roadmap to maintain and grow the primary industries of Western Australia.

This year, 96% of our fish stocks were assessed as not being at risk or vulnerable through exploitation (fishing); this includes those classified as **sustainable – adequate** where more than 90% of the State's fishery value comes from independently certified sustainable fisheries, including the Marine Stewardship Council (MSC) certified fisheries of Western Rock Lobster, West Coast Deep Sea Crab, West and South Coast Abalone, Shark Bay Prawn, Exmouth Gulf Prawn, Peel-Harvey Sea Mullet and Blue Swimmer Crab, Pearl Oyster, Octopus and Sea Cucumber.

Several resources were classified as **sustainable – recovering**, indicating that management actions taken to date have resulted in these resources recovering at acceptable rates. These included dusky and sandbar shark stocks that support the Temperate Demersal Gillnet and Demersal Longline Fishery and fish resources supporting Gascoyne Demersal Scalefish Fishery.

Two resources, the Cockburn Sound crab resource, and white bait and southern garfish in the West Coast Nearshore resource continue to be **environmentally limited** with stocks recovering from the 2010/11 marine heat wave with highly restricted management arrangements, or are closed to fishing.

The Greenlip Abalone of the Abalone Managed Fishery and fish resources supporting West Coast Demersal Scalefish Fishery are considered **inadequate** as a result of exploitation, with management actions already implemented to assist stock recovery.

Considerable work continues towards implementing the *Aquatic Resources Management Act 2016* (ARMA). This will be a once-in-a-generation change that will provide a modern, innovative framework to create a sound basis for effective, efficient and integrated fisheries and aquatic resource management for decades to come. It is expected that full proclamation of ARMA will occur in late 2023.

A key feature of the ARMA is that it is based around aquatic resources, 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 migrated to the new legislative framework.

Many staff at the Department of Primary Industries and Regional Development (DPIRD) have contributed to the production of this report, along with the stakeholders who contribute to managing the State's aquatic resources. The ongoing involvement of our Aboriginal, commercial, recreational and aquaculture stakeholders in specific research projects and monitoring programs remains critical. Logbook data, voluntary participation in recreational fishing surveys, the provision of biological samples, and access to vessels and sharing of 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.

This volume provides the public, fishers and other stakeholders with a starting reference source. This meets the reporting requirements of the Department, including the need to report on the Key Performance Indicators (KPIs) section of the Annual Report to Parliament in 2022 (See Overview).

Key species can also be found in the Status of Australian Fish Stocks (SAFS) reports at http://fish.gov.au.

This year's *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2021/22* 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.

HOW TO USE THIS VOLUME

To obtain full benefit from the information provided in this edition of the *Status Reports of the Fisheries and Aquatic Resources of Western Australia*, the various terms and headings used in the text, the fishery status overview table (which also appears in the Department of Primary Industries and Regional Development's *Annual Report* 2021/22 to Parliament) and the ecological resource level reports are described below.

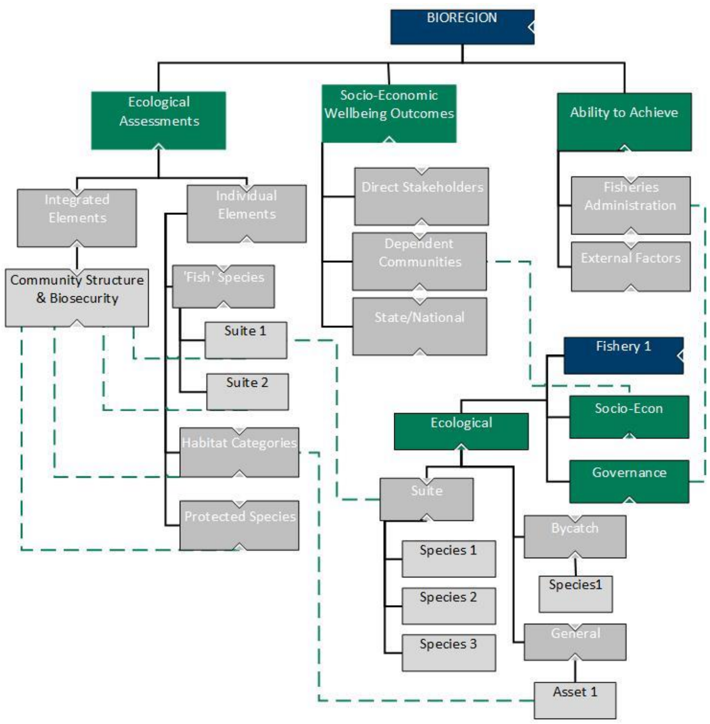
The terms and headings are a combination of the reporting structures first outlined in the National Ecologically Sustainable Development (ESD) reporting structure (Fletcher *et al.* 2002)[1], the Ecosystem Based Fisheries Management (EBFM) framework (Fletcher *et al.* 2010, 2012)[2] and the Resource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

In addition to the explanations provided below, acronyms are expanded at their first occurrence in each 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

As outlined above the Department has fully adopted EBFM, which is a risk based management approach. EBFM recognises the social, economic and ecological values at a regional level and the links among individual exploited fish stocks, 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 of the EBFM approach, 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, the component tree shows how ecosystem elements are composed of the integrated set of individual elements.

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

4 Piddocke *et al.* 2021. Status of Australian fish stocks reports 2020. Fisheries Research & Development Corporation, Canberra.

Each set of Bioregional level risks is made up of individual ecological risks at a species or stock level, and social and economic risks at a 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 an entire suite (e.g. demersal finfish) is evaluated based on the risk status of several indicator species, which have been chosen to be representative of the more vulnerable species within the suite (Newman *et al*. 2018)[1].

A similar process is applied to consolidate the items across the other EBFM components. Furthermore, the assessment of ecosystem status recognises that community structure and biodiversity within an ecosystem can 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).

BIOREGIONS

With the adoption of the EBFM approach, a fully bioregional structure has been implemented 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* section 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).

Bioregions and Suites

Western Australia (WA) has an extensive coastline that extends approximately 12,890 km (~20,780 km including islands) from the Northern Territory border through to the South Australian border. In addition, the WA coastline encompasses a very broad latitudinal range from approximately 10˚S to 40°S. The extensive coastline length and broad latitudinal range in WA, means that the State has a highly diverse fish and invertebrate fauna, including tropical and temperate species. Hutchins (2001) estimated that there were at least 3,000 species of fishes in WA waters.

Bioregions

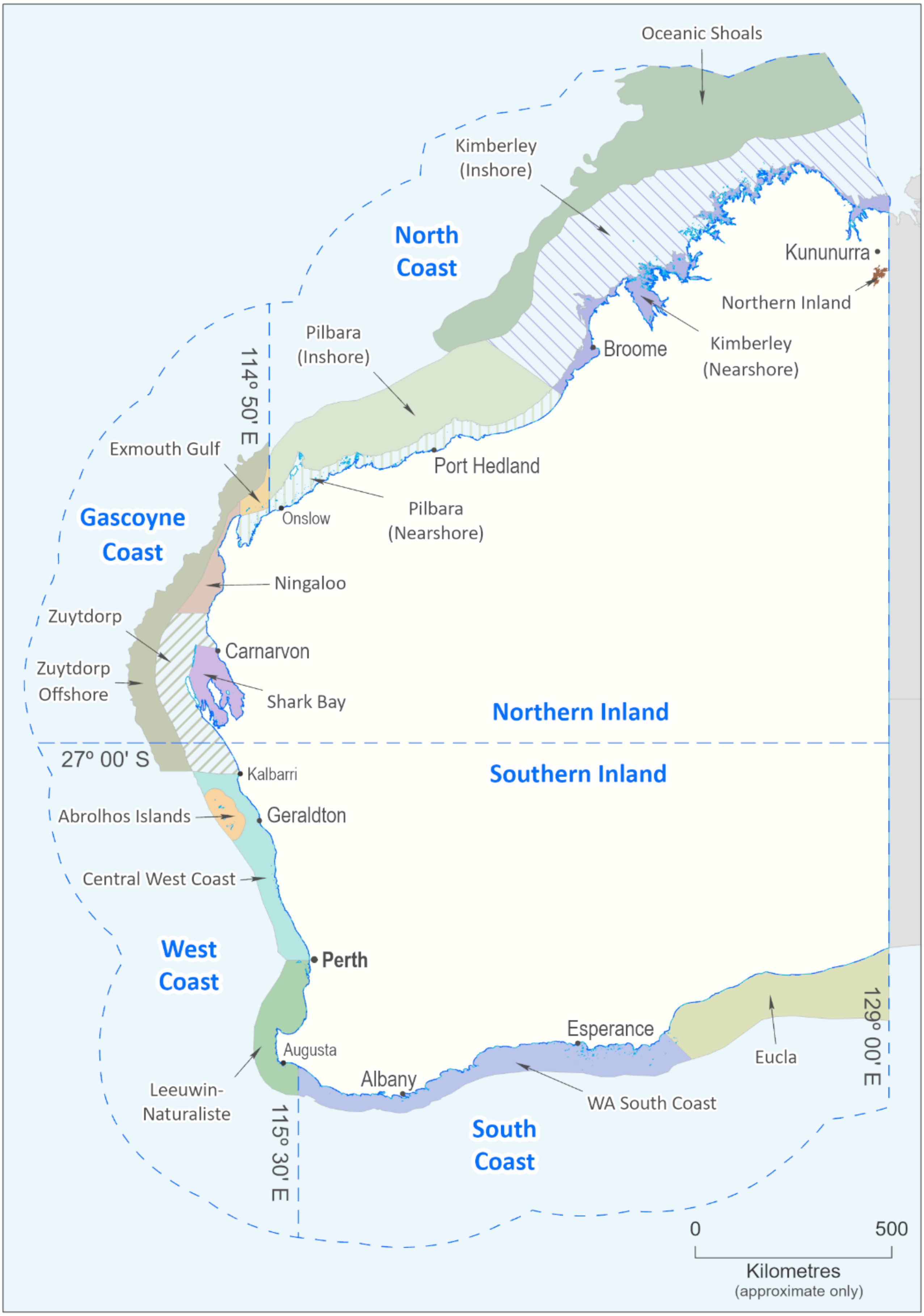
The extensive range of species occurring in WA interact with a range of fisheries and fishing methods. As such, the monitoring and assessment of fisheries and target species (indicator species where applicable) within WA is an ongoing challenge. In order to address this challenge, DPIRD has divided the coastline into four marine Bioregions (Introduction Figure 2). These Bioregions are:

- The North Coast Bioregion (extending from the Northern Territory Border south and west to a point just west of Onslow), which includes both the Pilbara and Kimberley regions;
- The Gascoyne Coast Bioregion, (from essentially Onslow south to south of Shark Bay);
- The West Coast Bioregion, (from south of Shark Bay to east of Augusta); and
- The South Coast Bioregion, (from east of Augusta to the South Australian border).

In addition to the marine Bioregions, there are also two Inland Bioregions: the Northern Inland Bioregion and the Southern Inland Bioregion. A single commercial fishery operates within the Northern Inland Bioregion. In contrast, there are no commercial wild harvest fisheries in the Southern Inland Bioregion.

Bioregions are based on broad ecological areas in order to facilitate management, monitoring and assessment.

1 Newman SJ, Brown JI, Fairclough DV, Wise BS, Bellchambers LM, Molony BW, Lenanton RCJ, Jackson G, Smith KA, Gaughan DJ, Fletcher WJ, McAuley RB, and Wakefield CB. 2018. A risk assessment and prioritisation approach to the selection of indicator species for the assessment of multi-species, multi-gear, multi-sector fishery resources. Marine Policy 88: 11-22.



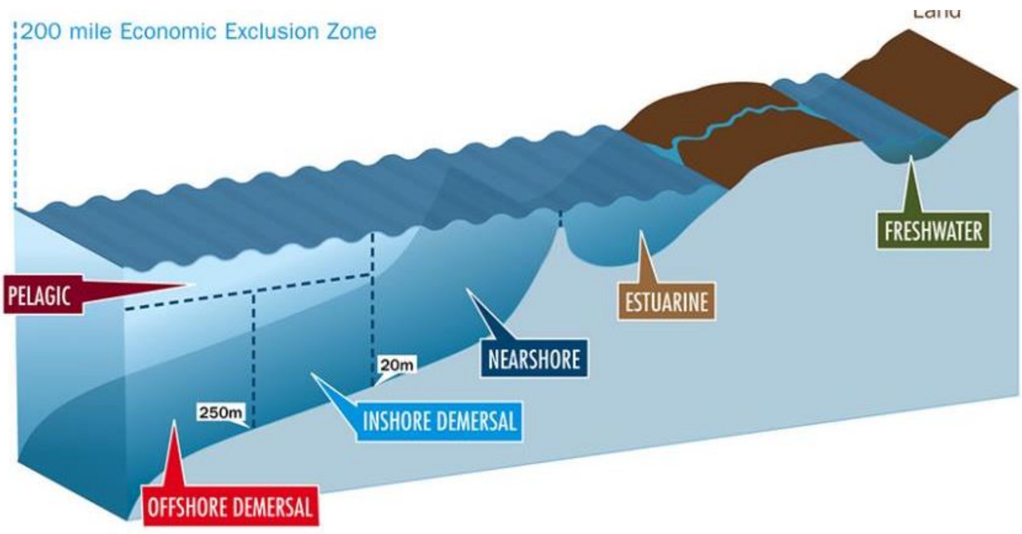
INTRODUCTION FIGURE 2.
Map of WA showing the boundaries of the four marine Bioregions, the two inland Bioregions and the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) ecosystems. The Bioregions are based on broad ecological areas to facilitate management, monitoring and assessment.

Suites

The four marine Bioregions divide the marine waters of the State into broad ecological areas. Nonetheless, the total number of fish species within each Bioregion is in the order of hundreds of species. To enhance and refine approaches to the monitoring and assessment of fishery resources, each Bioregion has been further divided into five ecological suites based on broad habitat and depth criteria (Introduction Figure 3.). These suites are defined as follows:

- Estuarine suite, defined as estuarine waters up to the mouth of a river.
- Nearshore suite, defined as nearshore waters extending from the beach to a depth of 20 metres.
- Inshore Demersal suite, defined as inshore waters between depths of 20 metres and 250 metres.
- Offshore Demersal suite, defined as offshore waters from the 250-metre isobath to the edge of the Exclusive Economic Zone (200 nautical miles).
- Pelagic suite, defined as pelagic waters or open ocean waters, which includes the pelagic fishes that occupy primarily the open waters 'above' the Inshore Demersal and Offshore Demersal suites.

These suites are applicable to both finfish species and other asset categories such as invertebrate resources and habitats. These ecological suites are broadly consistent within areas where major fisheries operate within a Bioregion. As such, the sub-division of a Bioregion into these suites categorises fish species into ecological groups that are vulnerable to similar fisheries. For example, in each of the four marine Bioregions there are multiple gears (sometimes resulting in separate fisheries) that target and capture inshore demersal scalefish (i.e., in depths of 20–250 m). Similarly, multiple fisheries within the West Coast Bioregion operate in depths of less than 20 m, targeting fish within the nearshore suite. Therefore, assigning each fish species within each Bioregion to a single suite allows multiple species, and the fisheries that they support, to be assessed, monitored, and managed. However, during discussions around allocation either among fisheries and/or sectors, negotiations may take place with stakeholders about the assignment of specific species to a single suite. This is a result of the suites being broadly representative of habitats; however, catches of a single species may be reported from multiple habitats. Thus, the allocation of a species to a single suite within a Bioregion is generally made based on the suite where most of the catches of a species are reported. While there are some exceptions, species assigned to a single suite within a Bioregion are generally acceptable to all stakeholders.



INTRODUCTION FIGURE 3.
Schematic representation of each of the five suites used to characterise species within each of the marine Bioregions of Western Australia.

References

Hutchins, J.B. 2001. Checklist of the fishes of Western Australia. Records of the Western Australia Museum Supplement No. 63: 9-50.

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 (protected) species.

Captured Fish: Captured fish species 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 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. ETPS are similarly defined under the new *Aquatic Resources Management Act* 2016.

Habitats: Habitat assets in each Bioregion are 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 a starting point, but merging of these or further division into separate estuarine/embayment and marine components was undertaken where relevant.

RISK ASSESSMENT

The Department's objective is to manage the sustainability of the community's aquatic ecological resources and assets to generate economic and/or social outcomes. Risks associated with each individual ecological asset and community outcomes were therefore examined separately using qualitative risk assessments (Consequence x Likelihood) (modified from Fletcher 2015)[2]. This enables the analysis of risk (using a five-year time horizon) for objectives related to captured species, habitat and community structure/ecosystem sustainability, plus social and economic outcomes to be completed in a practical and consistent manner.

The internationally accepted definition of risk is "the uncertainty associated with achieving objectives" (ISO, 2009). Uncertainties are therefore explicitly incorporated into assessments to enable each risk assessment to be completed with whatever data are available. All risk scoring 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 defined (Introduction Table 1).

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

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

Risk Category	Description	Likely Reporting and Monitoring Requirement	Likely Management Action
Negligible	Acceptable; not an issue	Brief notes – no monitoring	Nil
Low	Acceptable; no specific control measures needed	Full notes needed – periodic monitoring	None specific
Medium	Acceptable; with current risk control measures in place (no new management required)	Full performance report – regular monitoring	Specific management and/or monitoring required
High	Not desirable; continue strong management actions OR new / further risk control measures to be introduced in the near future	Full Performance report – regular monitoring	Increased management activities needed
Severe	Unacceptable; major changes required to management in immediate future	Recovery strategy and detailed monitoring	Increased management activities needed urgently

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

2 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: 1043-1056.

SEASON REPORTED

Individual fishery production figures relate to the latest full year or season for which data were available. Therefore, statistics in this volume generally refer either to the 2020/21 financial year or the 2021 calendar year, whichever is more appropriate.

In contrast, sections on Departmental activities in the areas of fishery management, new compliance activities and research summaries may include information up to June 2022.

ECOLOGICAL ASSETS

Captured Fish

Commercial Fishing

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 aquaculture producers.

Monthly returns or daily/ trip returns are provided that include information on the composition, quantity and location of catch and fishing effort that was used. Monthly returns from fish processors request quantity and price paid for fish products.

Recreational Fishing

The Department has implemented an integrated survey design to monitor recreational fisheries in a cost effective way[1]. These surveys provide estimates of catch and effort by boat-based recreational fishers at both state-wide and bioregional levels. These surveys utilise the Recreational Boat Fishing Licence as the sampling frame to contact fishers and multiple survey methods to validate estimates by enabling comparisons across the various methods.

The state-wide survey of boat-based recreational fishing has been repeated biennially or triennially between 2011/12 and 2020/21. Methods including digital technologies to cost effectively monitor shore-based recreational fishing as part of an integrated survey continue to be developed.

Estimates of catch and effort at state-wide and bioregional levels from 2020/21 presented in Ryan *et al*. (2022[2]) provide information for the recreational sector throughout this report.

The most recent (fifth) survey was undertaken from 1 September 2020 to 31 August 2021 with post-enumeration surveys from September to December 2021. Estimates of catch and effort at state-wide and bioregional levels from these surveys were made available in 2022.

Stock Assessment Methodologies

Each of the stock assessment reports now clearly identifies the types of data and assessment method(s) that have been used to determine the status of stocks. The specific methods used for monitoring and assessment vary among resources and indicator species and are influenced by many factors including; the level of ecological risk; the biology and the population dynamics of the relevant indicator species; the type, size and value of the fishery exploiting the species; data availability and historical level of monitoring.

The analyses that can be applied for assessing stock status vary according to data availability and resourcing. At one end of the spectrum, are relatively simple simulation (i.e. Catch-MSY) models applied to catch data only, but requiring relatively strong assumptions regarding stock productivity and stock depletion levels. At the other end are highly complex age and/or size-structured integrated stock assessment models, which use all available catch, effort, biological, compositional data (and sometimes also tagging data). Regardless of assessment level, where possible, model-based assessment analyses are used to produce quantitative estimates of key performance indicators (fishing mortality and spawning biomass), compared against internationally-accepted biological reference points (i.e. relating to B_{MSY}, expected spawning biomass required to achieve long-term maximum sustainable yield, MSY). Stock assessments are categorised into five levels (Introduction Table 2).

1 Ryan KL, Wise BS, Hall NG, Pollock KH, Sulin EH, Gaughan DJ. 2013. An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249. Department of Fisheries, Western Australia.

2 Ryan KL, Lai EK, Smallwood CB. 2022. Boat-based recreational fishing in Western Australia 2020/21. Fisheries Research Report No. 327. Department of Primary Industries and Regional Development, Western Australia.

INTRODUCTION TABLE 2.
Levels and descriptions of the categories of assessment methods

Level	Description
Level 1	Catch data and biological/fishing vulnerability. Catch-MSY analysis (if sufficient data).
Level 2	Level 1 and nominal or standardised fishery-dependent effort. Simple biomass dynamics models, depletion analysis (if sufficient data), or performance-indicator reference levels based on historical catch and/or CPUE time series.
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). Equilbrium assessment models (e.g. catch curve and per recruit analysis).
Level 4	Levels 1, 2 and (data-permitting) 3 plus reliable/informative abundance time series (e.g. spawning stock and/or recruitment indices from standardised fishery-dependent and/or fishery-independent data). Empirical analyses (e.g. stock-recruitment-environment relationships), dynamic stock assessment models (e.g. state-space production model, age-structured production model, statistical catch-at-age model without abundance information).
Level 5	Levels 1, 2, 3 and 4 plus dynamic, integrated stock assessment model (incorporating biological information, catch, abundance and compositional data, and potentially other information e.g. from tagging).

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 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. This assists in determining the overall risk level and directs areas of further research.

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. 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 management actions to support recovery have 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 last two categories include those species caught during a fishing operation that are not retained. 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 or over bag limits. These issues are covered in individual 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 animals from the ecosystem (food chain effects). Each fishery or resource is considered in terms of its potential/relative effects on habitat and the food chain with an outline of the assessment of current ecological risk ('negligible', 'low', 'medium', 'high' or 'severe') provided.

The Department is conducting periodic ecological risk assessments across the various resources.

These ecological risk assessments involve workshops with a broad range of stakeholders and provide risk scores based on available scientific monitoring, research information and expert knowledge on species, fishing activities, fishery regulations and management.

Social Effects

The Department has categorised the different level of social amenity generated by each aquatic asset. Note, by definition, there is no asset that has no social amenity (Introduction Table 3).

INTRODUCTION TABLE 3.
Levels and descriptions of the categories of 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 (Introduction Table 4). 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 specific GVP values may not be available.

INTRODUCTION TABLE 4.
Levels of relative economic importance

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 clear and specifically articulated reference levels and associated 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 covers target species abundance, and 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 management 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 whether the stock is being subjected to overfishing.

To calculate this range, as outlined in the *Harvest Strategy Policy*, a tolerance level establishes for each fishery what range of deviation in annual catch or effort is considered acceptable to meet stock based objectives and/or to meet any sectoral allocations (e.g. as developed by IFM determinations). These annual tolerances take into account natural variations in recruitment to a 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 catch or effort remains inside an acceptable range it is defined as having acceptable performance. Where annual catch or effort for a fishery/sector falls outside a range and the rise or fall cannot be adequately explained (e.g. environmentally-induced fluctuations in recruitment levels; low market demand or prices), a management review or additional research to assess the underlying cause may be required.

Annual catch tolerance range: For many commercial and recreational fisheries in WA, management plans seek to directly control the amount of fishing effort applied to stocks, with the level of catch taken providing an indication of the effectiveness of a plan. Where a plan is operating effectively, the catch by a fishery should fall within a projected catch tolerance range.

Annual effort tolerance range: For quota-managed fisheries, the measure of success for 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 was expended to achieve a TAC, or an industry fails to achieve a TAC by a significant margin (i.e. outside of tolerance levels), this may indicate that the abundance of a stock is significantly lower (or higher) than was anticipated. For these reasons, appropriate tolerance ranges of fishing effort required to achieve a TAC have 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 needed 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 fishery legislation which impact on aquatic resources or activities. An understanding of these factors, which are typically environmental (cyclones, ocean currents, climate change, changes in rainfall) but which may also include other factors (e.g. market factors, coastal development), is also necessary to interpret changes in catch and/or effort to fully assess the performance of a fishery.

OVERVIEW OF THE STATUS OF KEY ECOLOGICAL RESOURCES (ASSETS) ECOLOGICAL ASSETS

Captured Species (Fisheries and Stocks)

Annual Weight of Evidence (WOE) stock assessments, including analyses of trends in catch and fishing activity, are used to determine the status of each of the State's aquatic resources and 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 1). 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 Primary Industries and Regional Development (DPIRD) *Annual Report to Parliament 2021/22*.

OVERVIEW TABLE 1.

Breeding stock status, catch and effort ranges for WA's major commercial and recreational fisheries. The information underpins the four KPIs measuring the effectiveness of the Department's management plans and regulatory activities in:

- ensuring the sustainability status of the State's aquatic resources
- the success of keeping fish catches (or effort) at appropriate levels for
  - commercial and
  - recreational fisheries and
- ensuring that sustainably managed commercial fisheries provide benefits to the State as a result of significant local sales and export earnings from fish and fish products.

The term 'sustainable' is given where the breeding stocks are considered adequate as well as breeding stocks that are recovering. Terms 'inadequate' or 'environmentally limited' include where additional actions need to be taken or confirmation is required to ensure the breeding stocks are either adequate or are now recovering. The term 'overfished' is only given where breeding stocks are inadequate due to exploitation (i.e. overfishing) that have been identified but for which definitive management actions have yet to be fully implemented.

An acceptable catch or effort range may be determined for each of the major commercial and recreational fisheries. Commercial ranges 'under revision' or 'under development' are not assessed. Recreational ranges 'not developed' or 'under revision' are not assessed however 'not formal' ranges are assessed.

Acronyms:

NA – Not applicable

Q – Quota management

TAC – Total Allowable Catch

TACC – Total Allowable Commercial Catch

TARC – Total Allowable Recreational Catch

MSC – Certified by Marine Stewardship Council

CI – Confidence Interval

SE – standard error.

Assessment level (and method):

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

Level 5 – Levels 1 to 3 and/or 4 plus outputs from integrated simulation, assessment model

Resource	Fishery	Assessment level	Breeding stock assessment	Catch (and effort) range	Catch, effort and catch rate for season reported[1,2]	Catch (or effort or catch rate) level acceptable and explanation if needed
West Coast Bioregion						
Western Rock Lobster	West Coast Rock Lobster Managed Fishery (MSC)	Annual: Level 5	Sustainable: Adequate	Commercial: 6,615 t (TACC) extended to 9000 t (~18 month season TACC) due to Covid19 Recreational: 562 t (TARC)	Commercial: 6,333 t (12 month) Recreational - licensed: 434–541 t (95% CI); Charter: 17 t	Acceptable Commercial: Catch within TACC plus 1.5% water loss i.e. 6400 t Recreational: Catch within acceptable range on a five-year rolling average.
Statewide Abalone	Abalone (Roe's) Managed Fishery (MSC)	Annual: Level 4	Sustainable: Adequate	Commercial: 69.8 t (Q) (530–640 days) Recreational: 25–29 t Perth Metro area	Commercial: 29.7 t (223 days) Recreational: 19–23 t Perth Metro area; 14 t Other	Acceptable Commercial: Catch was below TACC due to economic impacts of COVID-19 on overseas markets. Recreational: Perth Metro catch range below TARC range due to weather conditions impacting fishing season.
Statewide Cephalopod	Octopus Interim Managed Fishery (MSC)	Annual: Level 2	Sustainable: Adequate	Commercial: 200–500 t Catch range review in progress Recreational: Not developed	Commercial: 487 t Recreational: 0–4 t (95% CI, boat only in 20/21)	Acceptable Commercial: Catch within acceptable range. Catch recovered in 2021 after COVID-19 issues.
South Coast and West Coast Scallop	Abrolhos Islands and Mid-West Trawl Managed Fishery	Annual: Level 4	Sustainable: Adequate	Commercial: 95–1,830 t Recreational: NA	Commercial: 616 t	Acceptable Commercial: Catch within acceptable range but above predicted range due to scallop catches from areas not used in the prediction.
West Coast Estuarine and Nearshore Scalefish and Invertebrates	Cockburn Sound Crab Managed Fishery	Annual: Level 4	Inadequate (environmentally limited)	Commercial: Closed Recreational: Closed	Commercial: 0 t Recreational: 0 t	NA Cockburn Sound fishery closed since 2014. In 2021 recruitment indices showed a slight decline while egg production improved marginally. However, both metrics remain below limit reference levels. Decline is consistent with an environmentally limited stock.
West Coast Estuarine and Nearshore Scalefish and Invertebrates	West Coast Estuarine Managed Fishery (Area 1 Swan Canning, Area 2 Peel Harvey (MSC), Area 3 Hardy Inlet)	Annual: Levels 1 and 2 Periodic: Level 3 – sea mullet, yellowfin whiting	Sustainable: Adequate – crabs/ sea mullet, yellowfin whiting	Commercial: 45–107 t (Peel Harvey crab) <150 t sea mullet (Peel Harvey), <12 t yellowfin whiting (Peel Harvey) Recreational: Informal (Peel Harvey crab) Not developed (finfish)	Commercial: 55 t (Peel Harvey crab) 73 t (sea mullet Peel Harvey), 10 t (yellowfin whiting Peel Harvey) Other West Coast Estuarine crab fisheries not reported due to confidentiality requirements. Recreational: 22–38 t (95% CI, boat only in 20/21, crabs in Perth Metro Zone)	Acceptable Commercial: Catch of crabs and finfish within acceptable ranges. Recreational: Catch levels are not considered a risk to stocks.

Resource	Fishery	Assessment level	Breeding stock assessment	Catch (and effort) range	Catch, effort and catch rate for season reported[1,2]	Catch (or effort or catch rate) level acceptable and explanation if needed
West Coast Estuarine and Nearshore Scalefish and Invertebrates	Cockburn Sound Fish Net Managed Fishery South West Beach Seine West Coast Nearshore Open Access Net Fishery South West Coast Salmon Managed Fishery West Coast Beach Bait	Annual: Levels 1 and 2 Periodic: Level 3 – whitebait, southern garfish Level 5 – Herring (State) 2022	Sustainable: Adequate – whiting/ salmon (State)/ tailor/herring (State) Inadequate - (environmentally limited) whitebait/ southern garfish	Commercial: <25 t (informal whitebait). Not developed (southern garfish), Recreational: Not developed	Commercial: 21 t (whitebait), 0.2 t (southern garfish -WCB) Recreational: 62–94 t (95% CI, boat only in 20/21, top 10 species)	Acceptable Metro Zone Garfish fishery closed in 2017. Declines in southern garfish and whitebait consistent with an environmentally limited stock. Recreational: Catch levels are not considered a risk to stocks.
Statewide Small Pelagic Scalefish (Purse Seine)	West Coast Purse Seine Managed Fishery	Annual: Level 1	Sustainable: Adequate	Commercial: 0–5,700 t (Q) Recreational: NA	Commercial: 504 t (all species) Recreational: <1 t	Acceptable
South Coast and West Coast Demersal Finfish	West Coast Demersal Scalefish Fishery	Annual: Level 1 Periodic: Level 5 – 2021	Inadequate	Commercial: ≤450 t Recreational (including charter): ≤250 t	Commercial: 259 t Recreational: (top 15 species) 200–256 t (95% CI, boat only in 2020/21); 65 t charter boats in 2020/21	Commercial: Acceptable Demersal suite catch within range. Recreational: Not acceptable Snapper and baldchin groper catches were above recovery benchmarks in 2020/21. The WA dhufish catch was around the benchmarks in 2020/21. Catch benchmarks under review.
Gascoyne Coast Bioregion						
Shark Bay Invertebrate	Shark Bay Prawn Managed Fishery (MSC)	Annual: Level 4	Sustainable: Adequate	Commercial: 1,350–2,150 t Recreational: NA	Commercial: 1,303 t	Acceptable Commercial: Western king prawn catches below their acceptable range in part due to smaller sized prawns throughout the season. Additional in season measures implemented to protect breeding stocks.
Northern Invertebrates	Exmouth Gulf Prawn Managed Fishery (MSC)	Annual: Level 4	Sustainable: Adequate	Commercial: 436–1,347 t Recreational: NA	Commercial: 777 t	Acceptable
Shark Bay Invertebrate	Shark Bay Scallop Managed Fishery	Annual: Level 4	Sustainable: Adequate	Commercial: Quota 625 t (200 t Denham Sound and 425 t northern Shark Bay) Recreational: NA	Commercial: 613 t	Acceptable Commercial: Quota season to 30 April 2022. At least 98% of quota achieved.
Shark Bay Invertebrate	Shark Bay Crab Managed Fishery	Annual: Level 4	Sustainable: Adequate	Commercial: 650 t (Q) Recreational: Not formal	Commercial: 549 t Recreational: 1–4 t (95% CI, boat only in 20/21)	Acceptable Commercial: Spawning and recruitment levels have slightly declined under the current environmental conditions and harvest levels. Recreational: Catch levels are stable.

Resource	Fishery	Assessment level	Breeding stock assessment	Catch (and effort) range	Catch, effort and catch rate for season reported[1,2]	Catch (or effort or catch rate) level acceptable and explanation if needed
Gascoyne Nearshore Scalefish	Shark Bay Beach Seine and Mesh Net Managed Fishery	Annual: Level 2 Periodic: Level 3 Yellowfin whiting – 2014	Sustainable: Adequate	Commercial: 235–335 t Recreational: NA	Commercial: 135 t	Acceptable Commercial: Catch below the acceptable range due to ongoing very low levels of effort, further impacted by effects of COVID.
South Coast and West Coast Crustacean	West Coast Deep Sea Crustacean Managed Fishery (MSC)	Annual: Level 2	Sustainable: Adequate (2020 Assessment)	Commercial: Class A: 154 t (Q); Class B: 20 t (Q); Class C: 1 t (Q); 60,000–105,000 pot lifts (crystal crab) Recreational: NA	Commercial: Class A: 140 t Class B: 14; Class C: 0 t (125,219pot lifts crystal crab)	Not Acceptable Commercial: TAC achieved but effort is above acceptable range. The stock status is currently being reviewed.
Gascoyne Demersal Scalefish	Gascoyne Demersal Scalefish Managed Fishery	Annual: Level 2 Periodic: Level 5 Snapper – 2017	Sustainable: Recovering	Commercial: Snapper 51.4 t (Q) Other demersals 227 t (Q) Recreational: Not formal	Commercial: Snapper 38.9 t Other demersals 125 t Charter: Snapper 8 t Recreational: 74–112 t (95% CI, boat only in 20/21, top 15 species)	Acceptable Commercial: Acceptable Recreational:Acceptable Snapper spawning biomass close to limit level with additional management action undertaken in 2018 including TACC reduction.
Gascoyne Demersal Scalefish	Inner Shark Bay Demersal (Snapper)	Periodic: Level 5 2015	Sustainable: Adequate	Commercial: 3.8 t Eastern Gulf (EG), 3.8 t Denham Sound (DS), 1.2 t Freycinet Estuary (FE) Recreational: 11.2 t EG, 11.2 t DS, 3.8 t FE	Commercial: <1 t Charter: 0.5 t EG, 1.3 t DS, 1.1 t FE Recreational: 2.1 t EG (95% CI 0.8–3.4 t), 4.6 t DS (95% CI 3.4–5.9 t), 11.5 t FE (95% CI 4.3–18.7 t) (boat only, assumed same as in 2018)	Not Acceptable Commercial: NA Incidental catch. Recreational: Not Acceptable Catch in Freycinet above acceptable range.
North Coast Bioregion						
Northern Invertebrates	Onslow Prawn Managed Fishery	Annual: Level 1	Sustainable: Adequate	Commercial: 60–180 t Recreational: NA	Commercial: <60 t	Acceptable Commercial: Low effort in 2021.
Northern Invertebrates	Nickol Bay Prawn Managed Fishery	Annual: Level 1	Sustainable: Adequate	Commercial: 90–300 t Recreational: NA	Commercial: 123 t	Acceptable
Northern Invertebrates	Broome Prawn Managed Fishery	Annual: Level 1	Sustainable: Adequate	Commercial: 55–260 t Recreational: NA	Negligible	NA Commercial: Minimal fishing occurred in 2021.
Northern Invertebrates	Kimberley Prawn Managed Fishery	Annual: Level 1	Sustainable: Adequate	Commercial: 240–500 t Recreational: NA	Commercial: 204 t	Acceptable Commercial: Catch below range but lower rainfall experienced.

Resource	Fishery	Assessment level	Breeding stock assessment	Catch (and effort) range	Catch, effort and catch rate for season reported[1,2]	Catch (or effort or catch rate) level acceptable and explanation if needed
Northern Estuarine and Nearshore Scalefish and Invertebrates	Kimberley Gillnet and Barramundi Managed Fishery	Annual: Level 2	Sustainable: Adequate	Commercial: 33–44 t (barramundi) Recreational: Not formal	Commercial: 67 t (barramundi) 100 t (total) Recreational: 12-23 t (95% CI, boat only in 20/21, top 10 species)	Acceptable Commercial: Catch is above the acceptable range but is considered acceptable as the catch rate remains high.Noting that in 2020 the landed catch was at the lower end of the range. Recreational: Catch levels considered appropriate.
Northern Demersal Scalefish	Northern Demersal Scalefish Managed Fishery	Annual: Level 2 Periodic: Level 5 – 2018	Sustainable: Adequate	Commercial: 440–533 t (goldband snapper) 121–154 t (red emperor) Catch range review in progress Recreational: Not formal	Commercial: 1,544 t (total) 592 t (goldband snapper – not including other jobfish) 167 t (red emperor) Recreational: 41–63 t (95% CI, boat only in 20/21, top 15 species)	Acceptable Commercial: Acceptable Recreational:Acceptable (Catch levels are combined for Kimberley and Pilbara.)
Northern Demersal Scalefish	Pilbara Fish Trawl (Interim) Managed Fishery	Annual: Level 2, 3 Periodic: Level 5 – Underway	Sustainable: Adequate	Commercial: 136–244 t (red emperor, combined trawl, trap and line) Recreational: NA	Commercial: 1,928 t (all species, trawl) 192 t (red emperor, combined trawl, trap and line)	Acceptable Commercial: Acceptable Combined trawl, trap and line commercial catch of indicator species red emperor within acceptable range.
Northern Demersal Scalefish	Pilbara Demersal Trap Managed Fishery and Pilbara Line Fishery	Annual: Level 2, 3 Periodic: Level 5 – Underway	Sustainable: Adequate	Commercial: 136–244 t (red emperor, combined trawl, trap and line) Recreational: NA	Commercial: 662 t (all species, trap) 124 t (all species, line) 192 t (red emperor, combined trawl, trap and line)	Acceptable Commercial: Acceptable Combined trawl, trap and line commercial catch of indicator species red emperor within acceptable range
Statewide Large Pelagic Scalefish	Mackerel Managed Fishery	Annual: Level 2	Sustainable: Adequate	Commercial: 246–430 t (Q, Spanish Mackerel) Recreational: Not formal	Commercial: 238 t (CDRs) Recreational: 89–138 t (95% CI, boat only in 20/21, top 15 species)	Acceptable Commercial: Catch just below range due to changes in fishery. Recreational: Catch levels remain appropriate. Charter/FTO: catch back to historical range.
Northern Shark	Northern Shark Fishery	No assessment	NA	<20 t (sandbar)	0	NA No fishing since 2008/09.
Pearl Oyster (P. maxima)	Pearl Oyster Wildstock Fishery (MSC)	Annual: Level 4	Sustainable: Adequate	Commercial 786,170 oysters (Q) (14,071–20,551 dive hours) Recreational: NA	Commercial: 590,064 oysters (8,175 dive hours)	Acceptable Commercial: Catch below quota as COVID-19 issues reduced fishing. Catch rates increased from 2018 to 2021.
Statewide Hand Collection	Western Australian Sea Cucumber Fishery (MSC)	Annual: Level 2	Sustainable: Adequate	Commercial: Sandfish (Kimberley) 0–100 t Sandfish (Pilbara) 0–80 t Redfish 0–150 t Recreational: NA	Commercial: Sandfish (Kimberley): 31.5 t Sandfish (Pilbara): 0 t Redfish (Gascoyne):8.8 t	Acceptable Rotational harvest schedule by industry. Kimberley fished for first time in 3 years. Shark Bay stock fished 2 years running. Biomass survey completed.

Resource	Fishery	Assessment level	Breeding stock assessment	Catch (and effort) range	Catch, effort and catch rate for season reported[1,2]	Catch (or effort or catch rate) level acceptable and explanation if needed
South Coast Bioregion						
South Coast and West Coast Crustacean	South Coast Crustacean Managed Fishery (includes old Windy Harbour, Augusta Fishery)	Annual: Level 2	Sustainable: Adequate	Commercial: 50–80 t (southern rock lobster) Recreational: NA	Commercial: 6.8 t (southern rock lobster) 6.7 t (western rock lobster) 5.5 t (giant crab)	Not Acceptable Commercial: Catch below acceptable range. The stock status is currently being reviewed.
Statewide Abalone	Abalone (Greenlip/ Brownlip) Managed Fishery (MSC)	Annual: Level 4	Inadequate	Commercial: 48.8 t (Q) (3,440–5,270 hours) Recreational: Not formal	Commercial: 39 t (1412 hours) Recreational: 8 t	Not Acceptable Commercial: Catch below TACC due to commercial industry decisions. TACC reduced to 45 t and spatial closures maintained for the 2022 season. Recreational: Catch levels still not considered a risk to stocks.
South Coast Estuarine and Nearshore Scalefish and Invertebrates	South Coast Estuarine Managed Fishery South Coast Herring Trap (closed) South Coast Salmon Managed Fishery South Coast Nearshore Net Managed Fishery (formerly South Coast Open Access Net Fishery)	Annual: Levels 1 and 2. Periodic: Levels 3 to 5 Herring – 2022 Salmon – 2017 Cobbler – 2018	Sustainable: Adequate– Cobbler (Wilson Inlet), Herring (State), Salmon (State) Mullets/ Bream/Whitings	Commercial: <40 t cobbler (Wilson Inlet – informal). <300 t Herring (state – informal). Salmon under revision . Recreational: Not developed	Commercial: 20 t cobbler (Wilson Inlet). 102 t herring (state), 137 t salmon (state). 3.5 t blue swimmer crab (South Coast estuaries) Recreational: finfish 17–31 t (95% CI, boat only in 20/21, top 10 species)	Acceptable Cobbler in Wilson Inlet now considered adequate as catch has been <40 t tolerance level for 3 years. Low catch in 2021 thought to be due to change in license holders and targeting. Herring (state) stock has recovered. Salmon lighly exploited due to low effort a market demand. Low blue swimmer crab catches in 2021 not considered a sustainability issue as stocks levels are largely environmentally driven (primarily water temperature). Recreational: Catch levels are not considered a risk to stocks.
Statewide Small Pelagic Scalefish (Purse Seine)	Albany/King George Sound Purse Seine	Annual: Level 1	Sustainable: Adequate	Commercial: 2,683 t (Q) Recreational: NA	Commercial: 837 t	Acceptable
Statewide Small Pelagic Scalefish (Purse Seine)	Bremer Bay and Esperance Purse Seine	Annual: Level 1	Sustainable: Adequate	Commercial: 3,000 t (Q) Combined Recreational: NA	Commercial: 388 t	Acceptable.
South Coast and West Coast Demersal Finfish	Temperate Demersal Gillnet and Demersal Longline Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery	Annual: Level 1 Periodic: Gummy and whiskery: Level 5 – 2017 Dusky and sandbar: Level 4 – 2017	Sustainable: Adequate– Gummy and whiskery Sustainable: Recovering– Dusky and sandbar	Commercial: shark 725–1,095 t Recreational: NA	Commercial: 718 t (key species only) 835 t (total sharks and rays)	Acceptable Relative lower catches in 2020-21 attributed to a lower effort. Standardised catch rates remain stable for the key shark species.

Resource	Fishery	Assessment level	Breeding stock assessment	Catch (and effort) range	Catch, effort and catch rate for season reported[1,2]	Catch (or effort or catch rate) level acceptable and explanation if needed
South Coast and West Coast Demersal Finfish	South Coast Open Access Line, Trap and Net , South Coast Estuarine Managed Fishery, TDGDLF	Annual: Level 1 Periodic: Level 3 – 2014	Sustainable: Adequate	Commercial: Under development Recreational: Not formal	Commercial: 202 t Recreational: 34–60 t (95% CI, boat only in 20/21, top 10 species)	Acceptable Current commercial and recreational catches are at acceptable levels.
Northern Inland Bioregion						
Northern Inland Freshwater Scalefish and Invertebrates	Lake Argyle Silver Cobbler Fishery	Annual: Level 1	Sustainable: Adequate	Commercial: 93–180 t Recreational: NA	Commercial: 60 t	Acceptable Commercial: Catch is below acceptable level due to low levels of effort.
Southern Inland Bioregion						
South and West Coast Inland Freshwater Resource	South West Recreational Freshwater Angling Fishery Recreational Marron Fishery	Annual: Level 1	Sustainable: Adequate	Commercial: NA Recreational: 50,000–100,000 (marron) 50,000–120,000 (fish)	55,440 marron (± 4,630 se) 113,528 fish (±11,101 se)	Acceptable Catch (marron) within acceptable range since 2003. Review of acceptable catch range (fish) is required as stocking protocols have changed.

1. Commercial and recreational 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

Key Performance Indicators

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

Description

This KPI helps stakeholders to understand our role and effectiveness in ensuring the long-term sustainability of natural resources on which WA fishing relies and impacts.

The department undertakes annual assessments of fisheries that are subject to management. These assessments have been used to determine the sustainability status of the State's most significant commercial and recreational fisheries.

Calculation

Performance is measured as the proportion of all fisheries (that 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
- are recovering from a depleted state at an appropriate rate following management intervention.

The indicator is derived from annual assessments and trends in catch and fishing activity. The calculation of the proportion of fish stocks identified as not being at risk or vulnerable through exploitation is:

- [number of stocks maintained or recovering] divided by [total number of stocks].

Results

OVERVIEW TABLE 2.
Proportion of fish stocks identified as not being at risk or vulnerable through exploitation

	2021/22 Target (%)	2021/22 Actual(%)
Proportion of fish stocks identified as not being at risk or vulnerable through exploitation	95	96

OVERVIEW TABLE 3.
Historic data on the proportion of fish stocks identified as not being at risk or vulnerable through exploitation

Year	Target (%)	Actual (%)
2008/09	82	86
2009/10	85	89
2010/11	83	94
2011/12	86	94
2012/13	91	97
2013/14	94	97
2014/15	94	97
2015/16	97	95
2016/17	97	95
2017/18	97	97
2018/19	95	98
2019/20	97	98
2020/21	95	98

Analysis

Aquatic resource status assessments are based on all information up to and including the most recent fishing season. Because aquatic resources have various levels of available information, resource status is based on all available data using a risk-based weight-of-evidence assessment approach, full details of which are in the companion Status Reports on Western Australia's Fisheries and Aquatic Resources 2021/22. Status updates were undertaken during March–June with 48 resource and fishery combinations reviewed for 2021/22. The one fishery not examined is northern shark, which has not operated since 2009. Of the 47 assessments, 41 were considered to have adequate breeding stock levels and a further two fisheries (the Temperate Demersal Gillnet and Demersal Longline Fishery [TDGDLF] and the Gascoyne Demersal Scalefish Fishery) had breeding stocks considered to be recovering at acceptable rates. The TDGDLF targets relatively long-lived species so recovery is expected to take decades to complete. Of the four remaining fisheries, the Cockburn Sound Crab Managed Fishery and the West Coast Beach Bait Fishery continue to be environmentally limited with stocks recovering from the 2010/11 marine heat wave. Two fisheries (the Abalone Managed Fishery and the West Coast Demersal Scalefish Fishery [WCDSF]) have stocks that are considered inadequate as a result of exploitation with management actions already implemented to assist stock recovery.

The department's 2021/22 target for the proportion of fish stocks not at risk from fishing is 95%. For the 2021/22 reporting period, the proportion of the assessed groups identified as not being at risk or vulnerable through exploitation is 96%, which is above the target level. The department considers it has met this indicator.

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

Description

This KPI helps stakeholders to understand our role and effectiveness in ensuring the long-term sustainability of natural resources on which WA fishing relies and impacts. It 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).

Where management is operating effectively, annual catches by each fishery should vary within an acceptable range. The extent of this range reflects the degree to which normal environmental variations affect the recruitment of juveniles to the stock that cannot be 'controlled' by fishery management.

Additional factors 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 individual fisheries.

Calculation

For most fisheries in WA, each management plan seeks to directly control the amount of fishing pressure 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 an acceptable range.

For quota-managed fisheries, the measure of success of management arrangements is that the majority of the Total Allowable Catch (TAC) is achieved and 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 fails to achieve the TAC by a significant margin, this may indicate that the abundance of the stock is significantly lower than anticipated. For these reasons, an appropriate range of fishing effort to take a TAC has also been incorporated for assessing the performance of quota-managed fisheries.

Acceptable levels of catch are also determined for each of the major recreational fisheries.

The KPI shows the percentage of commercial and/or recreational fisheries achieving acceptable catches or effort levels (i.e. the number of days taken to achieve the catch). The calculation of the proportion of fisheries achieving acceptable catches or effort levels is:

- [number of fisheries achieving acceptable levels] divided by [total number of fisheries].

Results

OVERVIEW TABLE 4.
The proportion of commercial and recreational fisheries where catches or effort levels are achieved.

	2021/22 Target (%)	2021/22 Actual (%)
The proportion of commercial and recreational fisheries where catches (or effort levels) are acceptable	90	90

OVERVIEW TABLE 5.
Historic data on the proportion of commercial and recreational fisheries where catches (or effort levels) are achieved

Year	Commercial		Recreational		Overall	
	Target (%)	Actual (%)	Target (%)	Actual (%)	Target (%)	Actual (%)
2008/09	85	96				
2009/10	90	93				
2010/11	90	94				
2011/12	94	100				
2012/13	88	97				
2013/14	92	89	80	77		
2014/15	95	89	80	85		
2015/16	95	90	80	100		
2016/17	95	93	85	100		
2017/18	95	93	85	92		
2018/19		100		88	90	96
2019/20		93		88	90	91
2020/21		90		88	90	90

Analysis

Fisheries catch and effort information are provided by commercial and charter fishers through mandatory returns and recreational fisheries through surveys. Fisheries catch and effort data are dependent on the fishers' accuracy and completeness of data reporting, which is based on the most recent fishing season or most recent survey estimate.

Status updates were undertaken during March–June and, for the purpose of this indicator, comparisons between actual commercial catches (or commercial effort) with acceptable ranges have been undertaken for 34 of the 48 resource and fishery combinations reviewed for 2021/22. In addition, 17 of the 48 resource/fishery combinations have been identified as having a 'material' recreational catch share with associated recreational catch estimates were compared with acceptable ranges. A relatively high number of fisheries were not assessed due to a combination of ongoing environmentally induced stock issues or poor economic conditions resulting in minimal or no material levels of catches during this reporting period. 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 assessed recreational fisheries, only six currently have formal acceptable catch ranges developed and another 11 were assessed based on non-formal ranges related to resource sustainability. Of these, the data from the 2020/21 statewide survey of boat-based recreational fishing and additional annual surveys had catch estimate levels for 15 that were within acceptable catch ranges and two that exceeded the acceptable catch range. These were baldchin groper and pink snapper, which exceeded the acceptable catch range of the recreational sector within the WCDSF, and pink snapper, which exceeded the recreational catch range within Inner Shark Bay.

Of the 34 commercial fisheries, 12 were primarily catch-quota managed, with 22 subject to effort-control management. Of the 12 individually transferable catch-quota managed fisheries, three operated within, seven were acceptably below and two were unacceptably below (West Coast Deep Sea Crustacean Managed Fishery, greenlip abalone in the Abalone Managed Fishery) their effort/catch ranges. In the 22 effort-controlled fisheries, 15 were within, two were above, four were acceptably below and one was unacceptably below (southern rock lobster in the South Coast Crustacean Managed Fishery) their catch ranges. Catch/effort above or below their acceptable ranges were determined acceptable due to adequate resource sustainability. In summary, 15 of the 17 recreational fisheries and 31 of the 34 commercial fisheries (46 of the 51 fisheries overall) assessed were considered to have met their performance criteria.

The department's 2021/22 target is 90% for all major recreational and commercial fisheries. For the 2021/22 reporting period, the percentage of fisheries where acceptable catches are achieved is 90%, which is at the target level. The department considers it has met this performance indicator.

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 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

Environmental fluctuations and perturbations can influence aquatic resource status. While beyond the control of fishery management, monitoring and analysing trends in environmental variables (e.g. temperature) and correlations with fish stock dynamics (e.g. recruitment) are important to the ongoing monitoring and assessment of fishery resources and advice to managers. Similarly, the effects of climate change on fishery resources are being investigated and monitored as part of the inputs to fishery management advice.

Monitoring and analysing environmental data is undertaken by DPIRD staff in collaborations with a range of other research groups (e.g. Universities, CSIRO, etc.).

DPIRD is the lead State government agency responsible for the management of aquatic and terrestrial 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. Statewide Biosecurity in marine and terrestrial systems is now managed under the Sustainability and Biosecurity Pillar in DPIRD. This Pillar is also responsible for coordinating the fish kill response program within the State.

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.

OCEAN CLIMATE SUMMARY

A. Chandrapavan and N. Caputi

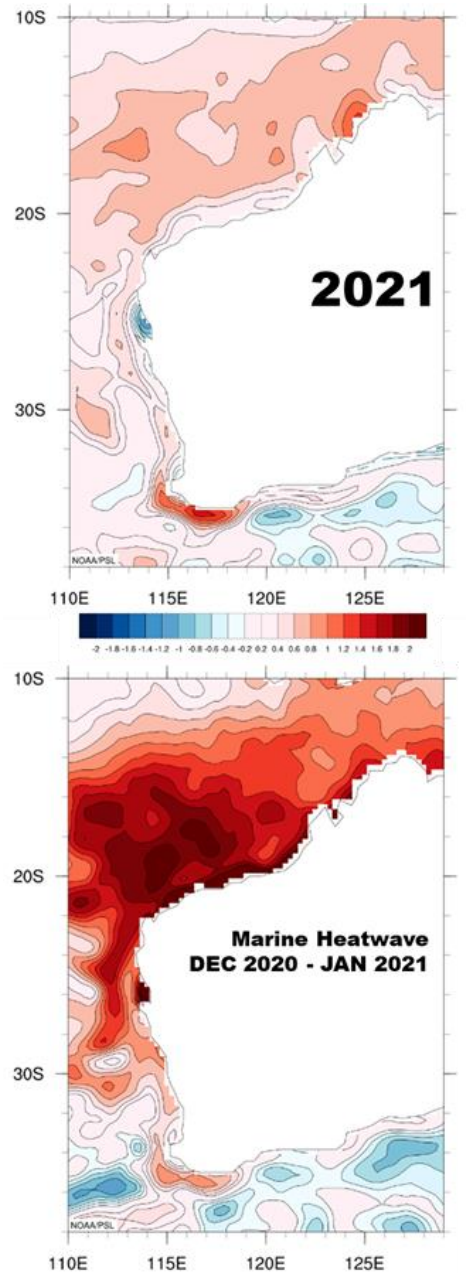
2020-21 La Niña Event

Early indications of a developing La Niña climate driver emerged in June 2020, which later established only as a ”weak” event between October 2020 and March 2021, peaking during January 2021 (Climate Change Overview Figure 1). This event was both short lived and weaker than the previous strong 2010-12 La Niña. La Niña like conditions persisted throughout 2021 and this is reflected in the overall warmer than average sea surface temperatures (SSTs) reported around WA (Climate Change Overview Figure 1).

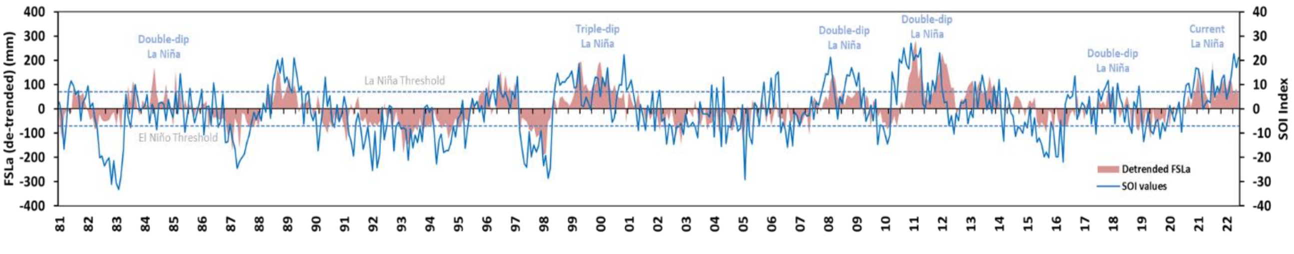
Leeuwin Current

The Leeuwin Current (LC) system, which can be up to several hundred kilometres wide along the West Coast, flows most strongly during the autumn/winter (April to August) period 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 up to 3 knots on occasions. The strength of the LC is inferred from the de-trended Fremantle Sea Level and has a strong relationship with ENSO (El Niño Southern Oscillation) (Climate Change Overview Figure 2). La Niña events are sustained by individual positive Southern Oscillation Index (SOI) values and El Niño events are indicated by sustained negative SOI values (Climate Change Overview Figure 2).

The LC flowed down the WA coast at an average strength over the 2020 autumn/ winter months and then increased over the 2020-21 La Niña months, particularly between December and February. Above average LC strength has persisted into 2022, although pulses of sea level increases can also be attributed to tropical low-pressure systems impacting the coastline such as those observed during July 2021.



CLIMATE CHANGE OVERVIEW FIGURE 1.
Mean sea surface tempertaure anomalies for 2021 (Top), and marine heatwave temperature anomalies between December 2020 and January 2021 (bottom). Data from NOAA High-resolution Blended Analysis.



CLIMATE CHANGE OVERVIEW FIGURE 2.
The strength of the LC is inferred from the de-trended Fremantle Sea Level (FSLa) anomalies (red bars) and has a good relationship with ENSO (SOI index) (blue line). La Niña events are associated with sustained positive SOI values and El Niño events with sustained negative SOI values.

Climate Extremes

January 2021 Marine Heatwave

A marine heatwave (MHW) event is a prolonged period when the ocean is much warmer than usual at a particular location and time of year. WA lies within the eastern Indian Ocean basin where major MHW events are strongly associated with ENSO events. Soon after the commencement of the 2020/21 La Niña, and as the LC strengthened its flow, a MODERATE to STRONG marine heatwave formed over a large area extending from the Kimberley on the North Coast through the Mid West and down to Perth metro regions (Climate Change Overview Figure 1). SSTs were elevated by 1–3°C and were likely to be higher in the shallow inshore regions of the mid to north WA coastal regions.

Low pressure and cyclonic activity which formed at the end of January helped dissipate some of the heat on the north-west shelf, although warm anomalous water temperatures have persisted in some coastal regions well into May 2021.

Cyclones

The number of tropical cyclones (TC) in the 2020-21 season (8) was below the long-term average of 11 in the Australian Region, although the number of recorded tropical lows was above average for the recent two decades (since 2005-06).

TC Seroja crossed the Central West coast of WA on 11 April 2021, a rare occurrence of a severe cyclone (category 3) crossing the coast so far south and so late in a season making it the southern-most severe tropical cyclone to cross the WA coast since the early 1970s.

Seroja passed close to another tropical low (which briefly developed into tropical cyclone Odette), and experienced what is known as the Fujiwhara Effect, which is a phenomenon where two tropical lows in close proximity interact with each other.

This interaction contributed to Seroja taking a track that was more southerly than what it otherwise would have been and was further aided by the very warm SSTs off WA’s west coast. This aided TC Seroja in maintaining its strength as it moved further south.

Bioregional summaries

Water tempertaure is the most well measured and studied aspect of climate change impacts within the ocean. Around Australia, SSTs have warmed around 1°C since 1910, however at a more regional scale, this rate of warming varies both spatially and temporally (Climate Change Overview Figure 3, Climate Change Overview Table 1). In WA, the North Coast bioregion has experienced a notable warming period occuring between October and December, where mean SSTs are now 0.4-0.8°C warmer than during the 1980s. The North Coast Bioregion in 2021 experinced its 4th warmest year since 1982, with 134 MHW days recorded.

The Gascoyne Bioregion in 2021 recorded its 6th warmest year (since 1982) with 67 MHW days. During the past decade, the greatest warming period is over the spring/summer transition October to January where mean SSTs were 0.3-0.7°C warmer than in the 1980s. The winter period however exhibits a cooler trend and this is most prominent inside Shark Bay and the Exmouth Gulf embayments, which is associated with the dynamics of the sub-tropical ridge.

The West Coast Bioregion in 2021 recorded its 10th warmest year (since 1982) with 48 MHW days. The greatest warming period has been during the past decade where summer months November to April are shown to be ~0.4°C warmer than in the 1980s.

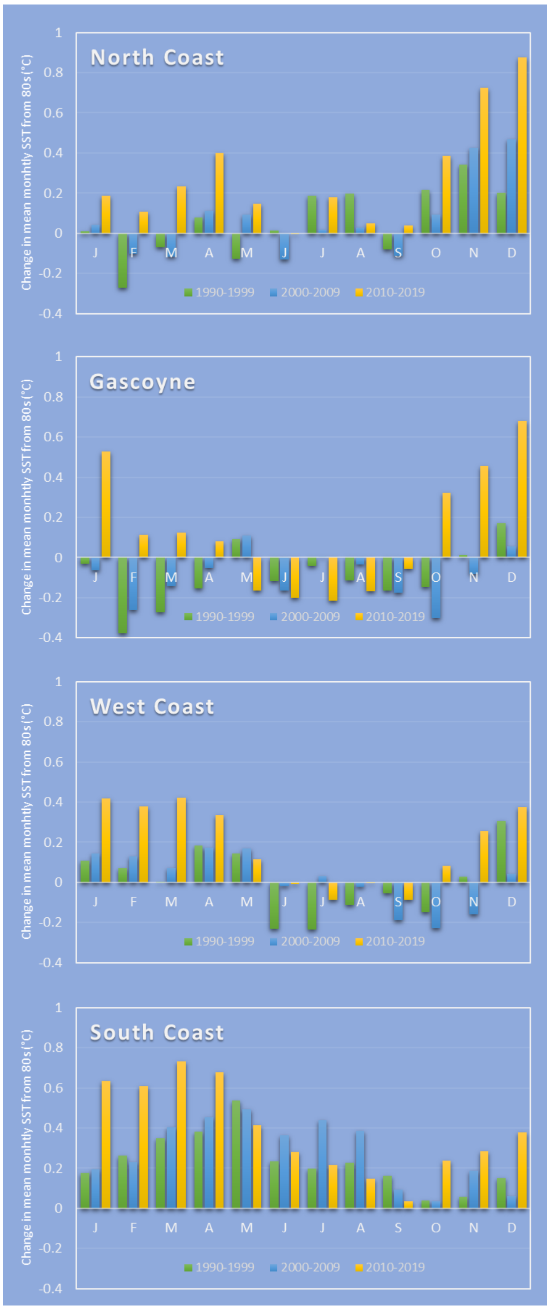
The South Coast Bioregion in 2021 recorded an average year with only 19 MHW days. However, it is the only bioregion that has consistently exhibited a warming trend across all months since the 1980s, with the past decade seeing a warming of 0.6-0.7°C between January and April and up to 0.2°C over the winter months.

Overall, the South-West region of WA State waters is exhibiting the greatest warming during the spring/summer months compared to the past decades. This may be a signal of the expansion of the tropical zone into temperate and sub-temperate latitudes due to climate change.

It is important to note that the trends discussed above are calculated over a large oceanic region and these trends do not always represent the nearshore shallow coastal regions of WA (where many of the fish stocks reside), where SSTs are strongly influenced by the local wind regime, tide fluctuations and air-sea interactions.

CLIMATE CHANGE OVERVIEW TABLE 1.
Overview of the bioregional summaries of mean annual (2021) SST and anomaly (relative to the 1982-2018 climatology) and the total number of marine heatwave days (mean daily SST > the 90% percentile) for 2021. These analyses are based on NOAA IOSST V2 dataset for the bioregions indicated on Introduction Figure 2.

2021 Bioregion	Annual Mean SST °C	Annual Mean SST Anomaly °C	Rank (out of 40 years)	Total MHW Days	Rank
North Coast Record	28.59 28.89 (2016)	+0.58 +0.87	4th	134 199 (2016)	3rd
Gascoyne Record	25.42 29.65 (2011)	+0.47 +0.69	6th	67 149 (1999)	12th
West Coast Record	19.37 20.28 (2011)	+0.18 +1.21	10th	48 260 (2011)	10th
South Coast Record	16.72 17.39 (2011)	-0.05 +0.63	22nd	19 196 (2011)	21st



CLIMATE CHANGE OVERVIEW FIGURE 3.
Decadal differences in mean monhtly SST between the 1980s and the 1990s (green), 2000s (blue) and 2010s (orange) for the four bioregions. Data from NOAA High-resolution Blended Analysis.

WA Ocean climate projections

CSIRO's regional climate projections for WA (https://research.csiro.au/cor/wp-content/uploads/sites/282/2021/07/Summary-of-Regional-projections-W-Australia-v3.pdf) and specifically for the region between the Pilbara and Albany by 2040 includes;

- 0.5–1°C increase in SST
- > 200 MHW days
- 10-20 cm sea level increase
- 20-30% increase in ocean acidification
- An increase in storm intensity and variability
- 3-5% rainfall decrease

Climate change is already impacting the biological, economic and social aspects of many WA fisheries in both negative and positive ways. For our invertebrate species, seasonal shifts in temperature increases, tempertaure extremes and their timing are influencing the timing of spawning, larval survival and retention, leading to changes in recruitment and productivity. Shifts in overall species distribution are less reported, however, reports of the occurrence of individual species outside their historical range are monitored in a national citizen-science program (www.redmap.org.au) in which the Department is a collaborator.

WEST COAST BIOREGION

ABOUT THE BIOREGION

The marine environment of the West Coast Bioregion between Kalbarri and Augusta is predominantly a temperate oceanic zone. However, 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 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. Some species have appeared to form self-sustaining populations in this Bioregion.

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 oceanic 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 up to 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 coastal finfish species.

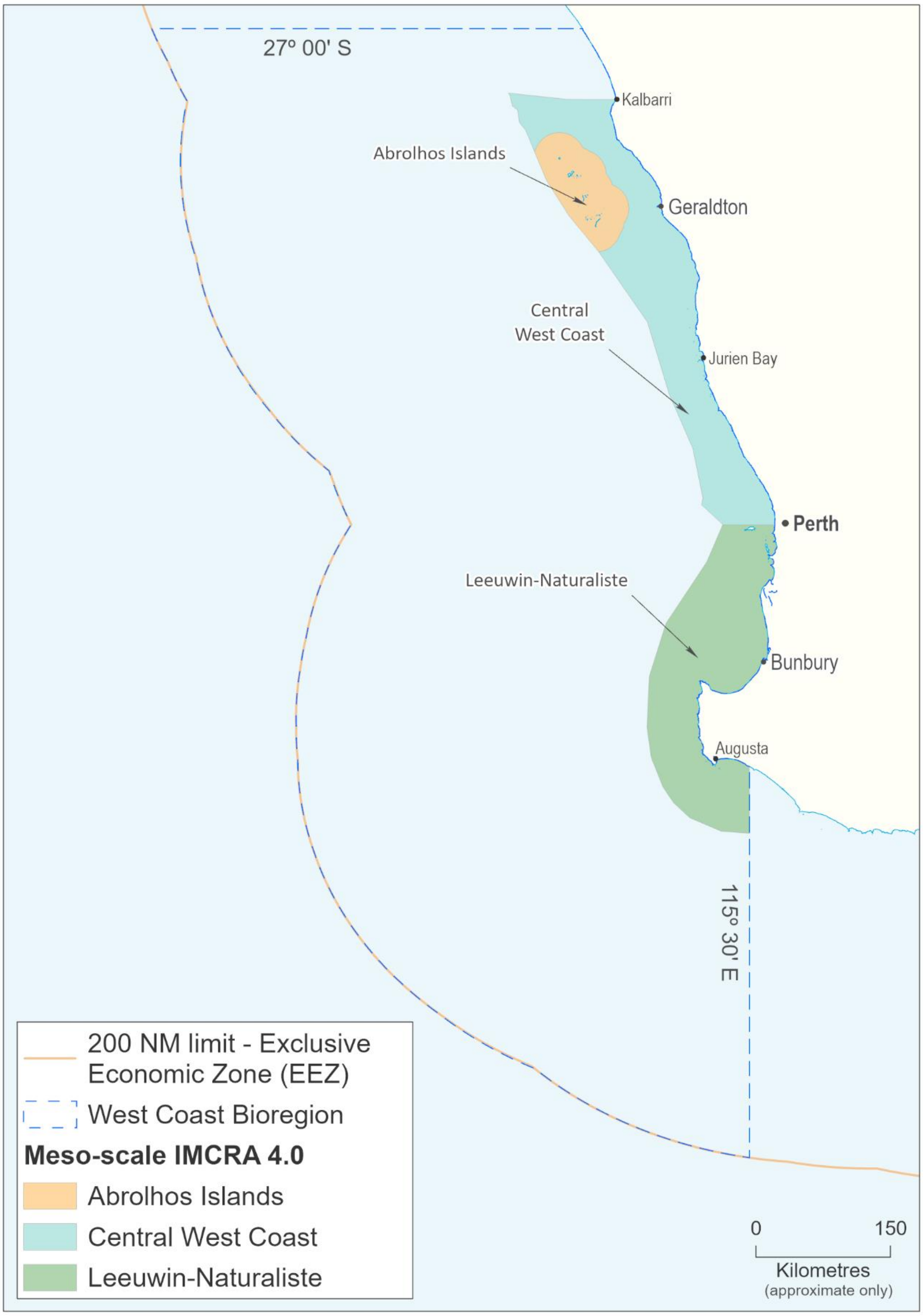
The most significant impact of the clear, warm, low-nutrient waters of the Leeuwin Current is on the growth and distribution of temperate seagrasses. These form extensive meadows in protected coastal waters of the West Coast Bioregion, generally in depths of less than 20 m (but up to 30 m), and act as major nursery areas for many fish species and particularly for western rock lobster.

The West Coast Bioregion 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, as well as behind Rottnest and Garden Islands in the Perth metropolitan area.

The two significant marine embayments in the West Coast Bioregion are Cockburn Sound and Geographe Bay. Along the West Coast, there are four significant estuarine systems – the Swan/Canning, Peel/Harvey and Leschenault estuaries, and the 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 and are depicted in West Coast Bioregion 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 those ecosystems separately.



WEST COAST BIOREGION OVERVIEW FIGURE 1
Map showing the three main IMCRA (V4.0) ecosystems in the West Coast Bioregion: Abrolhos Islands; 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:

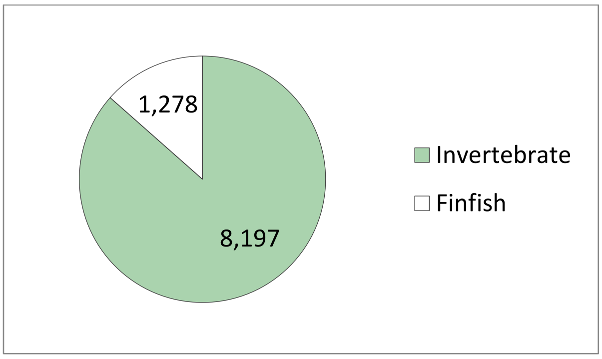
- increasing frequency of El Niño/Southern Oscillation (ENSO) events;
- more years with a weaker Leeuwin Current;
- increases in water temperature off the west coast of WA, particularly the lower west coast;
- increases in salinity, which includes some large annual fluctuations;
- change in the frequency and location of storms (and rainfall) affecting the lower west coast; and
- change in the frequency of cyclones (and summer rainfall) affecting the 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 of species; 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

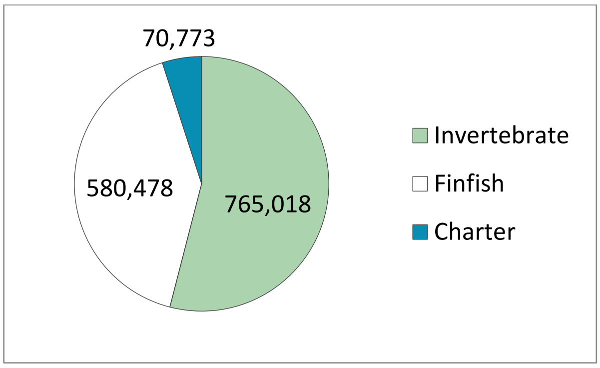
The commercial catch in this Bioregion is dominated by invertebrates (see West Coast Bioregion Overview Figure 2). The principal commercial fishery in this region is the western rock lobster fishery, which has historically been Australia's most valuable single-species wild capture fishery. There are 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 BIOREGION OVERVIEW FIGURE 2
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 (see 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. Fishing for demersal and pelagic/game species often occurs around islands, along bottom features, and out to the edge of the continental shelf. The recreational catch is dominated by invertebrates (West Coast Bioregion Overview Figure 3).



WEST COAST BIOREGION OVERVIEW FIGURE 3
Recreational catches (by number) in the West Coast Bioregion. Finfish and invertebrate catches were assessed in the statewide survey of boat-based recreational fishing in 2020/21[1]. Charter boat catch is for the same period. Estimates of shore based recreational catch are unavailable.

Vessel retrievals from key boat ramps have been monitored using remote cameras for previous state-wide surveys[2]. The typical seasonal pattern of vessel retrievals at Hillarys and Woodman Point was not observed during the early stages of COVID-19 restrictions from March to August 2020[3]. Activity patterns post COVID-19 travel restrictions are currently being analysed.

1 Ryan KL, Lai EKM, Smallwood CB. 2022. Boat-based recreational fishing in Western Australia 2020/21. Fisheries Research Report No. 327 Department of Primary Industries and Regional Development, Western Australia. 221pp.

2 Ryan KL, Lai EKM, Smallwood CB. 2022. Boat-based recreational fishing in Western Australia 2020/21. Fisheries Research Report No. 327 Department of Primary Industries and Regional Development, Western Australia. 221pp.

3 Ryan KL, Desfosses CJ, Denham AM, Taylor SM, Jackson, G. 2021. Initial insights on the impact of COVID-19 on boat-based recreational fishing in Western Australia. Marine Policy 132: 104646

Aquaculture

The principal aquaculture development activity in the West Coast Bioregion is the emerging black pearl industry based on the production of *Pinctada margaritifera* at the Abrolhos Islands. Initiatives to expand the number of aquaculture sectors in this bioregion currently include those for rock oysters, seaweed, and finfish. There is growing interest in the area generally and at the Abrolhos Islands in the production of seaweed for extraction of high-value products including pharmaceuticals, nutraceuticals and, for *Asparagopsis* species, the extraction of bromophores for use in ruminant feed for methane reduction. 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. A small-scale project growing yellowtail kingfish near Geraldton has ceased temporarily and there remains interest in offshore production of the species in the Aquaculture Zone. The Government supports the establishment of a marine finfish nursery at Geraldton to underpin growth of that sector. Planning for the nursery has been impacted by the COVID-19 pandemic with some aspects of the project requiring review.

Tourism

The State capital, Perth, is the principal gateway for more than two million (pre COVID-19) visitors to Western Australia each year and is 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, interstate and local visitors. Tourism numbers were affected by COVID-19 restrictions in place. Travel restrictions have now been lifted. 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) and the Royal Australian Navy's largest base (HMAS Stirling) on Garden Island. A land backed port is being developed in Kwinana (Westport) and a deep-water port at Oakajee, 24 km north of Geraldton. In addition to handling most of Western Australia's container trade, significant quantities of non-containerised cargo pass 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. Prior to COVID-19, international cruise ship visitations had increased and some cruise liners were home-based in Fremantle.

Major shipbuilding, repair, maintenance and offshore construction support industries are located at Henderson in the north-eastern corner of Cockburn Sound. Collectively, these enterprises directly employ over 2,000 people, indirectly support thousands of more jobs and generate significant economic activity.

There are a number of smaller ports (e.g. Augusta, Busselton) and a large number of public boat ramps and marinas in the Bioregion.

The impacts from vessels and ships tend to be concentrated around ports and favoured anchorage areas. Impacts include physical damage to the habitat, small pollution incidents and the potential to introduce marine pest species. The Department has surveillance in place for marine pests in key port areas to aid in the early detection of any unwanted aquatic species from other locations.

Other Activities

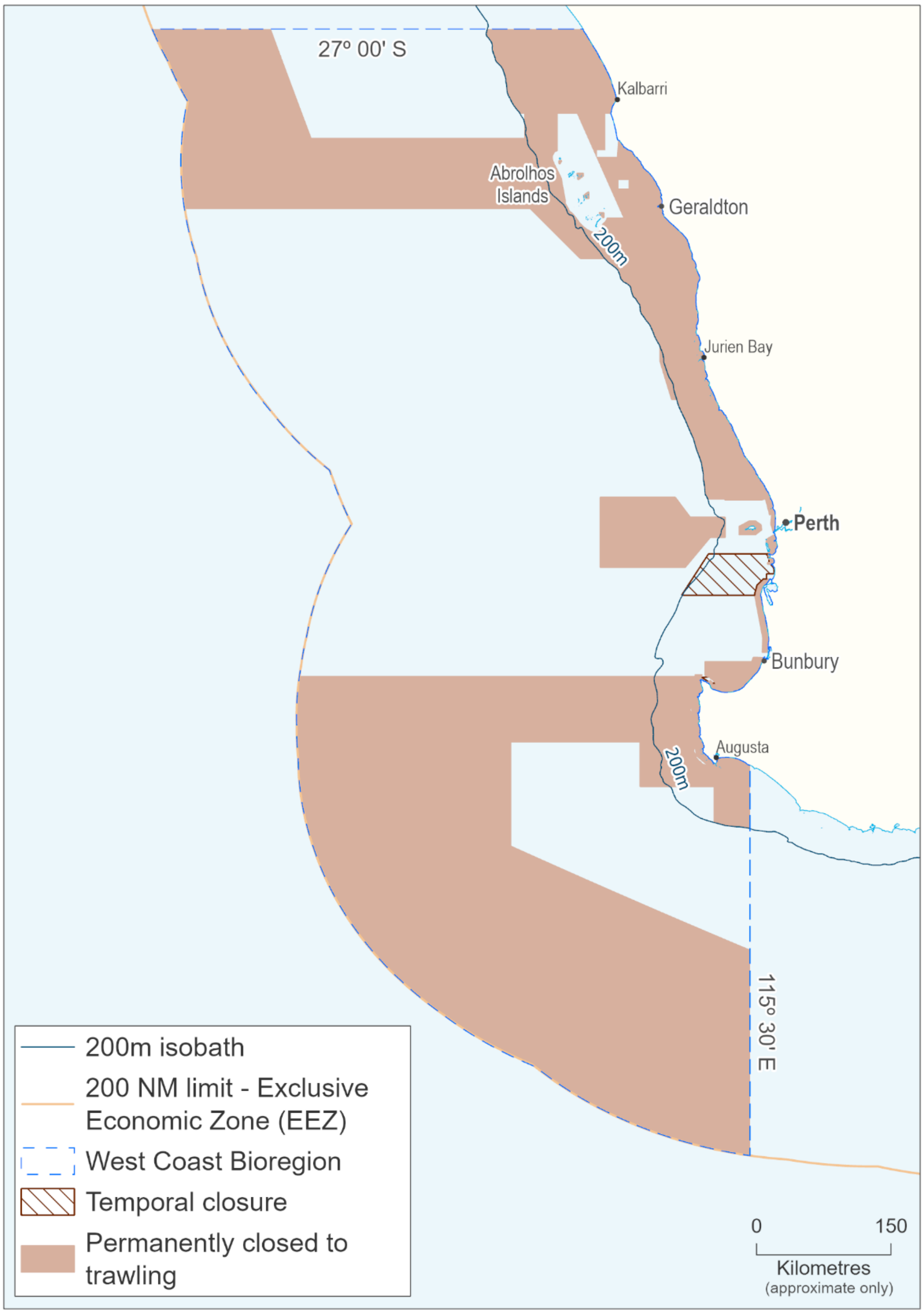
High rates of population growth and boat ownership in Western Australia have strained recreational boating facilities around major population centres, particularly in the Perth metropolitan region. New and upgraded marinas and boat launching facilities have been completed or are planned to accommodate this demand, including at Ocean Reef and Two Rocks. 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. Approval has been sought to develop two additional desalination plants in the metropolitan region, one of which is planned at Alkimos, which may develop if the population grows and water demands increase.

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 by extensive closures to trawling. These closures inside 200 m 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 Bioregion Overview Figure 4). Demersal gillnet and longline fishing was also prohibited from waters inside the 250 m isobath between 31º and 33º South from November 2007. The extent of these areas means that most of the West Coast Bioregion inside 200 m depth can be classified as one of the marine protected area categories of the International Union for the Conservation of Nature (IUCN) (West Coast Bioregion Overview Table 1).



WEST COAST BIOREGION 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 OVERVIEW 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 include State or Commonwealth closures that are currently in the process of implementation. These areas will be included in future volumes, when their respective implementation processes are concluded.

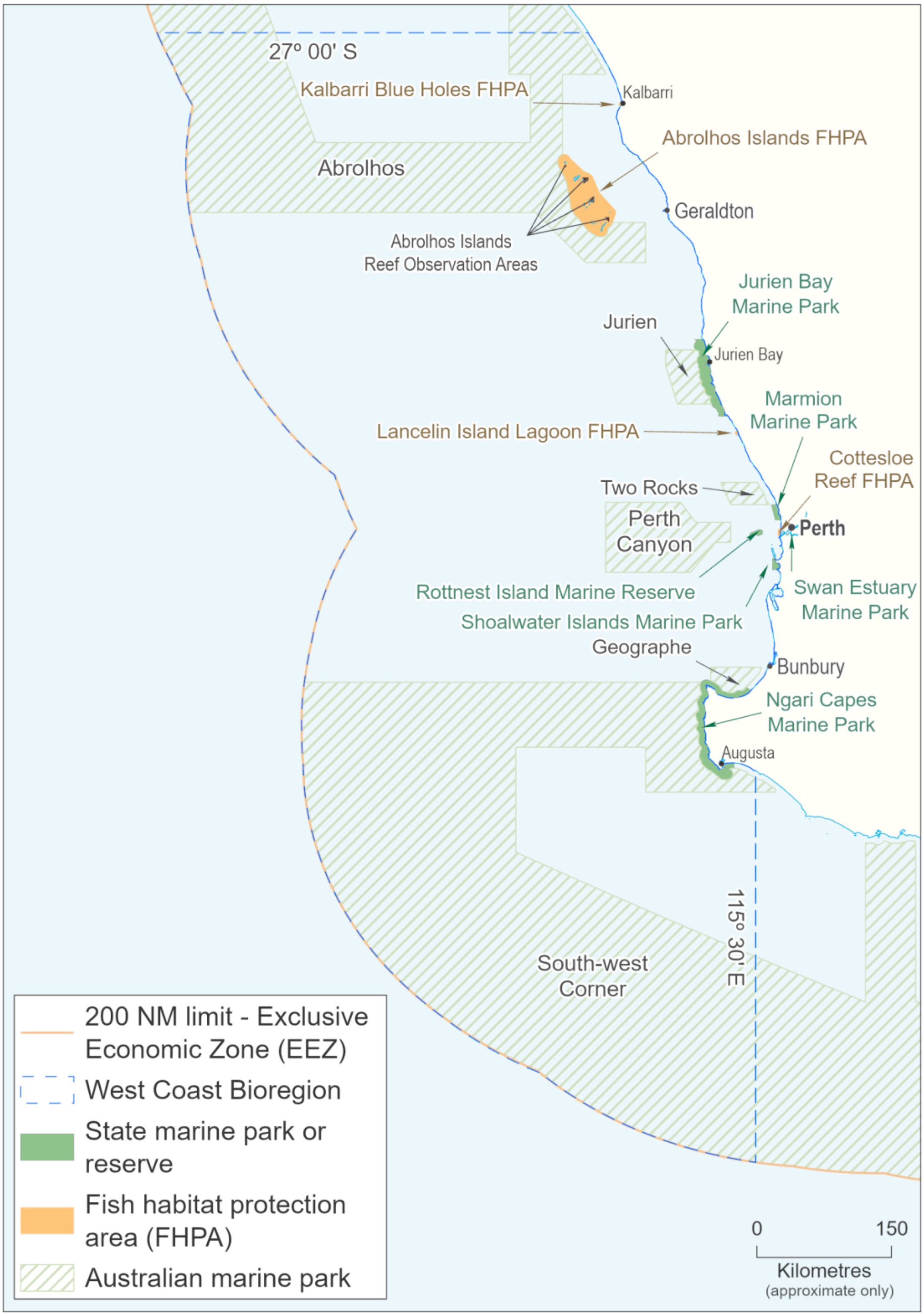
IUCN category or equivalent	State Waters only (10,088 km^2)				All Waters (481,488 km^2 (including State Waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km^2	%	km^2	%	km^2	%	km^2	%
I	0	0	0	0	0	0	0	0
II	1	< 1	310	3	1	< 1	1,200	< 1
III	0	0	0	0	0	0	0	0
IV	4,500	40	1,900	17	33,600	7	1,900	< 1
V	0	0	11	< 1	0	0	0	0
VI	3,400	30	1,200	11	445,700	89	17,840	4

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 Section 43 of the *Fish Resources Management Act 1994* at the Busselton Underwater Observatory and around the wrecks of the *Saxon Ranger* (Shoalwater Bay), *HMAS Swan* (Geographe Bay) and *Lena* (Off Bunbury).

In addition, State marine parks proclaimed under the *Conservation and Land Management Act 1984* include Jurien Bay, Marmion, Swan Estuary, Shoalwater Islands, and Ngari Capes marine parks. The Rottnest Island Marine Reserve is declared under the *Rottnest Island Authority Act 1987* (West Coast Bioregion Overview Figure 5).

In 2019 the State Government announced the ‘Plan for Our Parks’ initiative to create additional marine parks and terrestrial conservation reserves by February 2024. This initiative includes the review and expansion of the Marmion Marine Park from Trigg Point to Two Rocks.

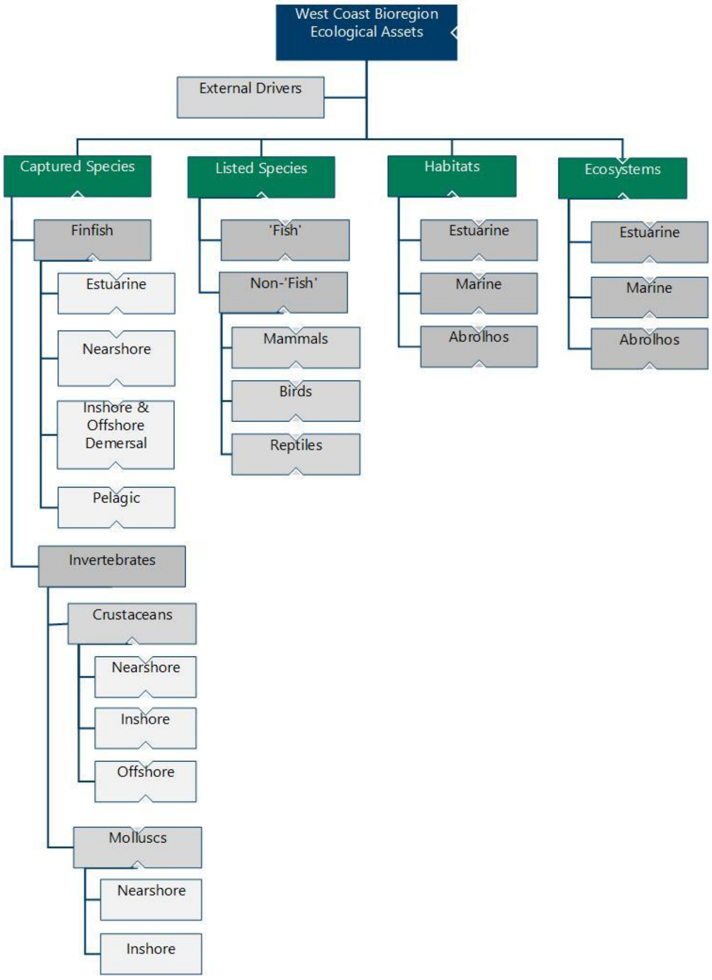
The Commonwealth Government implemented an Australian Marine Park in Commonwealth waters between Kangaroo Island (South Australia) and Shark Bay in July 2018, which includes a network of marine parks in the West Coast Bioregion (West Coast Bioregion Overview Figure 5).



WEST COAST BIOREGION OVERVIEW FIGURE 5
Map showing the West Coast Bioregion and current State and Commonwealth marine parks and reserves along the west coast.

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 (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. The key ecological assets identified for the West Bioregion are identified in West Coast Bioregion Overview Figure 6 and their current risk status reported on in the following sections.



WEST COAST OVERVIEW 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 fisheries 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[1,2,3] on fisheries has been assessed but further information is required to examine potential impacts on this bioregion.

Captured Species

FINFISH

Estuarine

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

Stock status is variable among species. The stock of Perth herring is classified as enviornmentally limited in the West Coast Bioregion mainly due to external (non-fishing) factors (e.g. poor water

1 Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M. and Gaughan, D. 2011. The “marine heat wave” off Western Australia during the summer of 2010/11. Fisheries Research Report No. 222. Department of Fisheries, Western Australia. 40pp;
2 Caputi, N., Jackson, G. and Pearce, A. 2014. The marine heat wave off Western Australia during the summer of 2010/11 – 2 years on. Fisheries Research Report No. 250. Department of Fisheries, Western Australia. 40pp.
3 Caputi, N. et al. (2015). Management implications of climate change effect on fisheries in Western Australia, Part 1: Environmental change and risk assessment. FRDC Project No. 2010/535. Fisheries Research Report No. 260. Department of Fisheries, Western Australia. 180pp.

quality, reduced water flows, water diversion, and other environmental factors).

Peel-Harvey Estuary sea mullet fishery holds MSC certification.

Nearshore

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

Stocks of Yellowfin whiting, Australian herring and Western Australian Salmon are classified as Sustainable-adequate. However, the stock of Southern garfish in the Perth metropolitan zone is classified as Inadequate-environmentally limited. Whitebait is also classified as Inadequate-environmentally limitied.

Inshore and Offshore Demersal

Captured Species	Aquatic zone	Ecological Risk
Finfish	Inshore Demersal	HIGH
Finfish	Offshore Demersal	LOW

The most recent (2021) stock assessment of West Australian dhufish and snapper demonstrated that fishing pressure is too high to allow stocks to replenish. A review is underway to determine the management measures required to recover the resource by 2030. The stocks of deep-water indicator species are considered sustainable based on the current catch levels.

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	MEDIUM
Crustaceans (Lobsters)	Inshore	LOW

The Cockburn Sound Crab Managed Fishery was closed in 2014 and the blue swimer crab stock is considered to be environmentally limited. As the 2021 egg production and juvenile indices were below their respective limit levels, the fishery remained closed for the 2021/22 season. It is unlikely that the stock will return to historical high levels, mainly as a result of changing environmental conditions (e.g. decline in nutrients and primary production).

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. Both the commercial and recreational sectors of the Peel-Harvey crab fishery are MSC certified. The stock levels of western rock lobster are currently at appropriate levels. Ongoing strong management of the rock lobster fishery has ensured that the lobster biomass and egg production are at record high levels. The Western Rock Lobster Fishery has maintained MSC certification since 2000.

Molluscs

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

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 Roe's abalone in the Kalbarri region and that region has consequently been closed since 2011/12.

Saucer scallops are fished using otter trawls. Catches in these fisheries vary widely depending on the strength of recruitment. The stock of scallops in the Abrolhos Islands and Mid-West Trawl Managed Fishery and the South West Trawl Managed Fishery are both considered to be Sustainable-Adequate.

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 Biodiversity Conservation Act 2016*, and the *Fish Resources Management Act 1994*.

Fish

Listed species	Ecological Risk
Fish	MEDIUM

Grey nurse shark (*Carcharias taurus*) are protected under State and Commonwealth legislation throughout this and all other marine bioregions. Blue groper (Rottnest Island) and baldchin groper (Abrolhos Islands FHPA between 1 November and 31 January) cannot be landed by

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

commercial or recreational fishers in particular areas and periods.

Non-Fish

Listed species	Ecological Risk
Mammals	MEDIUM
Birds and Reptiles	HIGH

The West Coast Bioregion lies to the south of the distribution of most marine turtles and, thus, there are minimal risks to turtles from fishing activities within this Bioregion. The 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 (SLEDs) have now been implemented for rock lobster pots near Australian sea lion breeding colonies. Gillnet exclusion zones are in place around known Australian sea lion colonies. Demersal gillnet fishing effort in the West Coast Bioregion, which has historically been responsible for a very small number of reported sea lion captures, is now less than 10% of its peak level of the late 1980s. A recent ecological risk assessment for the Western Australian Temperate Demersal Elasmobranch Resource identified Australian sea lions as being high risk[1]. This was attributed to the potential for interaction with commercial gillnets, a lack of population modelling and fishery-independent data validation. However, as most current gillnet effort occurs on the south coast, fishing activities are deemed to pose a medium risk to Australian sea lions in the West Coast Bioregion.

Regulated modifications to rock lobster fishing gear configuration during humpback and southern right whales' northerly winter migration have successfully reduced entanglement rates by ~60% in recent years. Thus, risks to whales from fishing activities in the West Coast Bioregion have decreased in recent years but are not yet considered to be low due to the social value (and therefore risk) around whales.

Fisher et al. (2020[2]), reported a high risk score for the migratory and threatened shorebird species that inhabit Peel-Harvey Estuary during the summer months, when there is potential for feeding and roosting birds to be disturbed by recreational scoop net fishers in key areas of overlap. As part of the MSC assessment process, the impacts of recreational crabbing in Peel Harvey Estuary on migratory ETP shorebirds is being assessed in more detail.

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 West Coast Bioregion, 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, and are an important food source, nursery ground and shelter for a variety of organisms. Along the WCB, there is a gradual transition from the 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. They are sometimes also found also on deep rock to over 50 m depth. Seagrasses provide habitat for many fish and crustacean species, stabilise coastal sediments, and prevent coastal erosion. In addition, seagrasses are 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 the West Coast Bioregion and South Coast Bioregion combined.

Corals: Due to the cool temperate waters, corals are not common in the West Coast Bioregion 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 recorded coral species at the Abrolhos. Elsewhere in the West Coast Bioregion 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, including shallow waters, areas deeper than 30m, and caves. As they are sessile filter-feeders, sponges flourish in areas of high current, although large sponges are also found in calmer deeper

1 Watt, M., Braccini, M., Smith, K., and Hourston, M. 2021. Ecological Risk Assessment for the Temperate Demersal Elasmobranch Resource. Fisheries Research Report No. 318. Department of Primary Industries and Regional Development, Western Australia, 110pp.

2 Fisher, E.A., Evans, S.N., Desfosses, C.J., Johnston, D.J., Duffy, R., Smith, K.A. 2020. Ecological Risk Assessment for the Peel-Harvey Estuarine Fishery. Fisheries Research Report No. 311. Department of Primary Industries and Regional Development, Western Australia. 102pp.

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	HIGH (non-fishing)
West Coast Habitat	Marine	LOW
Abrolhos Islands	Marine	MEDIUM

The West Coast is a micro-tidal, 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 marine protected areas in the West Coast (West Coast Bioregion Overview Figure 5). Spatial zoning restricts activities within these areas, including the prevention of trawling.

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. Fisher et al. (2020[1]), assessed the impacts of fishing on the various habitats in Peel Harvey Estuary as being either negligable or low. 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, Roe’s 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[2]. The Department has a long term coral reef monitoring program at the Abrolhos to detect potential impacts from human use and natural influences.

There are 45 public moorings installed at the Abrolhos Islands, distributed around the different island groups, to minimise impacts of anchoring on benthic habitats. The commercial scallop fishery also operates predominately in areas of sand away from coral reef habitats. Projected development of the tourism industry in the area may have effects on the habitats and will be monitored.

Ecosystems

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

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. Fish mortality events have been periodically reported from within the Peel–Harvey and Swan–Canning estuaries and in Cockburn Sound.

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)[3]. 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 are protected within a ‘Fish Habitat Protection Area’, and are not considered to be at an unacceptable risk from fisheries related activities. A significant coral bleaching event was observed during the marine heat wave event in 2011 (Abdo *et al*. 2012)[4]. The impact of this event is 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 Fisher, E.A., Evans, S.N., Desfosses, C.J., Johnston, D.J., Duffy, R., Smith, K.A. 2020. Ecological Risk Assessment for the Peel-Harvey Estuarine Fishery. Fisheries Research Report No. 311. Department of Primary Industries and Regional Development, Western Australia. 102pp.

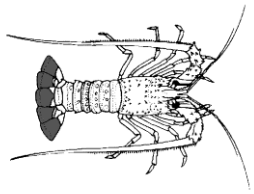
2 Evans, S.N., Konzewitsch, N., & Bellchambers, L.M. 2022. Houtman Abrolhos Islands Fish Habitat Protection Area: A Summary of Marine Resource Use and Ecological Attributes. Fisheries Research Report No. 321. Department of Primary Industries and Regional Development, Western Australia. 174pp.

3 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.

4 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.

FISHERIES

WEST COAST ROCK LOBSTER RESOURCE STATUS REPORT 2022



S. de Lestang and Rebecca Oliver

OVERVIEW

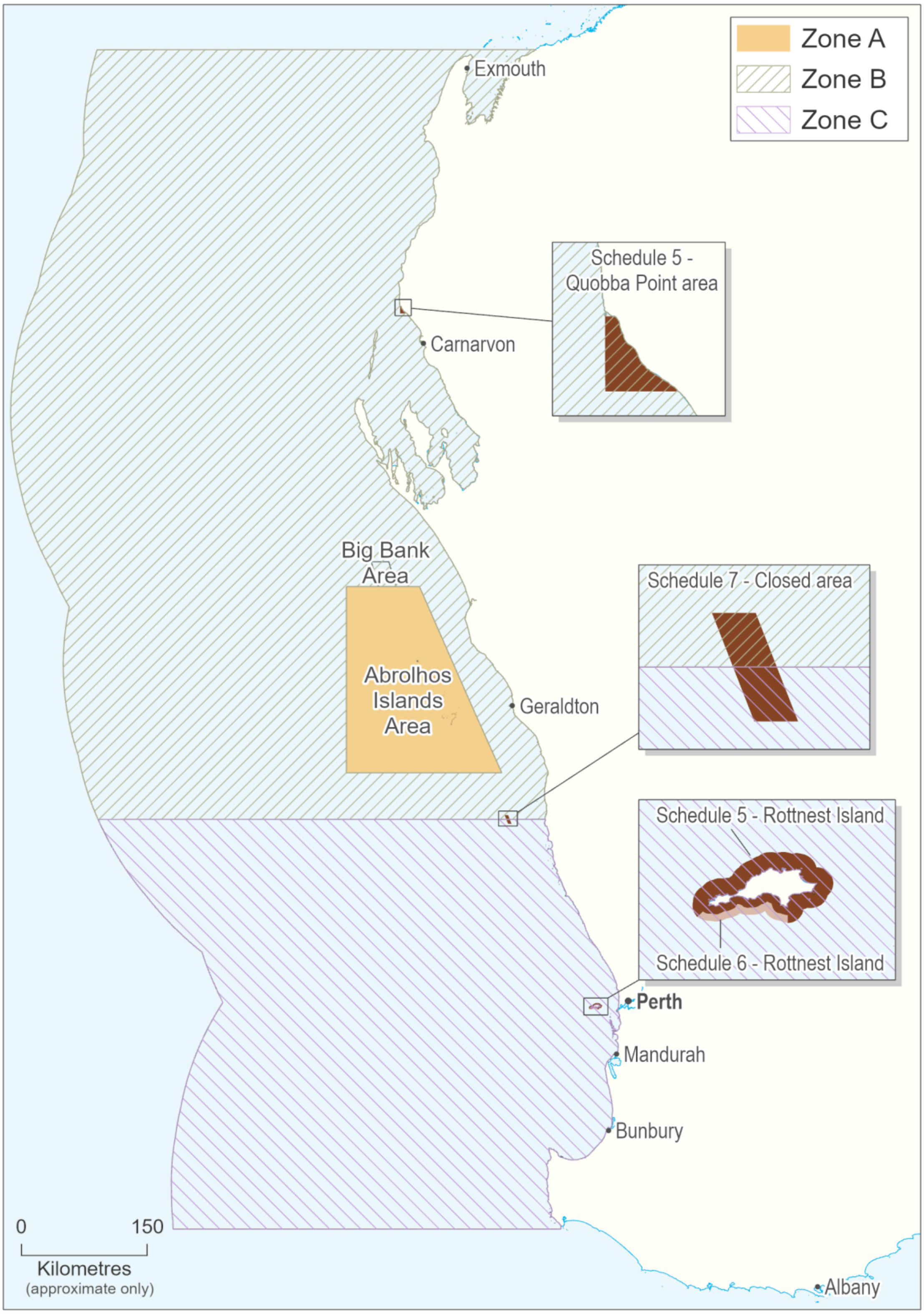
The West Coast Rock Lobster Managed Fishery (WCRLMF) targets the western rock lobster (*Panulirus cygnus*), on the west coast of Western Australia between Shark Bay and Cape Leeuwin. Lobsters are taken throughout their range by both the commercial and recreational sector and each sector operates to formal resource allocations.

The WCRLMF was one of the first limited entry fisheries in the world and for over 20 years utilised an Individual Transferable 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 on the assessment and management of this fishery; www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_9.pdf).

The commercial fishing season begins on 15 January each year and runs for 12 months, however due to Covid-19 related logistics and marketing issues, the 2020/21 season was extended to 18 months, from 15 January 2020 to 30 June 2021. The subsequent season was again extended (1 July 2021 to 14 January 2023) to bring the season structure back into alignment to a 12-month period from 15 January – 14 January the following year. Since the current extended season is still in progress, data has been reported for the period from 15 January 2021 to 14 January 2022. The recreational fishery still ran for 12 months state-wide and is nominally considered to span February to the following January (in an attempt to align it with the standard commercial season). 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 legislated bag and/or boat limits.

SUMMARY FEATURES

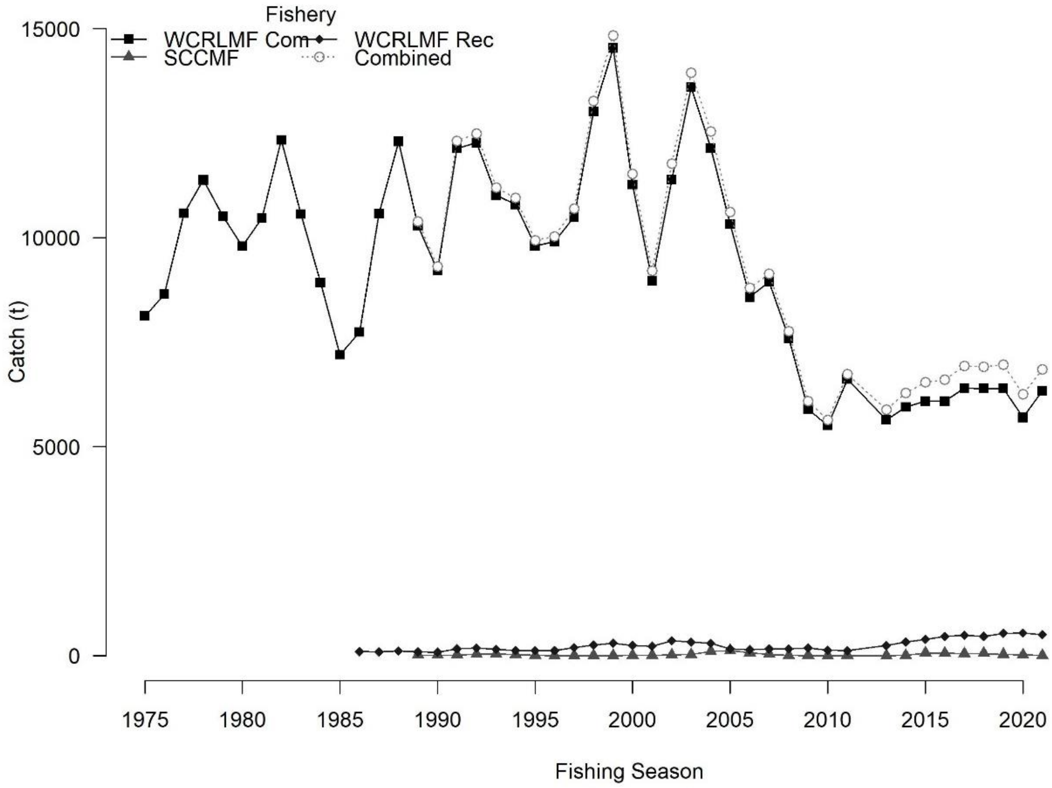
Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (6,615 + 1.5% t)	Total Catch Jan 2021/Jan 2022: 6334 t	Acceptable
Recreational fishery (562 t)	Total Catch Feb 2021/Jan 2022: 487 t (95% CI: 434–541 t). Charter: 17 t.	Acceptable
EBFM		
Indicator species		
Western Rock Lobster	Low Risk: Above biomass threshold	Adequate
Ecological		
Bycatch	Low Risk	Adequate
Listed Species	Negligible Risk	Adequate
Habitat	Low Risk	Adequate
Ecosystem	Low Risk	Adequate
Economic 2021/22 Financial year (GVP $203 m)	Moderate Risk	Acceptable
Social (high amenity)	Moderate Risk	Acceptable
Governance	Low Risk	Acceptable
External Drivers	High Risk (climate, market)	Acceptable



WESTERN ROCK LOBSTER FIGURE 1.
Map showing boundaries of the West Coast Rock Lobster Managed Fishery.

CATCH AND LANDINGS

The total commercial landings of western rock lobster in the 12-month season 2021/22 (15 Jan 2021 – 14 Jan 2022) from the WCRLMF were 6,334 t. On a pro rata basis the total allowable commercial catch for this period was 6,615 t. The estimated recreational harvest was 487 t (95% CI 434–541) and the charter catch was 17 t (Smallwood et al. 2022), which was below the Total Allowable Recreational Catch (TARC) of 562 t (Western Rock Lobster Figure 2).



WESTERN ROCK LOBSTER FIGURE 2.
Total landings by fishery including the South Coast Crustacean fishery (SCCMF) (and combined) for western rock lobster. Note for comparison with the other sectors, catches for the WCRLMF have been displayed on the historic 12-month fishing season (15 Jan – 14 Jan).

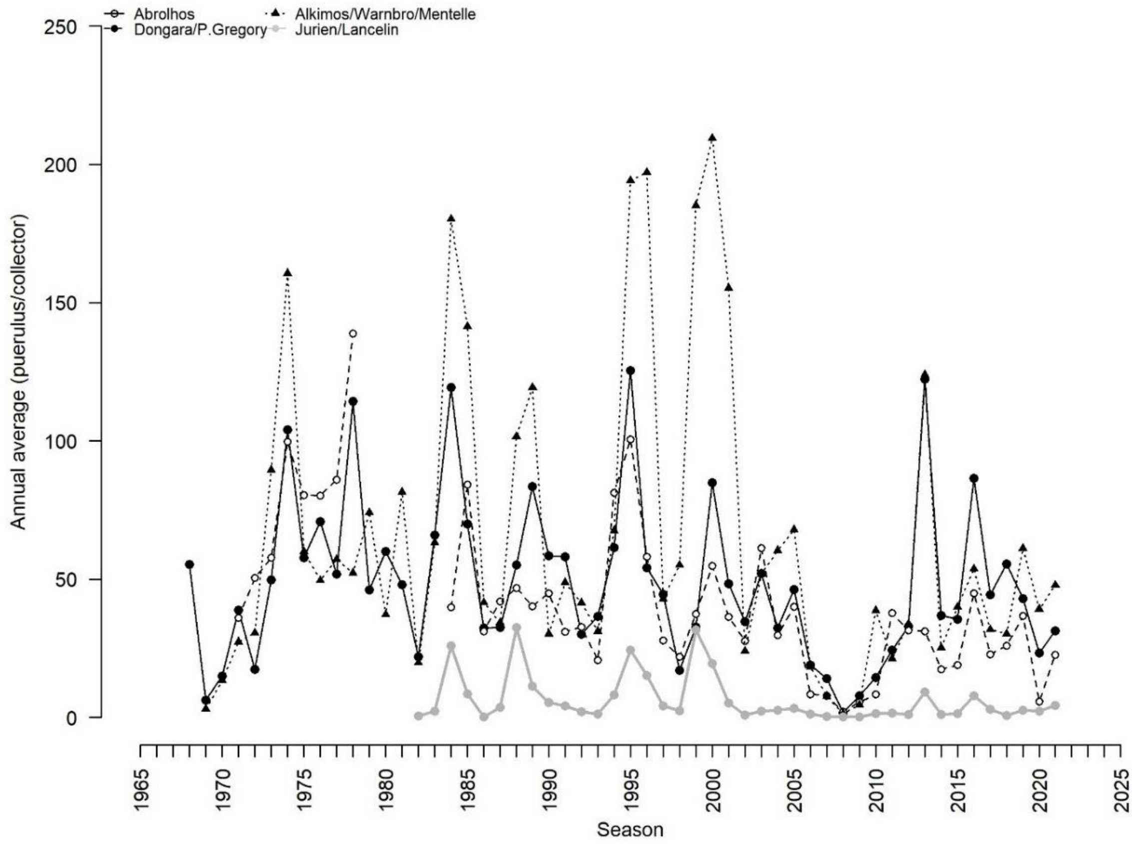
INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Western rock lobster - (Sustainable-Adequate)

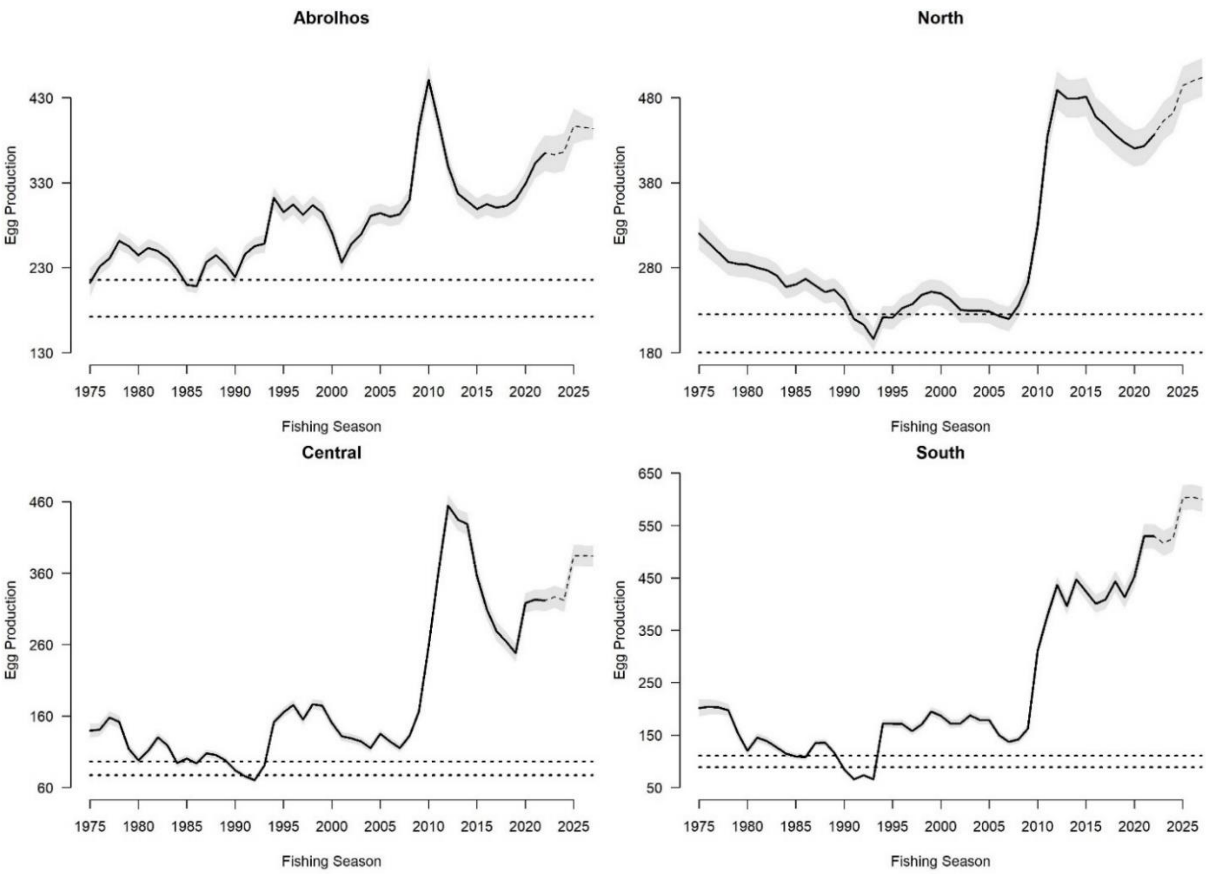
Commercial and recreational catch rates have been maintained near their record-high levels. Fishery-independent egg production indices at all sites are well above both threshold and long-term levels indicating that the biomass and egg production in all locations of the WCRLMF are at record-high levels since surveys began in the mid-1990s. The breeding stock is therefore considered **sustainable-adequate**.

Fishery-independent recruitment (puerulus) monitoring indicates that the puerulus settlement was close to average across all areas during 2021/22 (Western Rock Lobster Figure 3).

The integrated population model indicates that a continuation of fishing at similar or slightly higher TACCs (e.g. 6,500 t over 12 months) over the coming five-year period will result in a similar level of legal and spawning biomass, catch rates and harvest rates (see de Lestang *et al*. (2016), section 9.3.14 and Western Rock Lobster Figure 4).



WESTERN ROCK LOBSTER FIGURE 3.
Levels of puerulus settlement in four regions of the WCRLMF from 1968.



WESTERN ROCK LOBSTER FIGURE 4.
Modelled estimates (black) and projections (dotted line) of egg production for the four breeding stock management areas based on a TACC of 6,500 t. The 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

Bycatch

The main bycatch species landed in the WCRLMF are octopus, champagne crabs (CC) and baldchin grouper (BG). Octopus contributed most to the total bycatch landings with 7.6 t in 2021/22 and only incidental landings of the other species being recorded (1.1 t and 1.9 t for CC and BG, respectively). See Octopus, Deep Sea Crab and West Coast Demersal Scalefish reports for further information.

Protected Species

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 any 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 (~60%) reduction in reported whale entanglements. There was one entanglement in lobster gear reported in the 2021 migration.

Turtles can also get caught in the float rigs of lobster pots. In 2021/22 no turtles were reported to have been entangled in lobster fishing gear.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

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.

Ecosystem

WRL are an omnivorous generalist feeder, with a diet that consists of 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 section 6.2 in Bellchambers *et al*. (2017)).

SOCIAL AND ECONOMIC OUTCOMES

Social

The WCRLMF is important for regional employment with 238 commercial vessels operating in 2021/22 with most of the 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 2021/22. At current high stock levels there is a **moderate risk** to this valuable social amenity, however as the recreational catch is very close to its TARC, there may be the requirment for an adjustment in the near future.

In November 2019, a three-year trial commenced to provide increased tourism opportunities for charter operators undertaking pot-based rock lobster fishing tours and experiences for local, interstate and international visitors. Despite limited international tourism as a result of COVID-19, the outcomes of the trial to date have been positive and indicate potential for growth in the charter sector.

Economic

The estimated average price across all processors and all zones of the WCRLMF received by commercial fishers for western rock lobster in the 2021/22 financial year was $30.02 per kg. This was down from that paid in the 2020/21 financial year ($33.93/kg). The lower financial year beach price with similar landings resulted in the overall value of the WCRLMF dropping markedly to $203 million (12 month). The relatively low beach price is strongly related to limitations in exporting live lobster into the Chinese market. Since this is the main market for Western Rock Lobster it is considered to be a **high risk**.

GOVERNANCE SYSTEM

Harvest Strategy

The Harvest Strategy and Control Rules 2014-2019 (HSCR; DoF, 2014) were used to set catch limits for both the 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 maximise the profitability of the WCRLMF, i.e., to target 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 %)

increase in the TACC will move the WCRLMF towards MEY and maintain healthy levels of egg production.

Allowable Catch Tolerance Levels

The landed commercial catch of 6,334 t was slightly below the pro rata TACC of 9,135 t (6615 plus 1.5% for water loss). This is due to the extended (18 month) fishing season and the ability of fishers to vary when they land lobster within this 18 month period. Therefore the catch level was **acceptable**. The harvest control rules surrounding recreational catch are based on a five-year moving average (FYMA). The FYMA recreational catch in 2021/22 was 505 t, and was below the FYMA TARC of 520 t. The recreational catch was therefore considered **acceptable**.

Compliance

For the recreational sector, compliance efforts focus on bag limits, size limits and retention of totally protected fish through routine landing inspections. In addition, targeted compliance operations are utilised to detect serious offences such as gear interference and the unlawful sale of recreationally caught rock lobster.

For the commercial sector, 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/measures.

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 Department through 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

In September 2020 a series of amendments were made to the management settings for the commercial fishery. After consultation with industry, a COVID-19 response was implemented in order to minimise the economic impact of the pandemic on the fishery, given the significant reduction in demand for lobster in China in early 2020. The management response included extending the 2020/21 commercial season by 5.5 months, to end 30 June 2021; adjustment to the catch associated with the extended season (TACC of 9000 t plus 1.5% for water loss), and the introduction of a new mechanism for fishers to undertake 'back-of-boat sales'.

In May 2021, noting continuing economic impacts as a result of COVID-19, amendments were made to the management arrangements to provide for an 18.5 month season extending from 1 July 2021 to 14 January 2023 (2021-23 season). The TACC was retained at 9000 t (plus 1.5% for water loss) for the extended season.

Following implementation of the back-of-boat sales program, approximaly 48 t of WRL was sold direct to the public between September 2020 and June 2021. The program will continue for the 2021-23 season with an aim to increase community engagement through supply of WRL to the public.

During the second year of the rock lobster charter trial (November 2020 – November 2021), 1,162 trips were undertaken with 10,295 paying passengers. This resulted in approximately 14 t of rock lobster. The trial will continue for the 2021/22 season.

EXTERNAL DRIVERS

The variations in WRL recruitment to the fishery are largely a result of variable levels of puerulus settlement 3-4 years previously. Catches are also dependent upon the environmental conditions at the time of fishing.

In 2011, and to some extent 2012 and 2013, abnormally warm water temperatures were recorded throughout the northern half of the western rock lobster fishery. Preliminary analysis indicates that this event negatively impacted the puerulus to juvenile relationship in the northern region of the fishery (e.g. Kalbarri). There are now strong signs that this area may have fully recovered from this impact and returned to its historical relationship.

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 limitations in exporting live lobster into the Chinese market as this was the main market for Western Rock Lobster.

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WEST COAST ROE'S ABALONE RESOURCE STATUS REPORT 2022

L. Strain, J. Brown and N. Blay

OVERVIEW

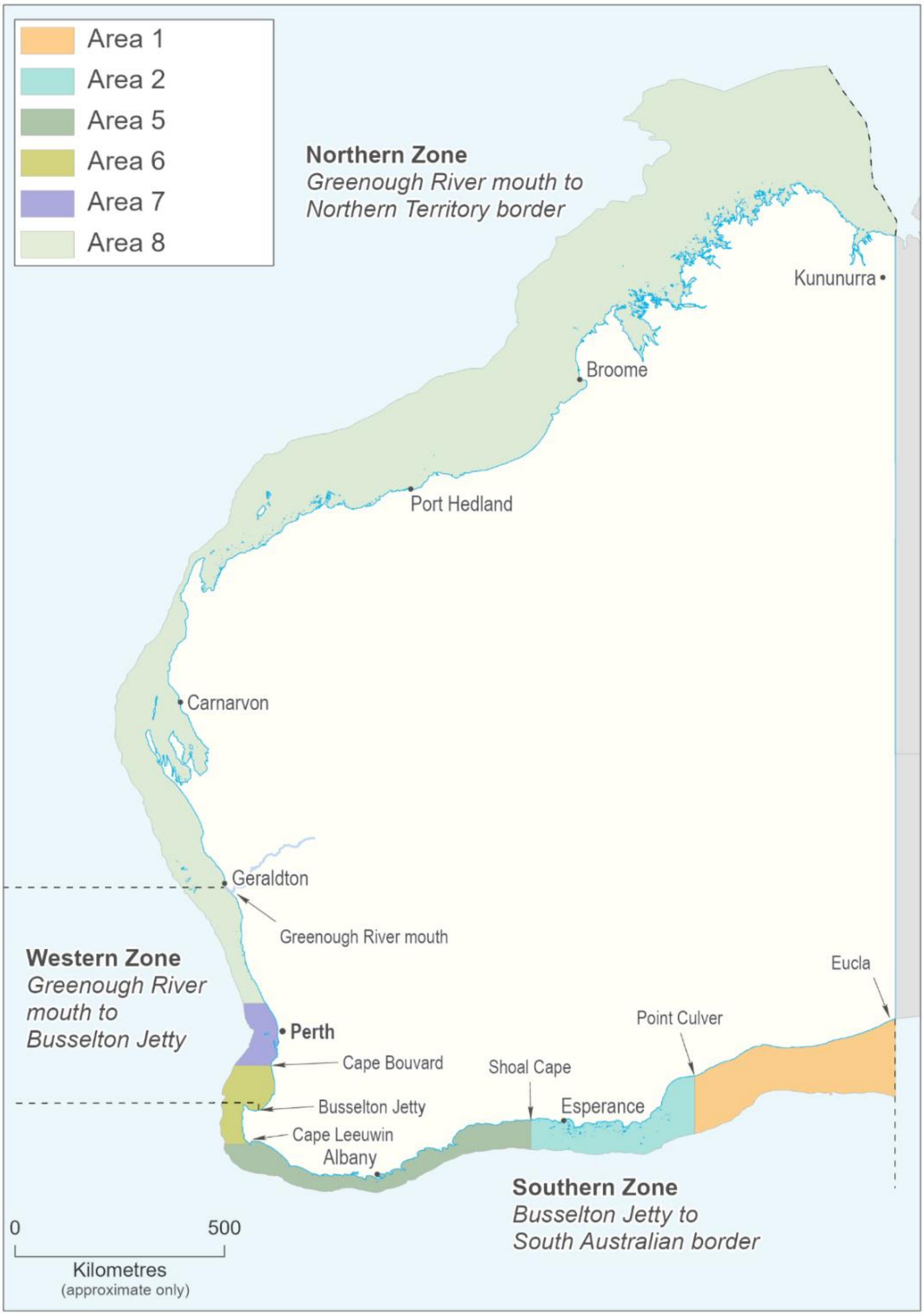
The Roe's abalone (*Haliotis roei*) resource is accessed by both the commercial and recreational sectors, and is a dive and wade fishery operating in shallow coastal waters along WA's western and southern coasts. The commercial Roe's abalone fishery is managed primarily through Total Allowable Commercial Catches (TACCs), which are set annually for each of the six management areas (Roe's Abalone Figure 1) and allocated as Individually Transferable Quotas (ITQs).

The recreational fishery is divided into three zones (Roe's Abalone Figure 1): Zone 1 (Western Zone - including Perth metropolitan fishery), Zone 2 (Northern Zone) and Zone 3 (Southern Zone). Management arrangements 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 information on the fishery can be sourced from Hart et al. (2017) and Strain et al. (2021) at www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_8.pdf. and http://www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_8_addendum_4.pdf.

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (69.8 t)	Total Catch 2021: 29.7 t	Acceptable
Recreational fishery (25–29 t Perth Metro Fishery)	Total Catch 2021: 19–23 t Perth Metro Fishery; 14 t Other	Acceptable
EBFM		
Indicator species		
Roe's abalone (*Haliotis roei*)	Above Target (excluding closed Area 8/Northern Zone)	Adequate
Ecological		
Bycatch	Negligible risk	Adequate
Listed Species	Negligible risk	Adequate
Habitat	Negligible risk	Adequate
Ecosystem	Negligible risk	Adequate
Economic (GVP $0.8 m)	High risk	Acceptable
Social (Amenity - Significant)	High risk	Acceptable
Governance	Low risk	Acceptable
External Drivers	High risk	Management Action



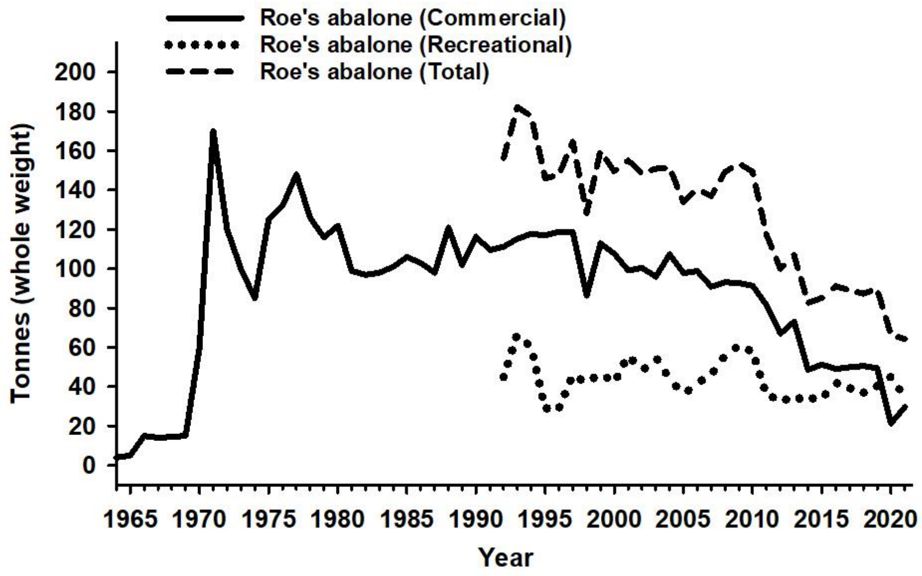
ROE'S ABALONE FIGURE 1.
Map showing the boundaries of the management areas for Roe's Abalone in the commercial Abalone Managed Fishery in Western Australia. Also showing the boundaries of the three zones within the Western Australian Recreational Abalone Fishery; the Western Zone, the Northern Zone and the Southern Zone.

CATCH AND LANDINGS

In 2021 the total commercial catch was 29.7 t whole weight, which was an increase of 63% from last season, but only 42% of the 69.8 t whole weight TACC (Roe's Abalone Figure 2). The commercial catch was less than the TACC in Area 1 (0% caught), Area 2 (29% caught), Area 5 (17% caught), Area 6 (22% caught) and Area 7 (75% caught). Commercial viability of Roe's abalone fishing in regional areas has suffered over recent years due to economic influences (low value of catch and few viable markets), high cost of accessing some areas and prevailing weather conditions (Area 6).

The TACC decreased slightly in Area 7 (by 3.7 t) given the influence of recent warmer seawater temperatures within the Roe's abalone stock prediction model. The potential impact of the Ocean Reef Marina (ORM) development on the fishery (loss of access), resulted in the TACC being restricted by an estimated annual forgone catch of 5.3 t again in 2021 (construction began in April 2021). In Area 7, only 75% of the TACC was caught, which was only the third season the full TACC hasn't been caught since an individual management area quota was introduced in 1999. The commercial industry has attributed the reduction in catch in Area 7 during 2021 to the continuing economic impacts of COVID-19 on overseas markets.

The recreational catch of Roe's abalone in 2021 was 34.7 t whole weight, which represents 54% of the total Roe's abalone catch (Roe's Abalone Figure 2). The recreational catch includes 19–23 t (20.7 t) from the Perth metropolitan stocks, which was below the TARC range (25–29 t) given the poor weather conditions experienced during the restricted fishing season. The TARC for the Perth metropolitan fishery was reduced by 4.7 t to account for the potential impacts of the ORM development. A catch estimate of 14 t was obtained 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 2.
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)

The stock status is assessed using commercial and recreational catch and effort statistics, and fishery-independent sampling. Trends in stock indicators were used to determine the 2021 TACC for each management area, and the TARC for Zone 1 of the recreational fishery.

Area 1 (near WA/SA border): There was only 10 kg caught in 2021 of the 5 t TACC. This area is a marginal part of the fishery in a remote location making it economically difficult for fishers given current market conditions.

Area 2 (Esperance): The catch in 2021 was 3.8 t whole weight of the 13.2 t TACC. The annual SCPUE declined between 2010 and 2015 to below the target reference level. It then increased in 2016 and has remained relatively constant above the target reference level over the last 6 seasons.

Area 5 (Albany): The catch in 2021 was 2.5 t whole weight of the 15 t TACC. The annual SCPUE has been slightly lower than the historical average between 2013 and 2019, but remained stable during this period and above the target reference level. In 2020 and 2021, the low catch has resulted in a high degree of uncertainty around the SCPUE estimate.

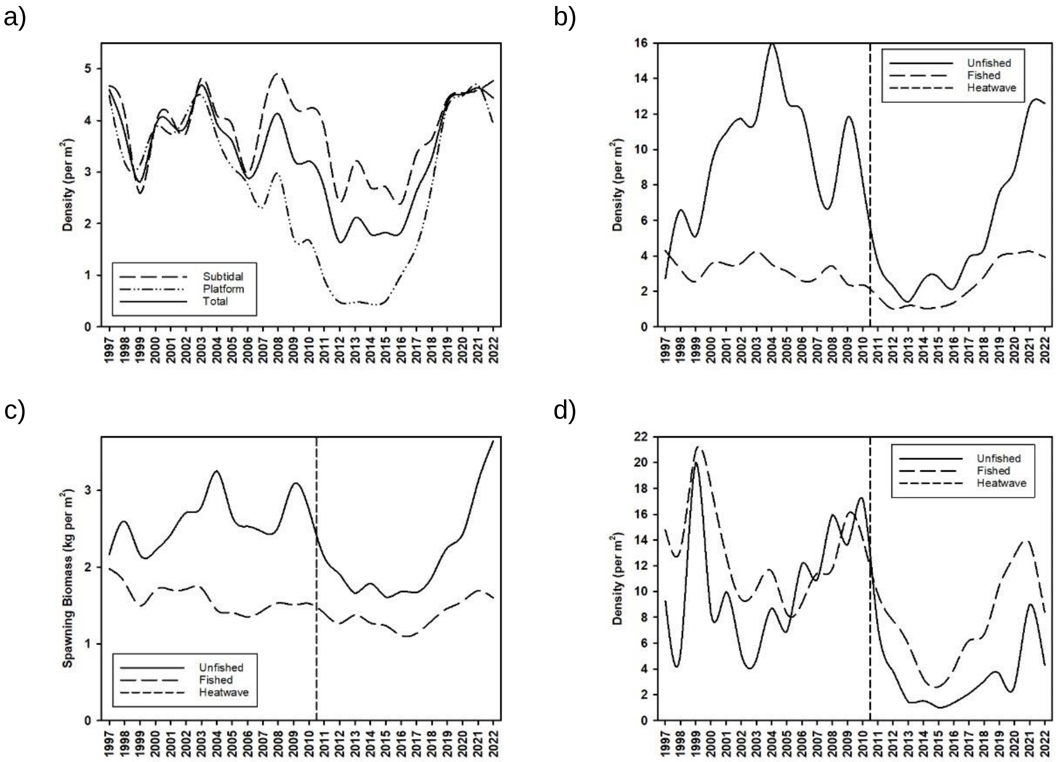
Area 6 (South West Capes): The catch in 2021 was 1.6 t whole weight of the 7.5 t TACC. The annual SCPUE declined sharply between 2010 and 2013 to below the target reference level. It then increased between 2017 and 2019 where it was above the target reference level and within the historical range. In 2021, the low catch has resulted in a high degree of uncertainty around the SCPUE estimate.

Area 8 (Kalbarri): This area has been closed since the 2011 season due to catastrophic mortality following the 2011 marine heatwave. With no evidence of natural recovery, a restocking project has been successful on a trial-scale, but it has yet to be implemented on a commercial scale to determined if restocking would recover the entire stock in the longer term (Strain et al. 2019).

Perth Metropolitan Roe's Abalone Fishery (Area 7 / Zone 1): The commercial catch in 2021 was 21.8 t of the 29.1 t TACC. The annual SCPUE in Area 7 has declined slightly over the last 2 seasons, but this followed a continual increase over the previous 5 seasons, since a steady decline occured between 2005 and 2014. The SCPUE is above the target reference level and the TACC was set using the stock prediction model based on juvenile abundance and an environmental factor. The recreational catch estimate was 19–23 t (20.7 t) whole weight, which was below the TARC range (25–29 t).

Fishery-independent surveys indicate that the density of harvest-sized Roe's abalone in both the subtidal and platform habitats, and across both fished and unfished areas experienced substantial declines between 2003 and 2012 (Roe's Abalone Figure 3a and b). Density of harvest-sized animals then increased from record-low levels during 2012-2016, and in 2021 were nearing/at record-high levels in the subtidal and platform habitats. In 2022, density of harvest-sized animals increased again in the subtidal habitat (3rd highest on record), whereas it declined slightly in the platform habitat (Roe's Abalone Figure 3a). The increasing trend in density in both unfished and fished stocks from 2012-13 halted in 2022, but both are still near record-high levels (Roe's Abalone Figure 3b). Spawning biomass declined slightly in the fished areas but is still above pre-2011 marine heatwave levels, while in the unfished area it increased again and is at record-high levels in 2022 (Roe's Abalone Figure 3c). Density of Age 1+ (17 – 32 mm) animals also showed an increase from record-low levels between 2015 and 2021 in both fished and unfished areas, after juvenile recruitment declined by 80% between 2010 and 2013 (post marine heatwave). However, in 2022 the juvenile recruitment exhibited a sharp decline in both areas (Roe's Abalone Figure 3d).

Recovery of the Perth Metropolitan Roe's Abalone Fishery from historically low levels was considered complete in 2021. Stock indicators for adult Roe's abalone (harvest-size animals and spawning biomass) are above pre-2011 marine heatwave levels with some at or near record-high levels. The recovery of these indicators had been aided by a marine cold spell that occurred during 2016-2019. However, the increasing trend across all stock indicators (post 2015) halted in 2022 and the increase in summer sea surface temperature over recent years as a result of a moderate marine heatwave is of concern.



ROE'S ABALONE FIGURE 3.

Density and spawning biomass of Roe's abalone in the Perth Metropolitan Fishery (Area 7/Zone 1) from fishery-independent surveys. a) Density of harvest-size Roe's abalone (71 mm+) in fished areas within the subtidal and platform habitats, b) Density of Roe's abalone (71 mm+) in the fished and unfished areas, c) Spawning biomass (kg per m^2 of <40 mm abalone) of Roe's abalone in the fished and unfished areas, d) Density of Age 1+ Roe's 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 24 vessels registered to operate in the commercial Roe's Abalone Fishery, but given the economic impacts outlined only a small number of divers fished during 2021. 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 abalone as a delicacy, and 17,255 licences were issued that would have allowed fishers to participate in the recreational abalone fishery. **High** risk.

Economic

Estimated annual value (to commercial fishers) for 2021 was $0.8 million, based on the estimated average price for Roe's abalone of $25.81/kg whole weight. The price of Roe's abalone has dropped by nearly 50% since 2000, when it was $55/kg whole weight. This was due to the value of the Australian dollar and wild caught Roe's abalone being in direct market competition with aquaculture produced abalone. **High** risk.

GOVERNANCE SYSTEM

Harvest Strategy (Formal)

The harvest strategy (DPIRD 2022) uses annual SCPUE as a proxy for biomass (key performance indicator), which is 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 an environment factor (DPIRD 2022). The predicted harvest-sized density 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. The TACCs (whole weight) have been set for the 2022/23 season; they are 5 t in Area 1, 16.2 t in Area 2, 18 t in Area 5, 7.5 t in Area 6, 29.1 t in Area 7 and 0 t in Area 8, totalling 75.8 t. The Area 7 TACC and Western Zone TARC may be varied following a mid-year review.

Annual Catch Tolerance Levels

Commercial – Acceptable: 69.8 t (TACC for 2021/22) (530 - 640 fishing days)

Recreational – Acceptable: 25–29 t (TARC for 2021/22) Perth Metropolitan Fishery only (Zone 1).

Commercial catch was below the TACC due to the economic impacts of COVID-19 on overseas markets. The commercial fishing effort (223 days) was also below the expected range. Area 8 is still closed due to the catastrophic mortality following the 2011 marine heatwave. The recreational catch range in the Perth Metropolitan Fishery was below the TARC range given the poor weather conditions experienced during the restricted fishing season.

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 a restrictive TARC, restricted season length, and bag limit.

Consultation

The Department undertakes consultation directly with the Abalone Industry Association of Western Australia (AIAWA), West Coast Abalone Divers Association (WCADA), the Southern Seafood Producers Association WA (SSPA) and licensees on operational issues. The Department convenes Annual Management Meetings through the Industry Consultation Unit at the Western Australian Fishing Industry Council (WAFIC), who are also responsible for undertaking statutory management plan consultation under a Service Level Agreement.

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

In 2021, the Department continued the management arrangements for the Western Zone (Zone 1) of the recreational abalone fishery that were reviewed and implemented in 2017 to improve fisher safety and stock sustainability. Given the reduction in the TARC range based on the prediction model forecast and the Ocean Reef Marina foregone catch estimates, the number of fishing sessions in the Western Zone was decreased from 5 to 4 for the 2021 season.

The commercial Roe's abalone fishery has undergone full MSC assessment and achieved certification in 2017, with the 4th surveillance audit and re-certification completed during 2021/22 (https://fisheries.msc.org/en/fisheries/western-australia-abalone-fishery/@@view).

The Department has reviewed the Harvest Strategy for the Western Australian Abalone Resource (DPIRD 2022).

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 of Roe's abalone were estimated at 99.9% (Strain *et al.* 2019). A complete closure of the commercial and recreational fisheries was then implemented. The heatwave also affected the Perth metropolitan stock but to a lesser extent (Hart *et al.* 2018). The recovery of the Perth metropolitan stock had been assisted by a marine cold spell during 2016-2019 (Feng et al. 2020). However, the increase in summer sea surface temperature over recent years is of concern given its significant relationship with the stock replacement and stock recruitment models. Roe's abalone has been assessed as a high risk to climate change effects.

Weather conditions during the time of fishing have a significant effect on catch rates and the total catch of recreational fishers. This was particualrly evident in 2021 with the recreational catch range below the TARC range.

The small size of Roe's abalone results in its direct competition with aquaculture-produced abalone and therefore, there has been a decline in the beach price and overall economic value during the last decade.There has also been other economic impacts on overseas markets, which subsequently reduced Roe's abalone catches and consequently the GVP of the fishery in 2021.

The Ocean Reef Marina development located within the Perth Metropolitan Fishery poses a significant risk to the Roe's abalone stock and subsequently the commercial and recreational fishery's. **High** risk.

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WEST COAST BLUE SWIMMER CRAB RESOURCE STATUS REPORT 2022

D. Johnston, E. Myers, C. Maus, and B. Brooks

Overview

Blue swimmer crabs (*Portunus armatus*) are found in waters less than 50 m depth along the entire coast of Western Australia. The commercial crab fisheries within the West Coast Bioregion since 2011 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.

Blue swimmer crabs represent the most important recreationally-fished nearshore species in the southwest of WA (Ryan *et al.* 2022). 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 limits, protection of breeding females and seasonal closures with effort controls in place for the commercial fishery.

For more detailed descriptions of blue swimmer crab biology and the West Coast crab fisheries see Johnston et al. (2020a, b).

www.fish.wa.gov.au/Documents/research_reports/frr307.pdf)

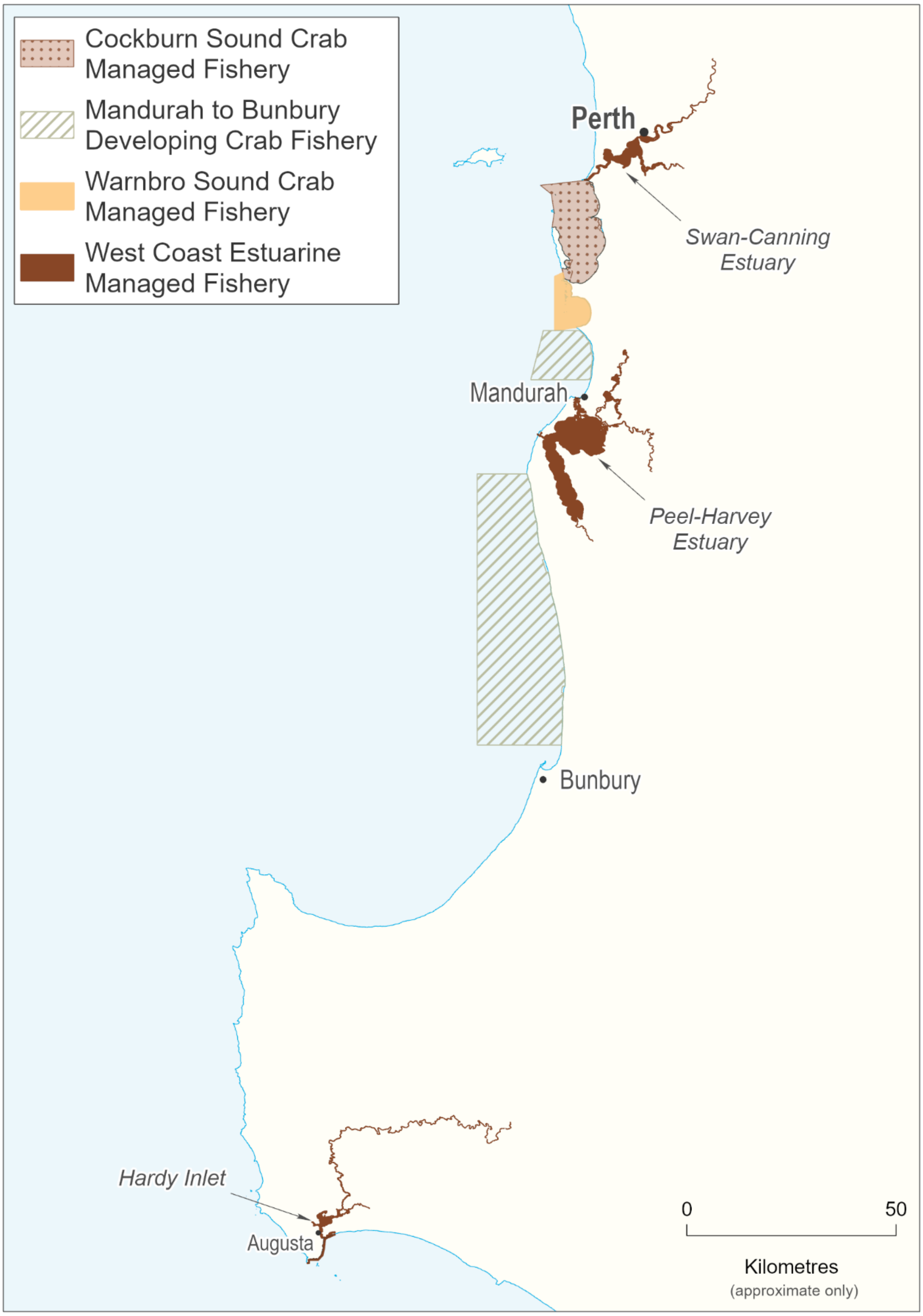
www.fish.wa.gov.au/Documents/research_reports/frr309.pdf)

Both the commercial and recreational Peel-Harvey crab fisheries attained Marine Stewardship Council (MSC) Certification in 2016 (see Johnston et al. 2015), and were recertified in 2021 for a further 5 years.

(www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_3.pdf

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery	Total Catch 2021: 70.7 t	Acceptable
Recreational fishery	Total Catch 2020/21: 43.3 t (boat-based only)	Acceptable
EBFM		
Indicator species		
Cockburn Sound	Below limit	Environmentally limited
Peel-Harvey	Above threshold	Adequate
Other SW	Above threshold	Adequate
Ecological		
Bycatch	Negligible Risk	Adequate
Listed Species	Negligible Risk	Adequate
Habitat (wading birds)	High Risk	Adequate
Ecosystem	Low Risk	Adequate
Economic (GVP <$1 m)	Moderate-High risk	Acceptable
Social (high amenity)	Moderate-High Risk	Acceptable
Governance	Moderate-High Risk	Acceptable
External Drivers	High Risk	

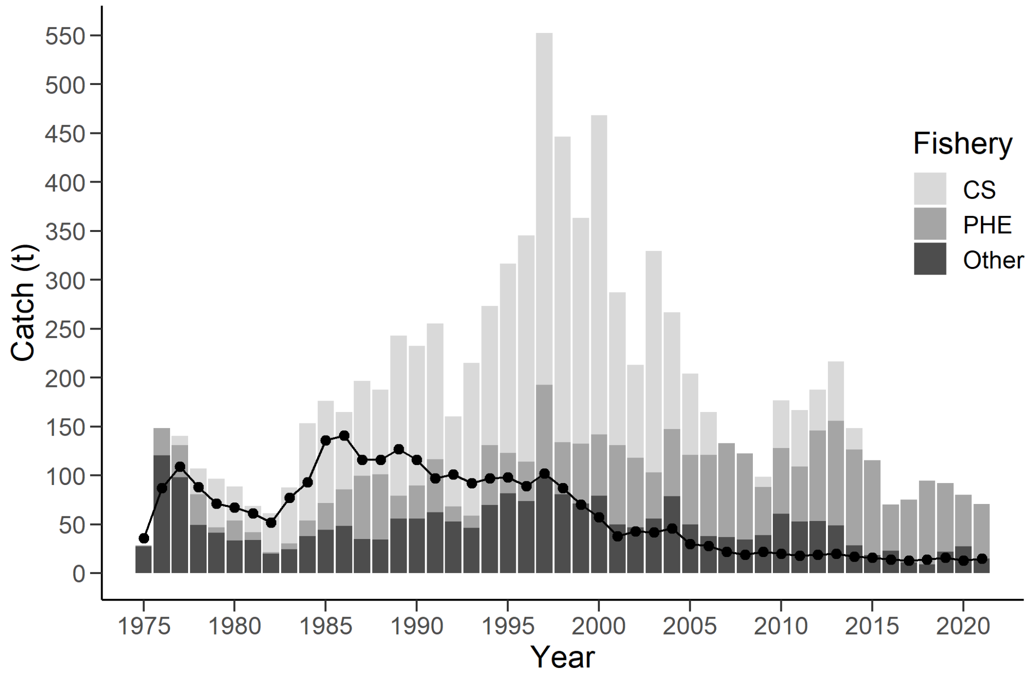


WEST COAST BLUE SWIMMER CRAB FIGURE 1.
Map showing the boundaries of the main commercial blue swimmer crab fisheries in the West Coast Bioregion:

CATCH AND LANDINGS

Commercial Sector

Total commercial catch of blue swimmer crabs in the West Coast Bioregion decreased from 80.2 t in 2020 to 70.7 t in 2021 primarily due to lower catches in the Swan-Canning Estuary (West Coast Blue Swimmer Crab Figure 2). This level of catch is well below the historical catch levels as Cockburn Sound remains closed. The West Coast catch accounted for approximately 11% of the State's total commercial blue swimmer crab catch of 642.5 t for 2021. The total State catch of blue swimmer crabs in 2021 was substantially lower to that landed in 2020 (714 t).



WEST COAST BLUE SWIMMER CRAB FIGURE 2.
West Coast bioregion commercial catch history for blue swimmer crabs in Western Australia since 1975 (by calendar year). The number of licensed fishing vessels retaining blue swimmer crabs each year is also shown (●). CS — Cockburn Sound, PHE — Peel-Harvey Estuary. Other fisheries include the Swan-Canning Estuary, Warnbro Sound, Mandurah to Bunbury (Area 1 and 2), Geographe Bay, Leschenault Estuary, Hardy Inlet and Greenhead. The Cockburn Sound Crab Managed fishery was closed from December 2006 – December 2009 and has been closed since April 2014.

Recreational Sector

The recreational harvest of blue swimmer crab by boat-based recreational fishers in Western Australia during 2020/21 was 43.3 t. The West Coast Bioregion boat-based recreational catch of blue swimmer crab represented 93% of the statewide boat-based recreational catch (kept by numbers) in 2020/21. The recreational harvest range for Blue Swimmer Crab in the West Coast was steady at 43 t (95% CI 29–57) in 2020/21 compared with 59 t (95% 45–72) in 2017/18 (Ryan et al. 2022). Recreational catch estimates for the Peel-Harvey Estuary account for the majority of the boat-based recreational catch in the West Coast Bioregion, although significant recreational catches are recorded for the Swan Canning Estuary and Geographe Bay (Ryan et al., 2022).

The shore-based recreational catch was not estimated but is believed to represent a significant proportion of the overall catches of blue swimmer crab. A previous (2008) 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 (Johnston et al. 2014).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Cockburn Sound (Environmentally limited)

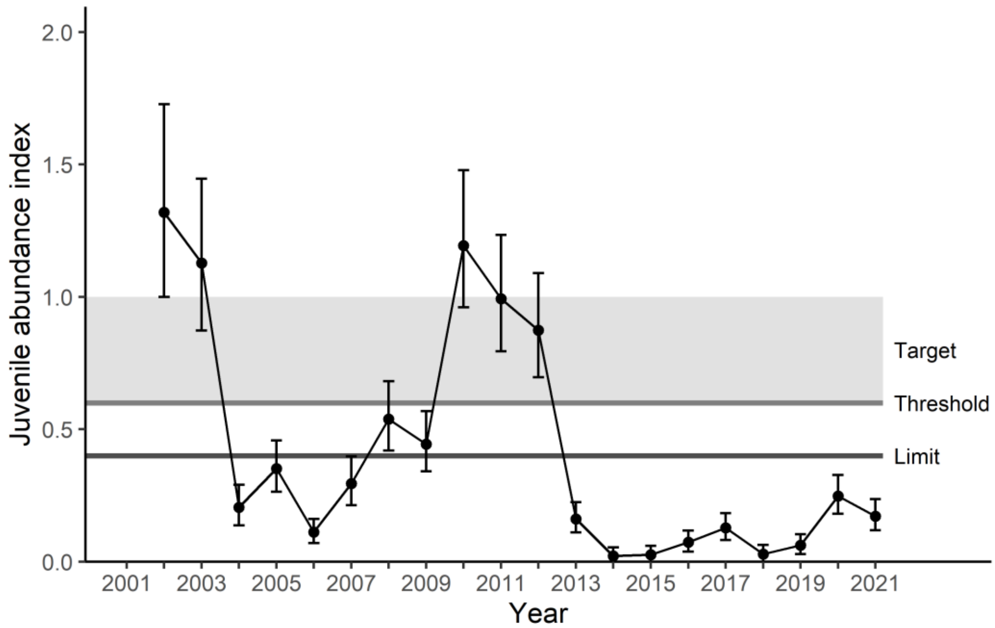
Since the fishery was closed in 2014, a harvest strategy has been determined for the Cockburn Sound Crab Fishery where the primary performance indicators are the juvenile abundance index and egg production index (Johnston et al. 2015; 2020a). A weight-of-evidence approach was used for the stock assessment where these 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**:** From 2014 to 2019 the abundance of juveniles in Cockburn Sound has remained very low (0.03–0.13 juveniles/100 m^2 trawled). The juvenile index significantly increased in 2020 (0.25 juveniles/100m^2), however, it decreased again in 2021 to 0.17 juveniles/100 m^2. The index remains substantially below the harvest strategy limit of 0.4 juveniles/100 m^2 trawled, indicating that recruitment remains at unacceptable levels (West Coast Blue Swimmer Crab Figure 3).

Egg Production index: While the 2021 value of 9.8×10^6 eggs/traplift was higher than that of 2020 (6.1×10^6 eggs/traplift), it is still significantly lower than the limit reference value of 12×10^6 eggs/traplift. This suggests that breeding stock levels continue to be unacceptable, and therefore the status of the stock has been classified as **environmentally limited.**

As the 2021 egg production and juvenile indices were below their respective limit levels, the fishery remained closed for the 2021/22 season. The outcomes of the research and management review of south-west crab stocks (DPIRD, 2018) continues to contribute to the future of this fishery.

Potential reasons for the stock decline include combined effects of reduced levels of primary productivity within Cockburn Sound, changes in water temperature, a low abundance of mature females and/or low proportion of berried females. The declines in abundance are believed to be substantially attributable to environmental changes, rather than fishing, as the fishery has been closed since 2014. The egg production index is currently under review.

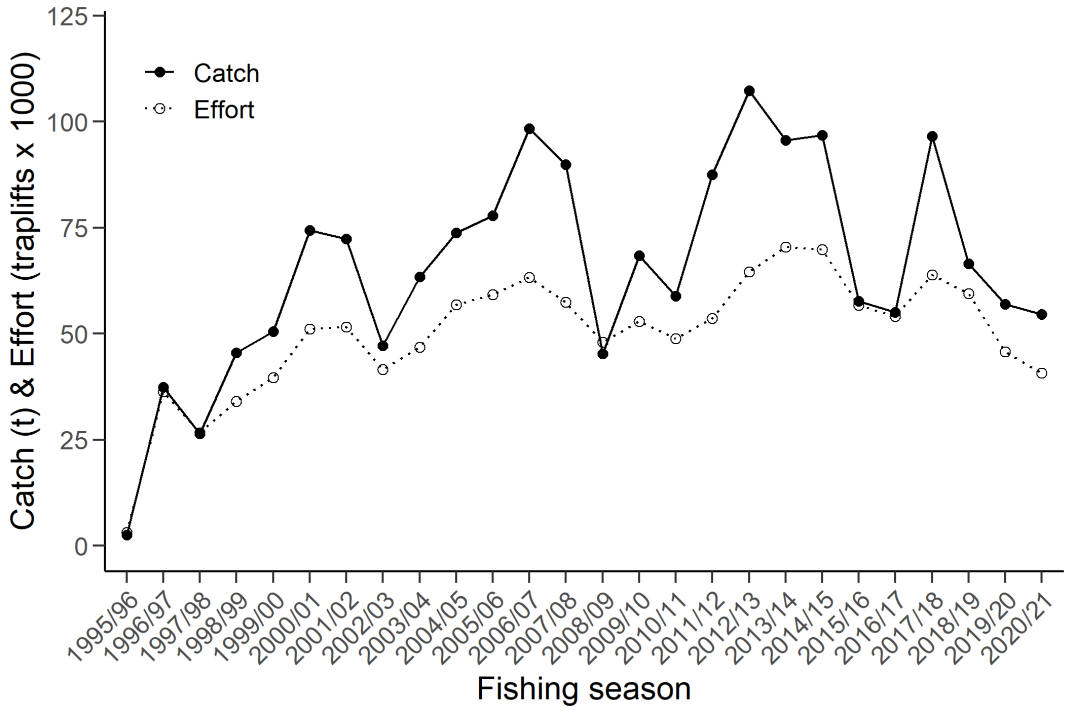


WEST COAST BLUE SWIMMER CRAB FIGURE 3.
Annual standardised index of juvenile (0+) blue swimmer crabs in Cockburn Sound calculated using data from juvenile research trawls conducted in April, May and June of each year. The index units are numbers of juveniles/100m^2 trawled. The associated reference points (target, threshold and limit) for the harvest strategy and the 95% confidence intervals are shown. The fishery was closed between December 2006 and December 2009, and has remained closed since April 2014.

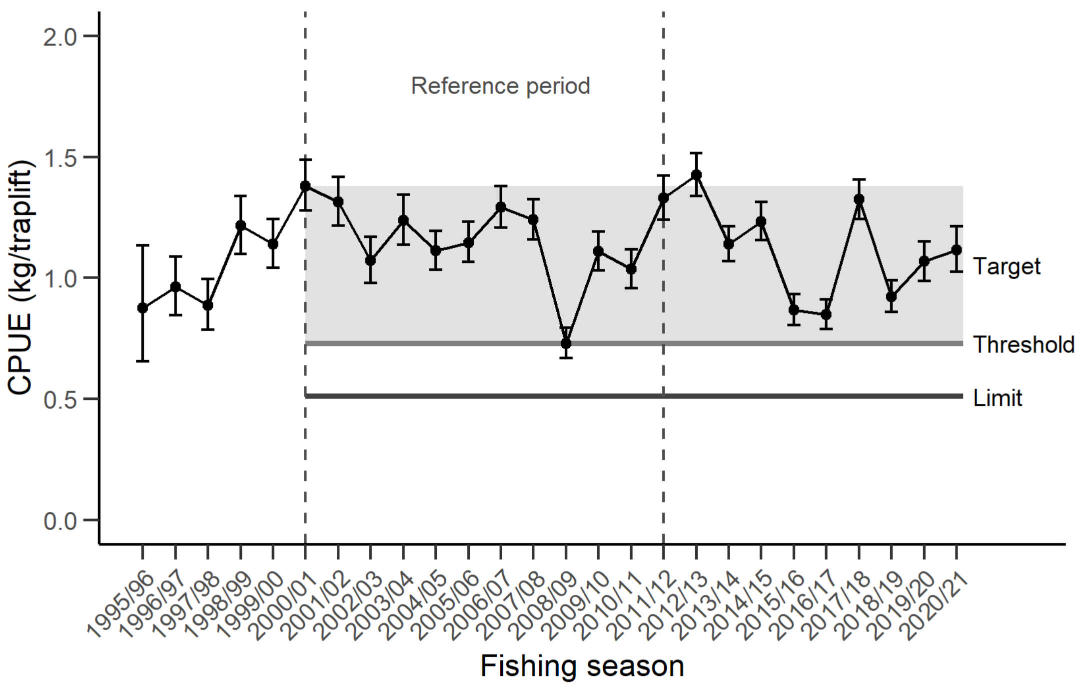
Peel-Harvey Estuary (Sustainable-Adequate)

The commercial catch and effort from the Peel-Harvey Estuary for the 2020/21 fishing season (December–August) was 54.6 t from 40,678 trap lifts, a slight decrease of ~2.5 t from the 2019/20 season and the fishing effort is the lowest in approximately 20 years (West Coast Blue Swimmer Crab Figure 4).

Since the conversion from nets to traps in 2000/01 annual standardised commercial catch rates have fluctuated between 0.7 and 1.4 kg/traplift, but have generally remained above 1 kg/traplift. The standardised catch rate of 1.12 kg/traplift for the 2020/21 fishing season represents a slight increase from 1.07 kg/traplift reported in 2019/20, and remains 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 5). A weight-of-evidence approach was 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 4.
Blue swimmer crab commercial catch (t) and effort (traplifts x 1000) for the Peel-Harvey Estuary from 1995/96 to 2020/21. Fishing season prior to the 2019/20 season is defined as 1 November to 31 August; 2019/20 onwards is defined as 1 December to 31 August.



WEST COAST BLUE SWIMMER CRAB FIGURE 5.
Annual standardised commercial catch rate (kg/traplift) of blue swimmer crabs in the Peel-Harvey crab fishery, with 95% confidence limits, relative to the associated reference points (target, threshold and limit) for the harvest strategy. The reference period (2000/01 to 2011/12) was a period of relative stability when the fishery was considered to have been operating sustainably. The target range extends between the maximum and minimum values of the reference period, where the latter denotes the threshold level, a proxy for the stock level at which Maximum Sustainable Yield (MSY) can be achieved. The limit is set at 70% of the threshold value (0.7BMSY). Fishing season is defined as 1 November to 31 August between 1995/96 and 2018/19 but from 1 December to 31 August from 2019/20 onwards. Annual values have been standardised using a generalised linear model to account for effects of month and fisher.

BYCATCH and PROTECTED SPECIES INTERACTIONS

Bycatch

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.

Protected species interactions

The crab trap longline system is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities and are therefore considered a **low** risk.

HABITAT and ECOSYSTEM INTERACTIONS

Habitat

Retrieval of traps may result in minor dragging across the mostly sandy substrate. The small amount of living seagrass removed, results in minimal habitat damage and hence trapping poses a **low risk** to benthic habitats. However, a **high risk** score was given to the migratory and threatened shorebird species that inhabit the estuary during summer months when there is potential for feeding and roosting birds to be disturbed by recreational scoop net fishers (and other recreational activities) in key areas of overlap (Fisher et al., 2020).

Ecosystem interactions

As the commercial take of crabs represents a relatively small portion of the biomass, which is effectively renewed annually and subject to high levels of natural variation in abundance, secondary food chain effects are likely to be minimal. 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 2021, approximately 17 people were directly employed as skippers and crew on vessels targeting blue swimmer crabs in the West Coast Bioregion. A voluntary fisheries adjustment scheme was implemented in the Peel-Harvey Estuary Crab Fishery during the 2019/20 season so this number declined to 16 by the end of that season. 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 2021 had an estimated gross value of production (GVP) of approximately $0.71 million, an increase on the $0.65 million reported in 2020 (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 2020/21 was $10.09 per kg. **Moderate-High** risk. The reasons for this risk level is the closure for the Cockburn Sound crab fishery and subsequent uncertainty around the economic value of the south west crab fisheries.

GOVERNANCE SYSTEM

Harvest Strategy

Cockburn Sound: Closed

As the 2021 egg production index and juvenile index were below their respective limit levels, the fishery remained closed for the 2021/22 season.

Peel Harvey:

The primary performance indicator is the standardised annual commercial catch rate. As the indicator was above the threshold for 2020/21, no resultant management action was required. However, a three month closure (1 September to 30 November) to commercial and recreational crab fishing was implemented in 2019/20 as a result of the south-west crab management review. Previously there was a 2-month closure in September and October with the start of season commencing from 1 November.

Other West Coast fisheries:

The primary performance indicator is the standardised annual commercial catch rate. As the indicators were above the threshold in 2021 for all other fisheries in the West Coast Bioregion (Swan-Canning Estuary, Warnbro Sound, Comet Bay), a three month closure (1 September to 30 November) to commercial and recreational crab fishing was implemented. The Warnbro Sound Crab Managed Fishery and the Mandurah to Bunbury (Comet Bay) Developing Crab Fishery were both closed in 2022. This provides additional protection to the breeding stock.

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 needs to be developed when the management arrangements and stock levels have stabilised. The acceptable catch range for Peel Harvey is based on 10 years of catch values between 2000/01 and 2011/12. This catch range will be reviewed in the future following the recent voluntary fisheries adjustment scheme and resultant reduction in number of commercial fishers. 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.

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 fishing activities 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) and the Southern Seafood Producers Association (SSPA), 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 review of the south-west blue swimmer crab resource was initiated in late 2018. The aim of the review was to improve the level of protection to the breeding stock, in particular mated pre-spawn females, and to improve resilience of the resource as well as improving the efficiency and consistency of management arrangements across the entire resource. The review included the release of *Fisheries Management Paper 288 - Protecting breeding stock levels of the blue swimmer crab resource in the south west* for public comment. Having considered public submissions and consultation with peak sector bodies, in August 2019 the Minister for Fisheries announced his decision to implement:

- an annual 3-month closure (1 September through 30 November) across all south west crab fisheries (except for Geographe Bay);
- a reduced bag limit of 5 crabs in the Swan and Canning Rivers;
- a maximum of 5 female crabs (as part of the 10 bag limit) in Geographe Bay; and
- a process to buy back commercial fishing licences in the Cockburn Sound, Warnbro Sound and Mandurah to Bunbury Crab Fisheries prior to their permanent closure. Arrangements will be finalised in the near fuuture.

The Department is now implementing the Minister's decisions and is working with Recfishwest, WAFIC and the SSPA to consider other potential changes to the management of the south-west blue swimmer crab resource.

Separate to the Crab Review, as part of the Government's election commitment, $1.5 million was allocated for projects to ensure the continued health of the Peel-Harvey Estuary. This commitment includes a voluntary fisheries adjustment scheme (VFAS) to buy back some of the 11 existing commercial licences operating on the estuary. The VFAS was completed during 2020 and achieved it's objective by removing four commercial licences from the Peel-Harvey Estuary.

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 initial decline (2006 closure) of the Cockburn Sound Crab Fishery. The level and timing of rainfall may also affect the Peel-Harvey and Swan River fisheries.

Potential reasons for the recent stock decline (2014 closure) and lack of recovery of crabs in Cockburn Sound include combined effects of reduced levels of primary productivity (Chlorophyll-a), changes in water temperature, and the negative effects of density-dependent growth which may have contributed to an observed decline in the proportion of berried females. The recent declines in abundance are believed to be substantially attributable to environmental changes, rather than fishing. It is unlikely that crab stock levels will recover to historical highs while productivity in the system remains low.

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 2022

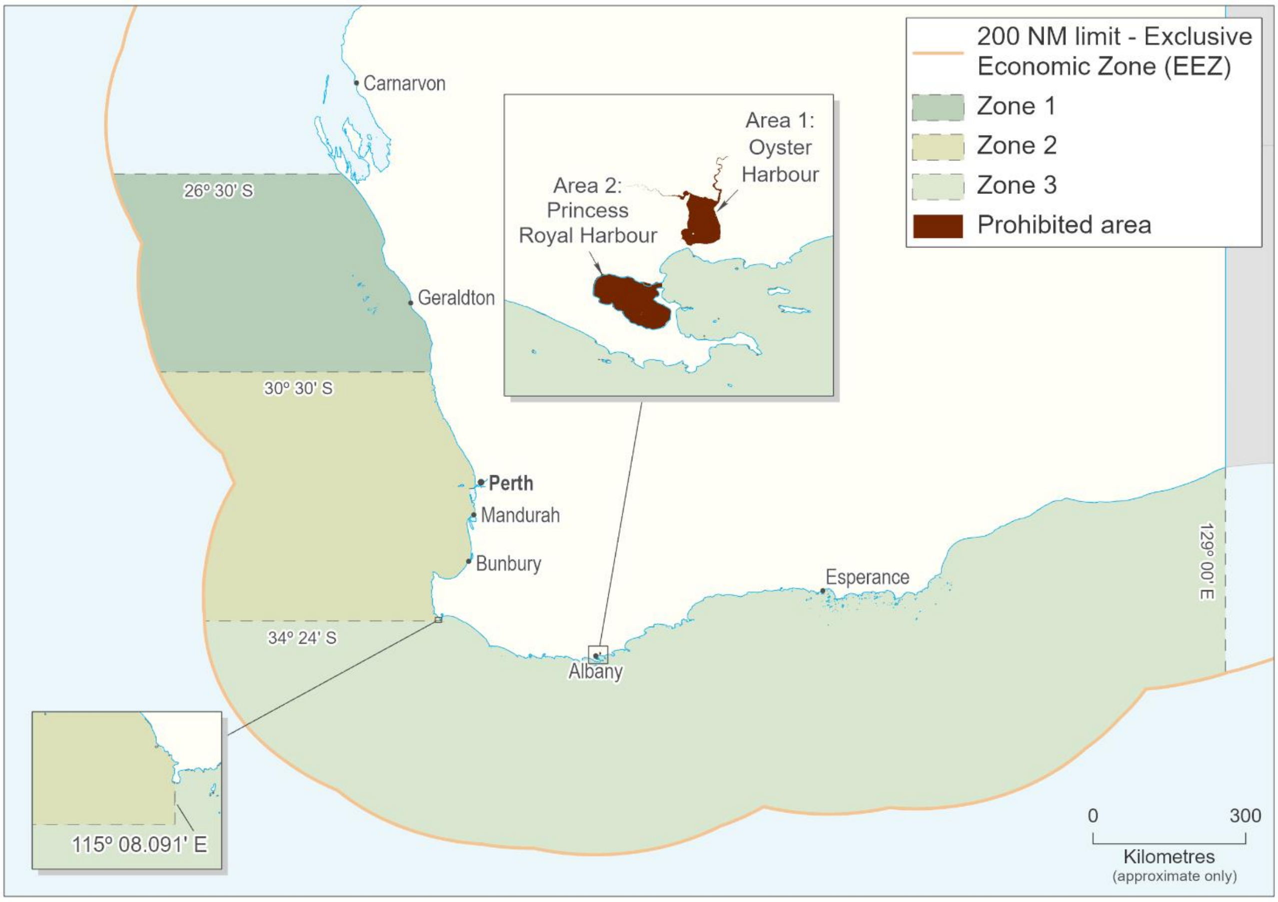
A. Hart, D. Murphy and N.Blay

OVERVIEW

The octopus fishery in Western Australia (WA) targets *Octopus djinda*, which is closely related to *Octopus tetricus* found on the east coast of Australia and New Zealand (Amor and Hart, 2021). 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 baited octopus trap that uses a combination of active trapping (trigger or sliding door traps) via trigger mechanisms, and passive trapping (shelter traps) via the use of open ended traps. Unbaited shelter pots are also used mainly in the Cockburn Sound Line and Pot Managed Fishery (CSLPMF) and octopus are also caught as by-product in rock lobster pots. Commercial management arrangements include input controls on the total allowable number of traps permitted in each of 3 management zones (Octopus Figure 1). More details are available in the octopus Resource Assessment Report (Hart et al. 2018) available at http://www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_14.pdf.

SUMMARY FEATURES 2022

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery	Total Catch 2021: 487 t	Acceptable
Recreational fishery	Total Catch 2020/21: 2 t (boat-based only)	Acceptable
EBFM		
Indicator species		
octopus (Octopus djinda)	Performance indicator above target	Adequate
Ecological		
Bycatch	Low Risk	Adequate
Listed Species	Low Risk	Adequate
Habitat	Low Risk	Adequate
Ecosystem	Negligible Risk	Adequate
Economic (GVP $6.1 m)	Low Risk	Acceptable
Social	Low Risk	Acceptable
Governance	Low Risk	Acceptable
External Drivers	Low Risk	Acceptable

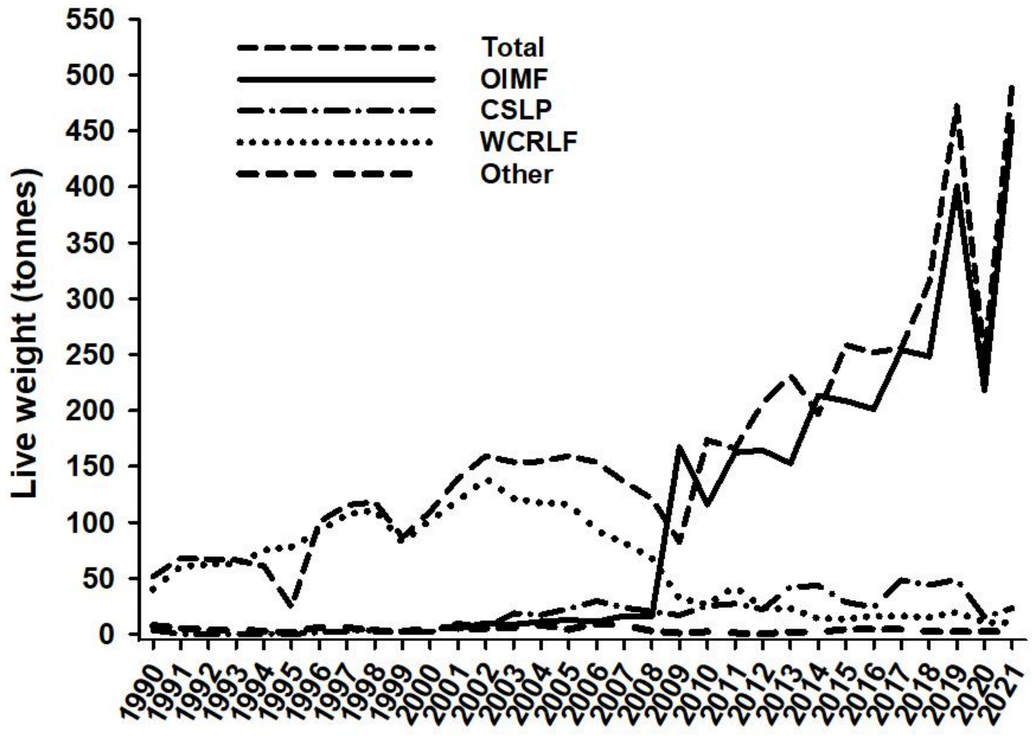


OCTOPUS FIGURE 1.
Map of the three fishery management zones (Zone 1, Zone 2, Zone 3) for the Octopus Interim Managed Fishery of Western Australia. The octopus fishery is primarily managed by the number of octopus traps permitted to be fished in each of these zones.

CATCH AND LANDINGS

In 2021 the total commercial octopus catch was 487 t live weight, which was 86% higher than the 2020 catch of 262 t (Octopus Figure 2). The increase was due to a recovery from COVID-19 related issues, with supply and trade route limitations interupting the harvest over a number of months in 2020. Bycatch from the trawl fishery's was 0.5 t and other estuarine fisheries was 0.3 t.

The retained harvest of octopus by boat-based recreational fishers in Western Australia during 2020/21 was 2.1 t (95% CI 0–4) (Ryan et al. 2022). The West Coast Bioregion boat-based recreational catch of octopus represented 92% of the statewide boat-based recreational catch (kept by numbers) in 2020/21.



OCTOPUS FIGURE 2.

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

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Octopus (Sustainable – Adequate)

Octopus djinda (previously *Octopus* aff. *tetricus*) was subject to a recent comprehensive resource assessment which looked at the biology, fishing efficiency, stock abundance and distribution (Hart et al. 2018). The overall conclusion was that the stock is highly productive, with an average maximum age of 1.5 years, as well as being abundant and widely distributed along the West and South Coast of WA. The estimated area of habitat fished in 2021 was 2000 km^2, a substantial increase from 2020. This area was estimated at 10% of the total estimated habitat area on the West Coast of 20,073 km^2 (Hart et al. 2019), where most of the fishing occurs. The current catch of 487 t is likely to be no more than 14% of the total biomass, at a conservative estimate. 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 2021 there was two reports of entanglement with a whale 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.

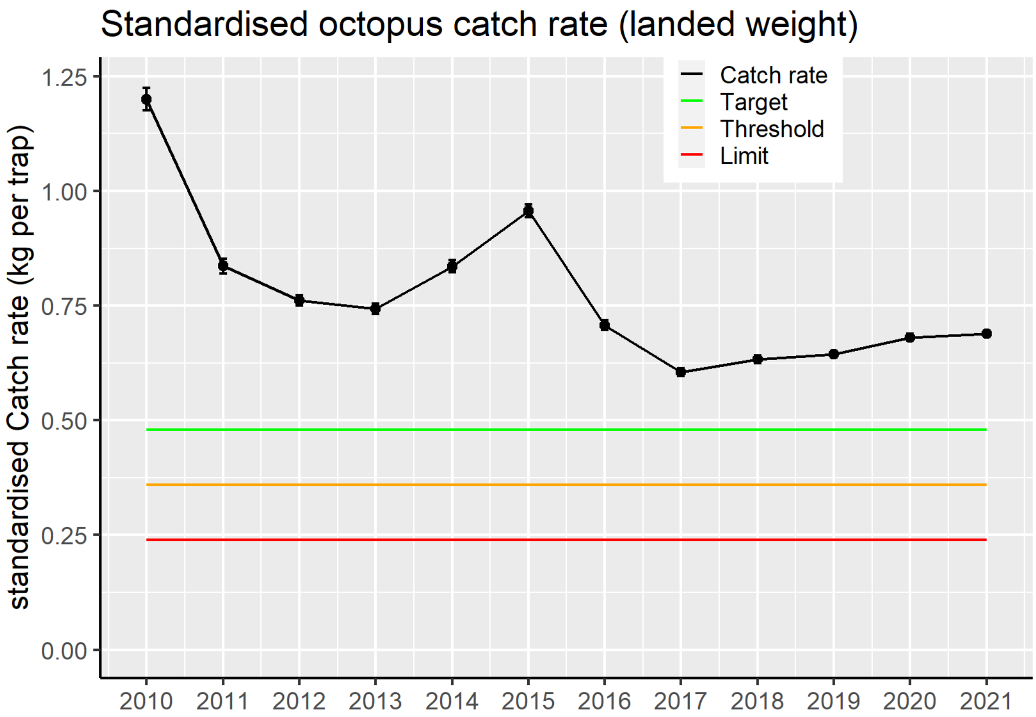
HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

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 10 days in the OIMF and 15-20 days in the CSLPF. Rock lobster potting in the West Coast Rock Lobster Managed Fishery (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.

Ecosystem

This fishery harvests only a small amount of octopus available in the ecosystem 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 incur a **Negligible** risk to the ecosystem.



OCTOPUS FIGURE 3.
Standardised catch per unit effort (SCPUE) (±95% CL) in kg / trap (landed weight) of *Octopus djinda*. Biological reference points (Target, Threshold, Limit) are also given (see DPIRD, 2018 for definition of BRPs).

SOCIAL AND ECONOMIC OUTCOMES

Social

Each dedicated octopus fishing vessel employs between 2 and 4 people. Within the octopus-specific fisheries, 3 vessels fished in the CSLP, and 24 vessels in the OIMF. More than 20 vessels landed octopus as a by-product in the WCRLMF. 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 2021 was $6.2 million based on the total catch of 487 t and an average product price of $12.68 /kg live weight. **Low** Risk.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

Commercial – Acceptable

The current target catch range for octopus is 200-500 t. The 2021 catch of 487 t was within the acceptable range.

Proposed New Five-Year Catch Tolerance Level for 2022-2027 is 500 – 1000 t.

Annual catch tolerance levels are regularly reviewed as part of keeping the Governance systems up to date. The new target range for the *Octopus djinda* fishery reflects the projected growth forecasts for this fishery, to move from a 10% vessel coverage of existing habitat, to a 20% coverage over the next five years. The fishery will be assessed against these tolerance levels in 2022. The new levels are not expected to raise any sustainability issues, as the estimated stock biomass is highly likely to be greater than 3000 tonnes (Hart et al. 2019).

Harvest Strategy (Formal)

The harvest strategy for the Octopus Resource of WA (2018 – 2022) was published in April 2018 (DPIRD, 2018). The main performance indicator in the harvest strategy is a standardised catch per unit effort (SCPUE) in kg/pot lift, which accounts for environmental and efficiency changes in the fishery. Target, Threshold, and Limit reference points have been set, and the fishery is currently above the target level (Octopus Figure 3).

Compliance

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

Consultation

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

Consultation processes with the recreational sector are facilitated by Recfishwest under a Service Level Agreement with the Department. However, the Department also 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

In 2021, the Department proposed management changes to formally incorporate the use of baited traps into the fishery, after scientific trials.

The Octopus Interim Managed Fishery successfully attained MSC certification in late 2019, passed the 1st audit in 2020, and the 2nd audit in 2021.

In 2020 and 2021, the Department in collaboration with the Department of Biodiversity, Conservation and Attractions have been working with permit holders in the OIMF to further improve whale entanglement mitigation measures. Arrangements will be formalised by amendments to the OIMF Management Plan in 2022.

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 WCRLMF from an effort-controlled fishery to a catch quota fishery, coupled with significant effort reductions, will ensure that the octopus catch in the WCRLMF remains a low proportion of the overall catch.

The COVID-19 pandemic had a major influence on the Octopus fishery in WA, reducing the harvest by over 50% in 2020 (Figure 3). However the effect was relatively short (1 year only), with catches reaching a new record high in 2021.

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WEST COAST NEARSHORE AND ESTUARINE FINFISH RESOURCE STATUS REPORT 2022

R. Duffy, A. Quinn, B. Brooks and S. Blazeski

OVERVIEW

The West Coast Nearshore and Estuarine Finfish Resource encompasses a number of commercial fisheries (West Coast Estuarine Managed Fishery, West Coast Beach Bait Fish Net Managed Fishery, South West Coast Salmon Managed Fishery, Cockburn Sound Fish Net Managed Fishery, South West Coast Beach Net Fishery (Prohibition Order 43), and Open Access fishing in the West Coast Bioregion using nets) as well as recreational and customary fishing that targets nearshore and estuarine species. The main commercial methods are haul, beach seine and gill netting. The main recreational method is line fishing from the beach or via a boat.

Four estuaries are open to commercial fishing (Swan-Canning Estuary, Peel-Harvey Estuary, Vasse-Wonnerup Estuary and Toby Inlet). The Peel-Harvey Estuary commercial fishery (Area 2 of the West Coast Estuarine Managed Fishery) received Marine Stewardship Council (MSC) certification for sea mullet in June 2016 alongside certification for blue swimmer crab (see DoF 2015; 2017) and was recertified in 2021.

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery	Total Catch 2021: 318.3 t	Acceptable
Recreational fishery	Total Catch 2020/21: 62–94 t (boat-based only)	Acceptable
EBFM		
Indicator species		
Western Australian Salmon	Above target	Adequate
Sea Mullet (WCB)	Above threshold	Adequate
Australian herring	Above target	Adequate
Yellowfin whiting	Above threshold	Adequate
Whitebait	Below limit	Inadequate (environmentally limited)
Ecological		
Bycatch	Low Risk	Adequate
Listed Species	Negligible risk	Adequate
Habitat	Negligible risk	Adequate
Ecosystem	Moderate risk	Adequate
Economic (GVP < $1 m)	Moderate risk	Acceptable
Social (high amenity)	Moderate risk	Acceptable
Governance	Moderate risk	Acceptable
External Drivers	High risk	

CATCH AND LANDINGS

In 2021, the total commercial catch within the West Coast Nearshore and Estuarine Finfish resource was 318.3 t. The increased total catch, compared to 2020, is attributed to higher catches of Western Australian Salmon and whitebait, which are similar to catches of those species in the preceding five years.

The species with the largest catch (~36%) was sea mullet (Nearshore and Estuarine Finfish Table 1), and nearly all of this was taken in a single fishery, the West Coast Estuarine Managed Fishery.

The harvest ranges for the top 10 nearshore and estuarine species in the West Coast (representing 95% of the resource kept catch by numbers) were steady at 78 t (95% CI 62–94) in 2020/21 compared with 53 t (95% CI 44–62) in 2017/18 (Ryan et al. 2022). The shore-based recreational catch was not estimated but is believed to represent a significant proportion of the overall catches of nearshore and estuarine species.

NEARSHORE AND ESTUARINE FINFISH TABLE 1.
Total catches (tonnes) of the top 5 finfish (ordered by catch (t) in reporting year) in commercial fisheries within the West Coast Estuarine and Nearshore Scalefish Resources over the previous five years.

Common name	Scientific name	2017	2018	2019	2020	2021
Sea mullet	*Mugil cephalus*	127.1	140.9	114.3	138.9	116.5
Western Australian salmon	*Arripis truttaceus*	103.8	139.5	147.8	16.6	88.5
Australian herring	*Arripis georgianus*	48.3	42.8	45.5	42.1	49.9
Yellowfin whiting	*Sillago schombergkii*	25.9	23.4	33.2	22.1	23.2
Whitebait	*Hyperlophus vittatus*	15.1	40.2	24.2	10.9	21.3
Other finfish		32.8	41.3	41.5	16.2	18.9
All Species		353.0	428.1	406.5	246.8	318.3

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. Use of the indicator species approach is currently under review.

Sea Mullet (Sustainable-Adequate)

Sea mullet in WA are managed as a single stock, consistent with what is thought to be a single biological stock. Higher level assessments are periodically undertaken (every 5 years) for the entire stock. Stock status is assessed annually based on the commercial catch in Peel-Harvey remaining below the annual tolerance level of 150 t and evaluating the standardised catch rate.

The most recent stock assesment, indicated that sea mullet biomass has largely been maintained at a level above that estimated for MSY, and is experiencing low levels of fishing activity (Duffy et al. 2022). The catch of sea mullet from the Peel-Harvey estuary in 2021 was below the 150 t tolerance level (Figure 1). Refer to Gascoyne Inner Shark Bay Scalefish Resource Status Report for the catch rate assessment.

On the basis of this evidence, the sea mullet stock is classified as **sustainable – adequate.**

Australian herring (Sustainable-Adequate)

The catch of herring in the WCB in 2021 of 50 t was similar to previous years (Figure 2), similarly for the recreational catch.

Refer to South Coast Estuarine and Nearshore Scalefish and Invertebrate Resource chapter for information on the stock status.

Yellowfin whiting – southern stock (Sustainable-Adequate)

Yellowfin whiting are currently managed as two separate stocks. The southern stock, reported here, includes the West Coast Bioregion and the South Coast Bioregion (SCB). It may be composed of multiple semi-discrete biological stocks. Higher level assessments are periodically undertaken for the southern stock as required. Stock status is assessed annually, based on commercial catch in Peel-Harvey remaining below the annual tolerance level of 12 t, trends in the commercial and recreational catch and management action.

The most recent level 3 assessment was based on age structure data collected in 2015 and 2016 (Duffy et al. 2022). ‘Spawner per recruit’ modelling (SPR) suggested that the spawning biomass was above the threshold level (30%). Therefore this stock is considered to have a medium risk to sustainability (Duffy et al. 2022).

The commercial catch of yellowfin whiting from Peel-Harvey was above the 12 t tolerance level in the mid 2010s as a result of a positive effect of the 2011 extreme marine heatwave on the stock (Smith et al. 2019). It has since returned to be below the 12 t tolerance level (Figure 2). Commercial catch of the southern stock in 2021 of ~23 t continued the stable trend.

On the basis of this evidence, the southern yellowfin whiting stock is classified as **sustainable – adequate.**

Western Australian Salmon (Sustainable - Adequate)

The catch of salmon in the WCB in 2021 was 89 t. This is an increase in catch since last year, and is similar to the recent trend.

Refer to South Coast Estuarine and Nearshore Scalefish and Invertebrate Resource chapter for information on the stock status.

Whitebait (Inadequate – environmentally limited)

Whitebait in WA is managed as a single stock, consistent with what is thought to be a single biological stock. Higher level assessments are peridoically undertaken as required. Stock status is assessed annually based on the commercial catch from the Bunbury region remaining below the annual nominal tolerance level of 25 t.

A stock assessment in 2018 indicated a severe risk to sustainability and attributed recent low catches to low stock abundance. Within a broader declining trend in catch attributed to environmental change, there is a highly cyclic trend of two to five year peaks and troughs existing in catch records (Figure 3). Whitebait has a lifespan of only 3-4 years, and so the cyclic trend likely reflects environmentally driven recruitment variability.

The severe risk rating resulted in a reduction in the season and a voluntary reduction in catch to less than 25 t. The level of catch in 2021 of 21 t was below this level (Figure 3). Some recovery of the stock would be expected due to management action.

The stock is classified as inadequate - environmentally limited.

Other Species

The following species are not considered indicators, but are of relevance due to catches in the MSC certified Peel-Harvey Estuary sea mullet fishery, or have undergone management changes due to stock status concerns.

Estuarine cobbler (Peel-Harvey: Sustainable -Adequate)

Estuarine cobbler are managed as a single stock in the WCB, however, each estuary has a discreet biological stock (Avayzian et al. 1994). Stock status is assessed annually based on commercial catch in Peel-Harvey in relation to recent trends and management action.

An ecological risk assessment of cobbler in the Peel-Harvey determined the species to have a medium risk to sustainability (Fisher et al. 2020). This was based on the large decline in cobbler catch from historic highs due to habitat change resulting in a reduced carrying capactiy of the estuary to support cobbler (Smith & Lenanton 2021).

The catch of cobbler in 2021 was 1.6 t. Recent low catches are not considered to be reflective of abundance rather it is a result of reduced targetting by commercial fishers. Therefore, the exploitation rate of cobbler in the Peel-Harvey estuary is thought to be low.

On this basis, the stock is classified as **adequate**.

Perth herring (Environmentally Limited)

Perth herring in WA is managed as a single stock, however each estuary may have a discrete or semi-discrete biological stock. Stock status is assessed annually based on the commercial catch in Peel-Harvey in relation to recent trends and management action.

An ecological risk assessment of Perth herring in the Peel-Harvey determined the species to have a high risk to sustainability (Fisher et al. 2020). This was based on the large decline in catch from historic highs due to low spawning success, resulting from environmental degradation in the upper reaches of the WCB estuaries and low rainfall.

Commercial catch of Perth herring in 2021 was less than 1 t. Recent low catches are not considered to be reflective of abundance rather it is a result of reduced targeting by commercial fishers. Therefore, the exploitation rate of Perth herring in Peel-Harvey estuary is thought to be low.

The stock is classified as **environmentally limited.**

Southern garfish (Perth metropolitan zone) (Inadequate -environmentally Limited)

Southern garfish in WA are managed as multiple stocks. It is thought to form multiple semi-discrete biological stocks (Smith et al. 2017). Stock status is assessed annually based on commercial and recreational catch in relation to recent trends and management action.

The most recent level 3 assessment indicated that spawning biomass in the Perth metropolitan zone was below the limit reference level (i.e. 20% of the unfished level), and indicated the risk to sustainability was high (Smith et al. 2017). In June 2017, this zone was closed to commercial and recreational fishing for southern garfish to aid stock recovery.

The species is considered 'seagrass-dependent' because it directly consumes seagrass and associated organisms, and it requires seagrass (or macro algae) for egg attachment for reproduction (Smith et al. 2015). As such, reductions in seagrass biomass, as observed in Cockburn Sound (Cockburn Sound Management Council 2021), are likely to negatively impact garfish abundance. In the absence of new data for the next stock assessment due in 2023, it is assumed that whilst some recovery in the stock would be expected due to management action (e.g. enhanced age structure), habitat loss is the main driver of abundance. A new assessment is due in 2023.

On this basis, the southern garfish stock in the Perth metropolitan zone is classified as **inadequate - environmentally limited.**

Tailor (Sustainable - Adequate)

Tailor in WA are managed as a single stock, consistent with what is thought to be a single biological stock. Stock status is assessed annually based on the commercial and recreational catch in relation to recent trends and management action.

Commercial catch in 2021 from the WCB was 4 t, consistent with the historic catch range. The catch rate of tailor fluctuates in response to recruitment variations, which are linked to environmental factors (Smith et al. 2013b, DoF 2017).

Refer to Gascoyne Inner Shark Bay Scalefish Resource chapter for information on the stock status.

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 and 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 boat-based recreational fishers. There is currently a **moderate risk** to these values.

Economic

Estimated annual value (Gross Value of Production) to commercial fishers for 2021:

Level 1: <$1 million

This reflects the commercial beach price of landed product only and does not include economic flow-on values such as employment within the fishery, additional employment/value in distribution networks, retail fish sales sectors and spending on fuel and equipment.

The West Coast Bioregion is the most heavily used area in Western Australia for recreational fishing (including charter-based fishing). The estimated value of all recreational fishing in the area is $1.7 billion. This consists of $305.6 million in the South West, $217.2 million in the Peel region, $1.1 billion in the Metropolitan area and $42.9 million in the Wheatbelt (McLeod and Lindner 2018). A significant amount of this value is derived from boat and shore-based fishing in nearshore and estuarine areas of the WCB.

The economic risk is considered **Moderate.**

GOVERNANCE SYSTEM

Harvest Strategy

This resource is harvested using a constant exploitation approach, where the annual catch taken is assumed to vary in proportion to 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 catch data is limited for these stocks). Additionally, higher level assessments are periodically undertaken for some stocks. The previous formal harvest strategy for finfish captured commercially within the Peel-Harvey Estuary (DoF 2015) was updated during 2020 (see DPIRD, 2020).

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 (DoF 2015). In 2021, the catches of sea mullet and yellowfin whiting were within the acceptable catch tolerance level of <150 t and <12 t, respectively, identified in the harvest strategy (DPIRD 2020). The Department reviewed the current risk posed by this catch level and determined that it was **acceptable**.

Nominal tolerance levels are used for other species.

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 in relation to the commercial sector directly with licensees on operational matters, as well as the peak commercial representative body, the Western Australian Fishing Industry Council (WAFIC). Industry Management Meetings are convened by the Department through the WAFIC, who also undertake statutory management plan consultation on behalf of the Department under a Service Level Agreement. 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

Closure of the metropolitan area to recreational and commercial catch of Southern garfish continued in 2022.

Within the WCEF, catch of secondary species including perth herring, yellowfin whiting and estuary cobbler remained under co-management arrangements with licence holders. This approach allows for ongoing adaptive management.

In addition to the above co-management arrangement, yellowfin whiting in the Peel Harvey Estuary is also managed under the Estuarine and Nearshore Finfish Resource of South-West Western Australia Harvest Strategy. When catch exceeds the trigger level of 10 tonnes within a season, managers meet with stakeholders to evaluate the appropriateness of the 12 t tolerance level for the present season in relation to environmental and fishing factors.

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.

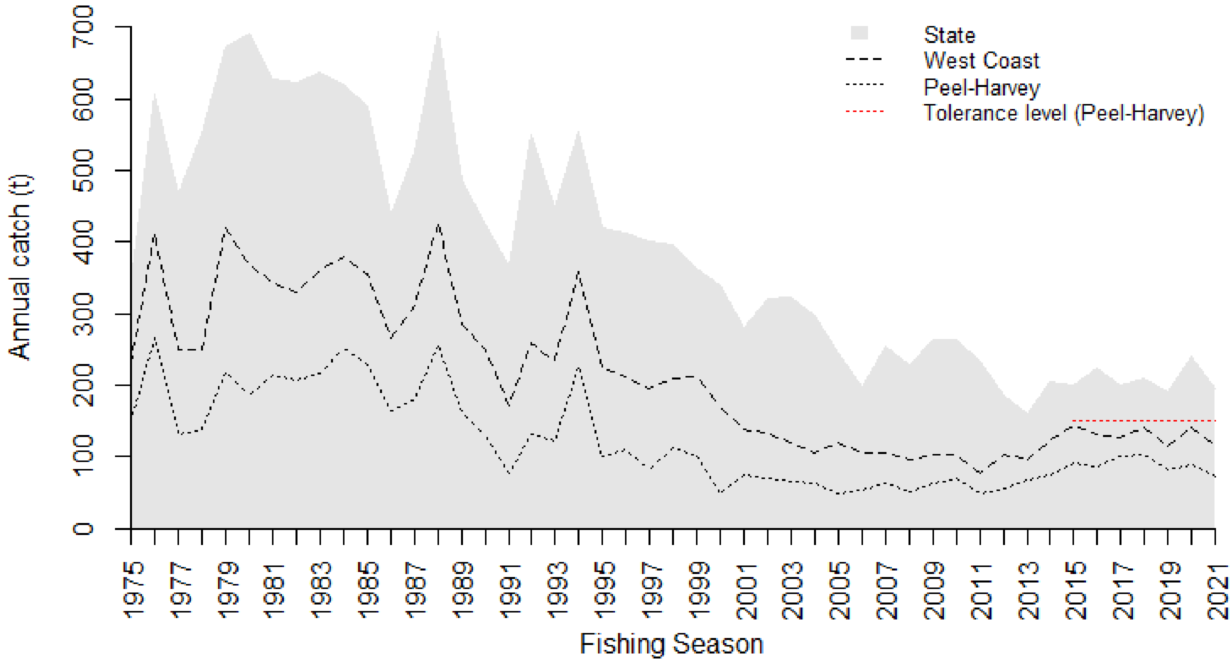
In 2011, a 'marine heatwave' event in coastal waters of south-western WA altered the distribution (e.g. tropical species occurring in temperate waters) and behaviour (e.g. spawning activity, migration) of many nearshore finfish species, which appears to have affected the abundance of these species in 2011 and in subsequent years (Caputi et al. 2014, Smith et al. 2019).

WCB estuaries are highly modified and often have degraded environments. As such, the impacts of environmental factors on estuarine fish are likely to be more important than fishing pressure.

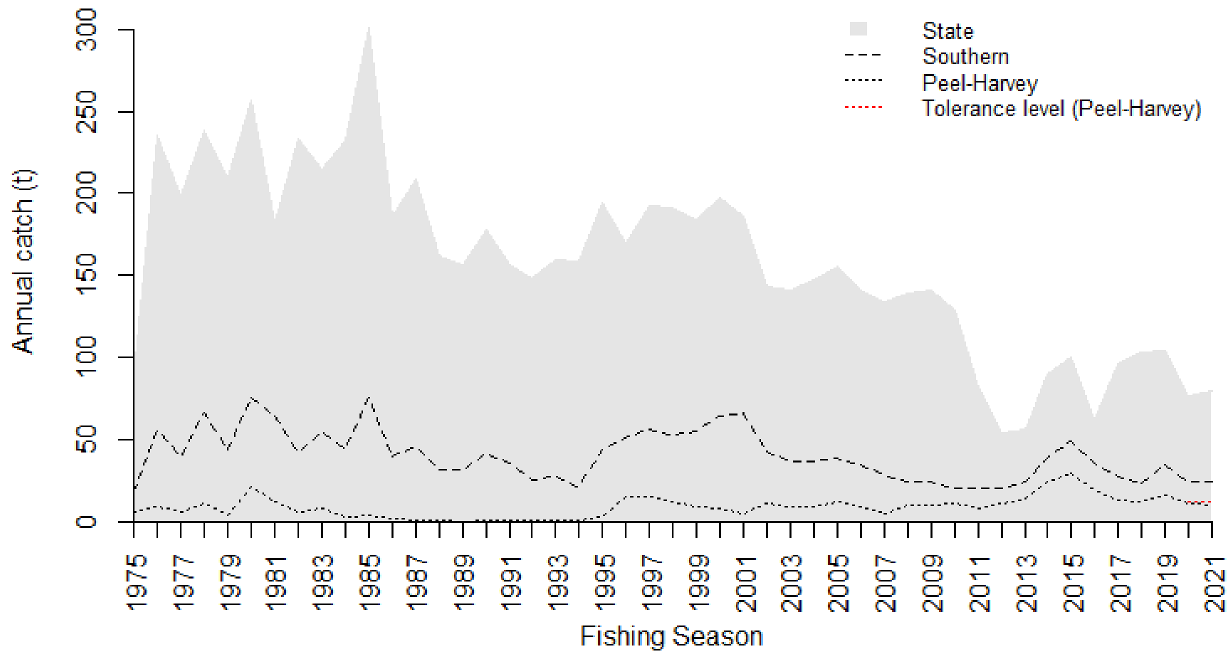
Impacts in estuaries are most pronounced among ‘estuarine-dependent’ species, i.e. those that rely on estuarine habitats for spawning, feeding and/or nursery areas (e.g. cobbler, Perth herring, black bream).

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

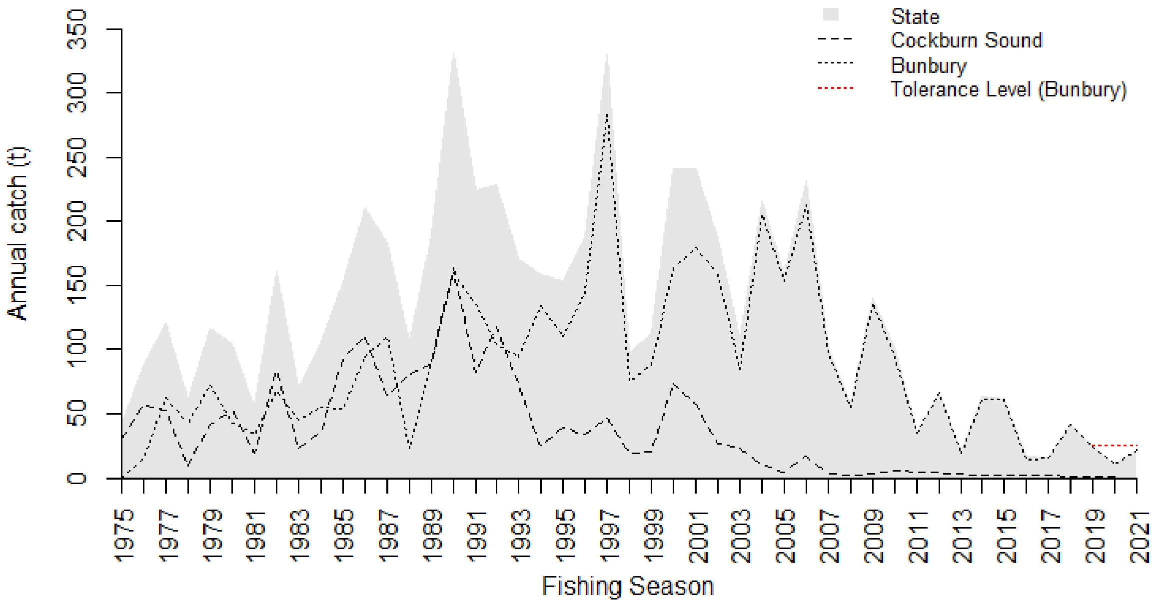
These external drivers represent a **High** risk.



NEARSHORE AND ESTUARINE FINFISH FIGURE 1.
Annual commercial catch of sea mullet in the State and in the West Coast Bioregion since 1975.Note data from 1975 is only for the second 6 months of the year when data collection began.



NEARSHORE AND ESTUARINE FINFISH FIGURE 2.
Annual commercial catch of yellowfin whiting in the State and in the West Coast Bioregion since 1975. Note data from 1975 is only for the second 6 months of the year when data collection began.



NEARSHORE AND ESTUARINE FINFISH FIGURE 3.
Annual commercial catch of whitebait in the State and in the West Coast Bioregion since 1975. Note data from 1975 is only for the second 6 months of the year when data collection began.

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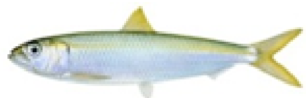
WEST COAST SMALL PELAGIC SCALEFISH RESOURCE STATUS REPORT 2022



J. Norriss and S. Blazeski

OVERVIEW

The five species comprising the west coast small pelagic scalefish resource are scaly mackerel (tropical sardine, *Sardinella lemuru*, pictured above), Australian sardine (pilchard, *Sardinops sagax*), Australian anchovy (*Engraulis australis*), yellowtail scad (*Trachurus novaezelandiae*) and maray (*Etrumeus jacksoniensis*). Scaly mackerel and Australian sardine are the indicator species and dominate the catch, which is taken predominantly by the West Coast Purse Seine Managed Fishery (WCPSMF) together with fishery developmental zone licence holders, using purse seine gear in waters between Geraldton and Cape Leeuwin. This region is split into three Zones - Northern Development Zone (all WA waters north of 31° 00’S, predominantly off Geraldton), Perth Metropolitan (31° 00’S to 33° 00’S, predominantly Cockburn Sound) and Southern Development Zone (33° 00’S to Cape Leeuwin, predominantly Geographe Bay). Licensees are also entitled to take Perth herring (*Nematalosa vlaminghi*), which forms part of the West Coast Nearshore and Estuarine Finfish Resource, but they have not reported catching this species since 1997.

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery Commercial notional TACs: Perth Metropolitan and Southern Development Zone combined: 3,000 t (Australian sardine 2,328 t, other permitted sp. 672 t); Northern Development Zone: 2,700 t scaly mackerel.	Total Catch 2020/21: 504 t (all small pelagic species & zones combined)	Acceptable
Recreational fishery (not defined)	Total Catch 2020/21: <1 t (boat-based only)	Acceptable
EBFM		
Indicator species		
Scaly mackerel	Above threshold	Adequate
Australian sardine	Above threshold	Adequate
Ecological		
Bycatch	Negligible Risk	Acceptable
Listed Species	Low Risk	Acceptable
Habitat	Negligible Risk	Acceptable
Ecosystem	Low Risk	Acceptable
Economic GVP <$1 m	Moderate risk	Acceptable
Social (Low amenity)	Negligible Risk	Acceptable
Governance	Stable	Acceptable
External Drivers	Low Risk	Acceptable

WEST COAST SMALL PELAGIC SCALEFISH FIGURE 1.
Map showing the boundaries of the West Coast Purse Seine Fishery and the Northern and Southern Development Zones, which comprise the large majority of the catch of the West Coast small pelagic scalefish resource.

CATCH AND LANDINGS

The total combined catch of the five west coast small pelagic scalefish species taken by the WCPSMF and developmental licensees in 2020/21 was 504 t, of which 73% was scaly mackerel, and 23% Australian sardine (West Coast Small Pelagic Scalefish Figure 2). Scaly mackerel have dominated the catch since Australian sardine suffered mass mortality events in 1995 and 1998/99 caused by a herpesvirus. Recreational catches are negligible (<1 t annually, Tate and Smallwood 2021, Ryan *et al*. 2022).

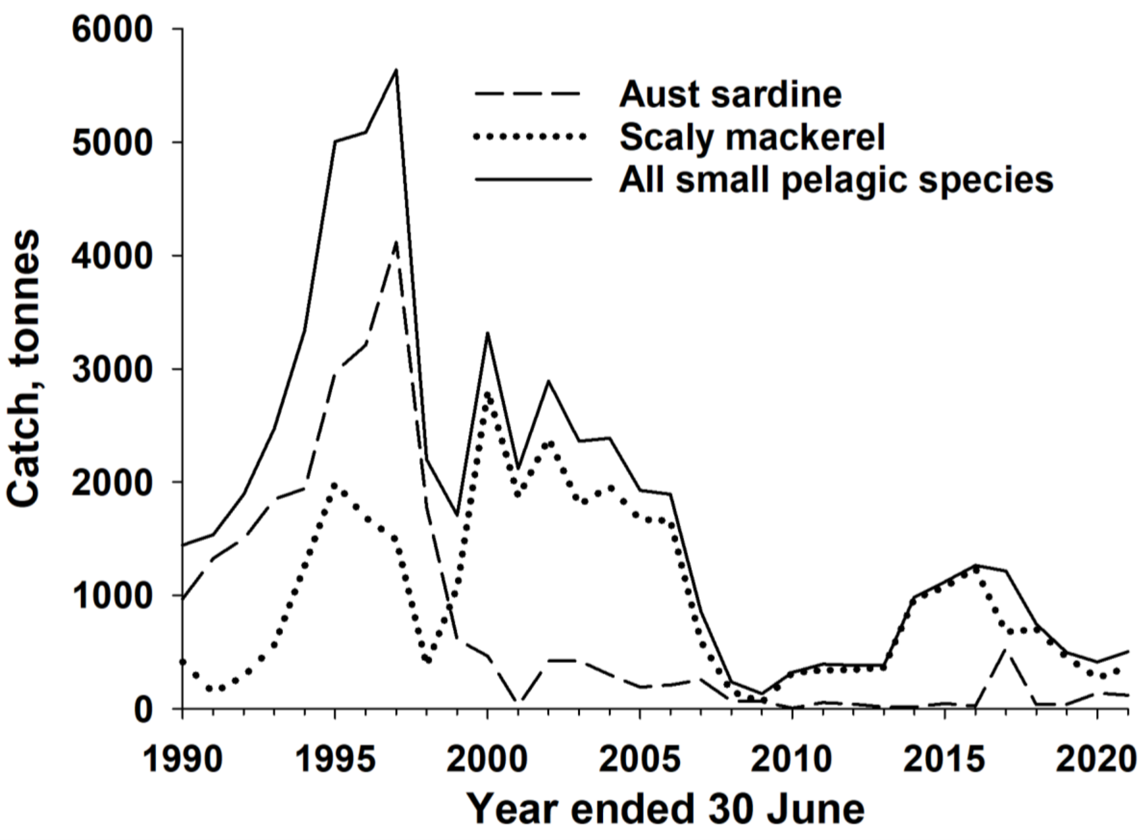
INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Scaly mackerel (Sustainable-Adequate)

Scaly mackerel are small, low trophic level pelagic species that feeds by filtering plankton. In WA longevity has been estimated to be up to 7 years of age, and maximum fork length and weight at 22 cm and 154 g respectively.

In WA, the WCPSMF and developmental zone licensees operate at the southern limit of the scaly mackerel's natural distribution. Analysis of otolith chemistry showed no evidence for the existence of separate populations between Carnarvon and Fremantle (Gaughan and Mitchell 2000). They are a highly mobile species resulting in a patchy but widespread distribution.

The WCPSMF and developmental licensee catch of scaly mackerel in 2020/21 was 367 t, a 36% increase from 2019/20 (West Coast Small Pelagic Scalefish Figure 2). Since around 2008, the catch and effort has been historically low. Confidentiality requirements preclude disclosure of the fine scale spatial distribution of catch quantities. Fishing in the Northern Development Zone was not undertaken during 2020/21 for economic reasons. The limited spatial distribution of fishing effort suggests that only a small proportion of a widespread stock is being targeted. A risk based, weight of evidence assessment (Blazeski et al. 2021) demonstrated that the catches and biological stock were considered to be **sustainable-adequate**.



WEST COAST SMALL PELAGIC SCALEFISH FIGURE 2.
Time series of the total annual catch of all five west coast small pelagic scalefish species combined, scaly mackerel and Australian sardine by the WCPSMF and developmental licensees from 1990 to 2021.

Australian sardine (Sustainable-Adequate)

Australian sardine is a small, low trophic level pelagic species that feeds by filtering plankton. Longevity is estimated to be up to 9 years of age, and maximum size in the range of 200-250 mm SL.

The WCPSMF and developmental licensee catch of Australian sardine in 2020/21 was 118 t (West Coast Small Pelagic Scalefish Figure 2). Catches declined precipitously during the mid to late 1990s following two mass mortality events caused by a herpesvirus. While the stock had recovered by the mid-2000s (see below), catches have remained low. This is due to reduced effort and the fishery transitioning to primarily land scaly mackerel.

Population modelling, based on spawning biomass estimates (from egg surveys), catch-at-age and catch data, suggested the stock had recovered from the mass mortality events by the mid-2000s (Gaughan et al. 2008). By this time the annual exploitation rate was low: less than 5 per cent (around 400 t) of the estimated spawning biomass of approximately 25,000 t. Since then annual catches have remained below this level and so are unlikely to cause the stock to become recruitment overfished (Blazeski et al. 2021). Catches and biological stock status are therefore considered to be **sustainable-adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

The species available for capture in the WCPSMF and Development Zones are restricted by the West Coast Purse Seine Managed Fishery Management Plan 1989, a Prohibition on Fishing (Purse Seining) Order and an Instrument of Exemption issued under Sections 43 and 7(2)(e) respectively of the FRMA.

Bycatch

Small quantities of other finfish species are sometimes taken as bycatch, but this occurs infrequently and the majority are released from the net unharmed. Juvenile spinner sharks are sometimes taken in Cockburn Sound but the large majority are released unharmed.

An ecological risk assessment (ERA) in 2021, assessed the impact of the WCPSMF and development zone activities on stocks of bycatch species as being **negligible** risk (Blazeski et al. 2021).

Protected species

Interactions with endangered, threatened and protected species (ETPs) must be reported to the Department on statutory monthly catch and effort returns. WCPSMF and development zone interactions are rare and usually result in the animal being released unharmed. No interactions were recorded by fishers in 2020/21.

The risk to protected species from WCPSMF and development zone activities was assessed as **negligible** (long nosed fur seal, Australian sea lion, syngnathids and other ETP species) and **low** (dolphins) in the 2021 ERA (Blazeski et al. 2021).

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

Purse seine nets are pelagic in nature, with little 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 habitats when this occurs, and any impact is restricted to a small, localised area. The WCPSMF and Development Zones is therefore considered to be a **negligible** risk to these habitats (Blazeski et al. 2021).

Ecosystem

Australian sardine are a relatively short lived, low trophic level species important for ecosystem structure and function. Their abundance is subject to large natural variations in response to environmental conditions, and catch quotas are likely to be <10% of the spawning biomass. The ecosystem impact from fishing in the WCPSMF and Development Zones is considered **low** risk (Blazeski et al. 2021).

SOCIAL AND ECONOMIC OUTCOMES

Social

Small pelagic fish are not a major target for recreational fishers and catches are low: the only species detected in the catch of boat-based recreational fishers during 2020/21 was <1 t of yellowtail scad (Ryan et al. 2022). **Negligible** risk.

Economic

Local employment was provided by six active vessels as well as local processing factories. Most of the catch is sold for bait with a smaller proportion for human consumption or feed for aquaculture and pets. Product export was permitted as the WCPSMF and Development Zones were granted a Wildlife Trade Operation by the Commonwealth Department of Environment and Energy in January 2020. The estimated gross value of production (GVP) for the WCPSMF in 2020/21 was <$1 million (Level 1). The economic risk is considered **Moderate**.

GOVERNANCE SYSTEM

Harvest Strategy

The WCPSMF is currently managed under a constant catch harvest strategy approach, with catches limited to notional Total Allowable Commercial Catches (TACCs).

Allowable Catch Tolerance Levels

Currently, a notional combined TACC, covering both the Perth metropolitan fishery and the Southern Development Zone, is set for Australian sardine and separately for other small pelagic species. For the annual licensing period (1 April to 31 March) the notional TACC is 2,328 t for Australian sardine and 672 t for other small pelagic species and Perth herring combined. For the Northern Development Zone the notional TACC is 2,700 t for scaly mackerel. Reaching or exceeding the notional TACCs will trigger a management response.

Compliance

Catches are assessed against notional TACCs through the lodgement of trip Catch Disposal Records (CDRs) by fishers to the Department. Compliance is monitored via aerial patrols and both at-sea and land based inspections.

Consultation

The Department undertakes consultation directly with the Southern Seafood Producers Association, WCPSMF and Development Zone licensees on operational issues on an as needs basis, and more formally via industry Management Meetings convened by the Western Australian Fishing Industry Council (WAFIC) pursuant to 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

The West Coast Small Pelagic Scalefish Resource will continue to be monitored principally through Level 1 (catch based) assessments. Purse seine catch sampling has commenced in te Perth Metropolitan region as part of a broader research program studying the Cockburn Sound ecosystem to assist planning for upgrades to port facilities (Westport). Purse seining in the Northern Development Zone was not undertaken during 2020/21 for economic reasons, suggesting lower ongoing catches of scaly mackerel may occur into the future.

An Ecological Risk Assessment (ERA) in 2021 focussed on evaluating the impacts of WCPSMF and Development Zone activities on all relevant retained and bycatch species, endangered, threatened and protected species, habitats and the broader environment (Blazeski et al. 2021). The ERA involved a broad range of stakeholders including representatives of the commercial fishing sector, State and Australian Government agencies, Birdlife Australia, Conservation Council WA, the University of Western Australia, Murdoch University and the Marine Stewardship Council. It will assist with the imminent application for renewal of its status as an approved wildlife trade operation for export approval.

A formal harvest strategy for the Statewide Small Pelagic Scalefish Resource is yet to be developed, however, it is noted as a future management initiative. Recently commenced catch sampling in the Perth Metropolitan area should assist in the development of the harvest strategy.

EXTERNAL DRIVERS

Planned upgrades to port facilities in Cockburn Sound (Westport) have the potential to impact fisheries operating in the area. Climate change is likely to be causing a gradual southward contraction in the natural distribution of Australian sardine (**moderate** risk) and facilitating a southward extension of the distribution for scaly mackerel (**negligible** risk).

Net damage from shark bite has reached an unprecedented level according to fishers in the Northern Development Zone (near Geraldton), resulting in fish leakage, major repair jobs and lost fishing time. Fishing ceased in this zone during 2020/21 for economic reasons.

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WEST COAST DEMERSAL SCALEFISH RESOURCE STATUS REPORT 2022

E. Fisher, D. Fairclough and S. Walters

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 primarily by boat-based commercial and recreational (including charter) line fishers. The indicator species for inshore waters include WA dhufish, Snapper and Baldchin groper (for the Mid-west Area only), while indicators for offshore waters include Hapuku, Blue-eye trevalla and Bass groper (DPIRD, 2021).

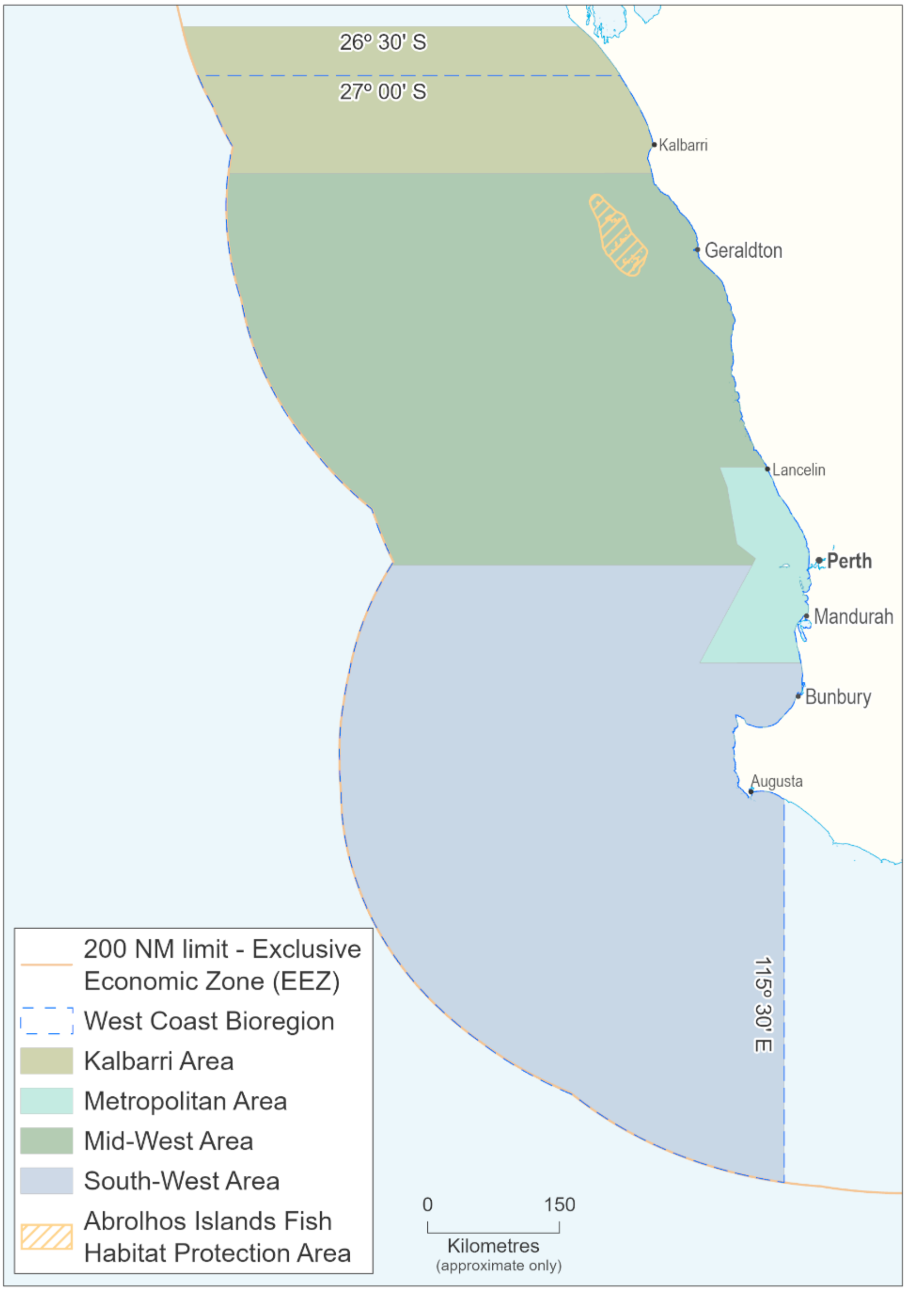
The WCDSR is currently managed under a 20-year recovery plan following a period of overfishing in the 1990s and 2000s (Wise et al., 2007). Management arrangements designed to recover the resource by 2030 were progressively introduced between late 2007 and early 2010, aiming to limit annual retained catches of demersal species by both the commercial and recreational sectors to 50% of 2005/06 catch levels, in line with a formal IFM sectoral allocation decision. To meet these objectives, the commercial fisheries permitted to land demersal scalefish in the WCB have individual management arrangements with access, gear, area (including a Metropolitan closure) and/or entitlement limitations. Similarly, boat-based recreational and charter fishers are licensed and managed by input and output controls, including a closed season.

The most recent (2021) stock assessment of WA dhufish and Snapper in the WCB has demonstrated that while declines in spawning biomass have been halted, fishing pressure is still too high to allow stocks to replenish (Fairclough et al., 2021). In line with the WCDSR Harvest Startegy (DPIRD, 2021), a review is underway to determine the management measures required to recover the resource by 2030.

SUMMARY FEATURES

Asset (Allowable catch)	Outcome	Status
[a]Commercial fisheries (450 t)	Total catch 2020/21: 259 t	Acceptable
[b]Recreational fishery (250 t)	Total catch range 2020/21: 265–321 t Total Catch 2020/21: 200–256 t (95% CI, private boat-based only); Charter 2020/21: 65 t	Not acceptable (2020/21)
EBFM		
Indicator species		
West Australian dhufish	[c]2021: $F > F_{limit}$, $B_{limit} < B < B_{threshold}$	Inadequate
Snapper	[c]2021: $F > F_{limit}$, $B \approx B_{limit}$	Inadequate
Ecological		
Bycatch	Low risk	Acceptable
Listed Species	Negligible risk	Acceptable
Habitat	Negligible risk	Acceptable
Ecosystem	Low risk	Acceptable
Economic (GVP $1-5 m)	High risk	Not acceptable; management action
Social (High amenity)	High risk	Not acceptable; management action
Governance	High risk	Not acceptable; management action
External Drivers	Medium risk	Acceptable

[a]Demersal suite; [b]Top 15 demersal species; [c]Date of last assessment.



WEST COAST DEMERSAL SCALEFISH RESOURCE FIGURE 1.
Map showing boundaries of the West Coast Bioregion and the West Coast Demersal Scalefish Interim Managed Fishery.

CATCH AND LANDINGS

The WCDSR Harvest Strategy (DPIRD, 2021) was published part way through the last season of catch data for the West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF) and the 2020/21 integrated survey of boat-based recreational fishing. Landings are therefore reported here against original catch recovery benchmarks. Future reports will compare catch to benchmarks that account for total fishing mortality (comprising retained catch and estimated mortality of released fish).

The total landings of demersal species by commercial fisheries in the WCB have remained below the original recovery benchmark of 450 t (50% of 2005/06 catches) since 2008, when management measures were introduced to recover stocks (West Coast Demersal Scalefish Resource Figure 2). In the most recent season (2020/21 or 2021), retained commercial catches of demersal scalefish in the WCB were 259 t. The WCDSIMF retained 221 t of this catch in 2021 (236 t total, including non-demersal scalefish), which was also below its recovery benchmark of 410 t. The Temperate Demersal Gillnet and Demersal Longline fisheries, the West Coast Rock Lobster Managed Fishery, the Cockburn Sound Line and Pot Managed Fishery, and other minor fisheries in the WCB landed 33 t, 3.4 t, 0.5 t and 1.4 t of demersal scalefish, respectively, in either 2020/21 or 2021.

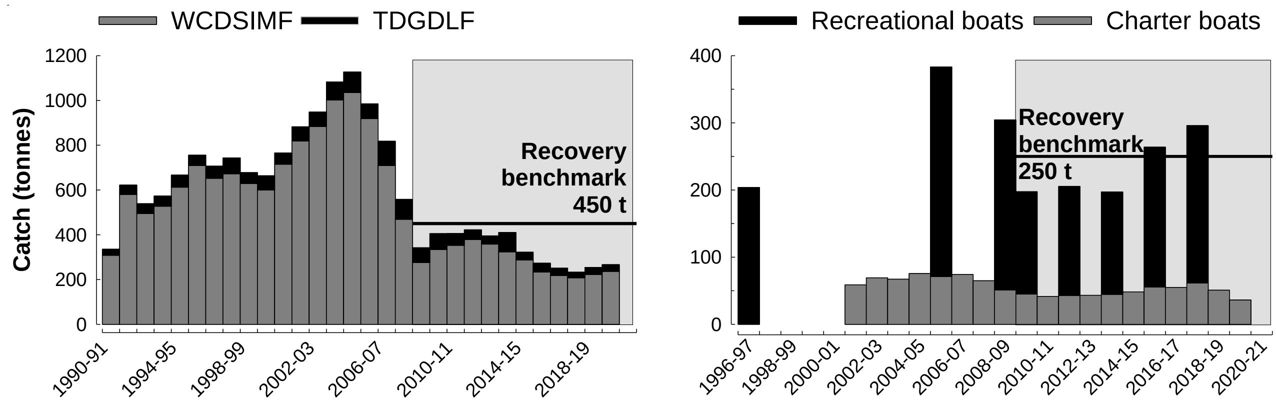
In 2021, retained catches of demersal scalefish by the WCDSIMF increased to 84 t in the Kalbarri

Area (75 t in 2020), while they declined to 92 t in the Mid-West Area (105 t in 2020). In the South-West Area, catches of demersal species by the WCSDIMF increased to 45 t in 2021 (38 t in 2020). Catches of indicator species are summarised in the sections below.
The WCDSIMF fished for ~7,160 hours in 2021, decreasing from ~8,610 in 2020. The majority of the effort in 2021 occurred in the Mid-West area (~4,130 h), followed by the Kalbarri (1,900 h) and South-West (1,140 h) areas. In 2021, the annual entitlement to fish (hours) consumed by the WCDSIMF in the Kalbarri, Mid-West and South-West areas was 60%, 45% and 41% of avaliable capacity, respectively.

The harvest of the top 15 demersal species/groups in the WCB by the recreational sector in 2020/21 was 265–321 t, derived from the statewide survey of private boat-based recreational fishing (95% CI 200–256 t) and reported catches of charter fishers in the same year (65 t) year. This harvest range exceeded the recovery benchmark of 250 t for the recreational sector (West Coast Demersal Scalefish Resource Figure 2).

The boat-based recreational harvest for the top 15 demersal species/groups in the WCB (representing 93% of the resource kept catch by numbers) remained relatively steady at 228 t (95% CI 200–256) in 2020/21 compared with 234 t (95% CI 203–266) in 2017/18 (Ryan et al. 2022). The boat-based recreational fishing effort in the WCB was steady in 2020/21 at 313,873 boat days (95% CI 276,096–351,650) compared with 306,761 boat days in 2017/18 (95% CI 271,436–342,086) (Ryan et al., 2022).

The charter catch of the top 15 demersal species/groups in the WCB increased to 65 t in 2020/21 (36 t in 2019/20), due in part to an easing of COVID-19 restrictions that impacted the charter sector in the previous year. The number of trips reported by charter fishers catching finfish in the WCB increased from ~1,370 in 2019/20 to 2,094 in 2020/21.



WEST COAST DEMERSAL SCALEFISH RESOURCE FIGURE 2.
Retained catches of demersal species in the West Coast Bioregion for the commercial (left) and recreational (right) sectors, compared to original recovery benchmarks introduced between 2008 and 2010. Retained catch by the recreational sector combine data for each financial year from charter logbooks introduced in 2001/02 and survey year for recreational boats. Private boat-based recreational catches are point estimates of the retained catch and do not show uncertainty (95% CIs), with 2011/12-2020/21 estimates derived from statewide phone diary surveys (Ryan et al., 2022) and prior estimates derived from boat ramp creel surveys (Lai et al., 2019). WCDSIMF = West Coast Demersal (Interim) Managed Fishery; TDGDLF = Temperate Demersal Gillnet and Demersal Longline Fisheries.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

As outlined in the WCDSR Harvest Strategy (DPIRD, 2021), reviews are undertaken annually to evaulate catches against relevant recovery benchmarks. Periodic weight of evidence assessments of indicator species evaluate additional key performance indicators for stock status, including estimates of fishing mortality (*F*) and relative spawning biomass (*B*), to determine the risk to stocks over the next five years using ISO 31000-based risk assessment methods (e.g. Fletcher, 2015). The most recent assessment of key indicator species for the WCDSR (WA dhufish and Snapper) was conducted in 2021 (Fairclough et al., 2021).

Inshore Demersal

West Australian dhufish (Inadequate)

Retained catches of WA dhufish in the WCB by all commercial fisheries and the WCDSIMF have been around or below respective recovery benchmarks of 82 t and 72 t since management arrangements were implemented in 2008 to recover stocks. In 2020/21, 43 t of WA dhufish were landed by all commercial fisheries in the WCB, of which 34 t were landed by the WCDSIMF in 2021 (West Coast Demersal Scalefish

Resource Figure 3). This represents declines from 55 and 48 t, respectively, from the previous season. The majority of retained WA dhufish catch by the WCDSIMF is taken in the Mid-West and South-West areas (23 t and 10 t, respectively, in 2021). Catches of WA dhufish in the Kalbarri Area remained low (< 1 t) in 2021.

The harvest of WA dhufish in the WCB by the recreational sector (private boat-based and charter fishers) in 2020/21 was 97–142 t, derived from the statewide survey of boat-based recreational fishing (95% CI 85–130 t) and reported catches of charter fishers in the same year (12 t) year (West Coast Demersal Scalefish Resource Figure 3). This harvest range exceeded the recovery benchmark of 126 t. The harvest range of WA dhufish also exceeded the recovery benchmark in 2017/18 (95% CI 112–166 t) and 2015/16 (95% CI 104–150 t) in 2015/16.

The boat-based recreational harvest of WA dhufish was steady at 108 t (95% CI 85–130) in 2020/21 compared with 127 t (95% CI 100–153) in 2017/18 (Ryan et al. 2022). The charter catch of WA dhufish increased to 12 t in 2020/21 (8 t in 2019/20) after a period of lower charter catches due to COVID restrictions. The retained catch of WA dhufish represented 49% of the 41,970 (SE=4,513) caught (retained and released) by boat-based recreational fishers in 2020/21 (Ryan et al., 2022) and 61% of the 3,656 caught by charter fishers in 2020/21.

The 2021 weight of evidence assessment of the WA dhufish stock at the bioregion level, including biological data up to 2017/18, estimated that relative spawning biomass (*B*) was between the limit and threshold reference points in 2020 (Fairclough et al., 2021). Model projections based on future catches being equivalent to the original recovery benchmarks (50% of 2005/06 catch) suggested that while *B* in the combined southern (South-West and Metropolitan) management areas is expected to rebuild to above the threshold by 2030, *B* in the combined northern (Mid-West and Kalbarri) areas is unlikely to recover at the required rate. Estimates of fishing mortality (*F*) based on catch curve analyses of age composition data indicate that fishing pressure on the stock remains too high as there continues to be a lack of older WA dhufish in the population, particularly in the Metropolitan, Mid-West and Kalbarri management areas. The rate of stock recovery may be impacted by the recent high recreational catches and a high level of post-release mortality of this species. This species was therefore assessed as High Risk (C3 × L4).

The above evidence indicates that while there are some signs of recovery of WA dhufish in the south of the WCB, indicators for the northern management areas are unlikely to meet recovery milestones by 2030 unless further management action is taken to reduce total fishing mortality (i.e. retained catches and post-release mortality). The biological stock is thus classified as **inadequate**.

Snapper (Inadequate)

Retained catches of Snapper in the WCB by all commercial fisheries and the WCDSIMF exceeded the respective recovery benchmarks of 126 t and 120 t between 2010 and 2014. Reductions in effort entitlements to WCDSIMF fishers in the Kalbarri and Mid-West areas in 2015 contributed to reducing total commercial and WCDSIMF landings below the benchmarks. Total Snapper landings of 109 t by all commercial fisheries in 2020/21, and of 97 t by the WCDSIMF in 2021, increased from 79 t and 72 t, respectively, in the previous season (West Coast Demersal Scalefish Resource Figure 3). The majority of Snapper catches retained by the WCDSIMF are from the Kalbarri and Mid-West management areas (49 t and 46 t, repectively, in 2021), while catches of this species in the South-West Area have remained low (< 5 t) since 2008.

The harvest of Snapper in the WCB by the recreational sector (private boat-based and charter fishers) in 2020/21 was 69–93 t, derived from the statewide survey of boat-based recreational fishing (95% CI 40–64 t) and reported catches of charter fishers in the same year (29 t) year (West Coast Demersal Scalefish Resource Figure 3). This harvest range exceeded the recovery benchmark of 37 t. The harvest range of Snapper also exceeded the recovery benchmark during the years of each of the five statewide surveys between 2011/12 and 2020/21.

The boat-based recreational harvest of snapper was steady at 52 t (95% CI 40–64) in 2020/21 compared with 48 t (95% CI 37–60) in 2017/18 and 36 t (95% CI 27–45) in 2015/16 (Ryan et al. 2022). The charter catch of snapper increased to 29 t in 2020/21 following an easing of restrictions on charter fishing due to COVID. The retained catch of Snapper represented 25% of the 84,002 (SE=9,150) caught (retained and released) by boat-based recreational fishers in 2020/21 (Ryan et al., 2022) and 41% of the 28,350 caught by charter fishers in 2020/21.

The 2021 assessment of the Snapper stock at the bioregion level, including biological data collected up to 2017/18, estimated that *B* in 2020 was just below the limit reference point (Fairclough et al., 2021). Model projections based on future catches equivalent to the original recovery benchmarks (50% of 2005/06 catch) demonstated that *B* is unlikely to rebuild to above the threshold reference level by 2030. Catch curve estimates of *F* have remained above acceptable levels, particularly in the northern management areas, as also indicated by a lack of older Snapper in the population. The recent high recreational catches, post-release mortality associated with high recreational sector release rates and unknown commercial release rates may be slowing the rate of stock recovery. Snapper is thus assessed as Severe Risk (C4 × L4).

The above evidence indicates that while the decline of Snapper spawning biomass has been halted, recovery milestones are unlikely to be met unless further management action is taken to reduce total fishing mortality (i.e. retained catches and post-realease mortality). The biological stock is thus classified as **inadequate**.

Baldchin groper (Inadequate)

Landings of Baldchin groper in the WCB by all commercial fisheries (11 t in 2020/21) and the WCDSIMF (8 t in 2021) were below respective recovery benchmarks of 22 t and 17 t, as they have been since the current management arrangements were implemented (West Coast Demersal Scalefish Resource Figure 3). In 2021, the majority of Baldchin groper catches retained by the WCDSIMF (7 t) were taken from the Mid-West Area, with the remainder mostly landed in the Kalbarri Area.

The harvest of Baldchin groper in the WCB by the recreational sector (private boat-based and charter fishers) in 2020/21 was 43–62 t, derived from the statewide survey of boat-based recreational fishing (95% CI 29–48 t) and reported catches of charter fishers in the same year (14 t) year (West Coast Demersal Scalefish Resource Figure 3). This harvest range exceeded the recovery benchmark of 33 t. The harvest range of Baldchin groper also exceeded the recovery benchmark in 2017/18, 2015/16 and 2011/12.

The boat-based recreational harvest of Baldchin groper was steady at 38 t (95% CI 29–48) in 2020/21 compared with 32 t (95% CI 23–41) in 2017/18 (Ryan et al. 2022). The charter catch of Baldchin groper increased to 14 t in 2020/21. The retained catch of Baldchin groper represented 68% of 26,681 (SE=3,647) caught (retained and released) by boat-based recreational fishers in 2020/21 (Ryan et al., 2022) and 61% of the 7,802 caught by charter fishers in 2020/21.

The last published assessment of Baldchin groper in 2014, based on age composition data collected from 2008/09 to 2010/11 (i.e. during management changes), showed that catch curve estimates of F at the biological stock level remained above the limit reference point of 1.5 times the value of natural mortality, M (Fairclough et al., 2014). Point estimates of the Spawning Potential Ratio (SPR, used as a proxy for B) were between the limit and threshold reference levels of 0.2 and 0.3, respectively. High recreational catches and a very high level of post-release mortality of this species may be impacting on stock recovery.

As age-based assessments of Baldchin groper have not been conducted since 2014, the status of this species at the time of the 2021 assessment is assumed to be the same as the primary indicator species for the WCDSR, WA dhufish and Snapper. While it is likely that the decline in spawning biomass of Baldchin groper has been halted, recovery milestones are unlikely to be met unless further management action is taken to reduce total fishing mortality (i.e. retained catches and post-realease mortality). The biological stock is thus classified as **inadequate**.

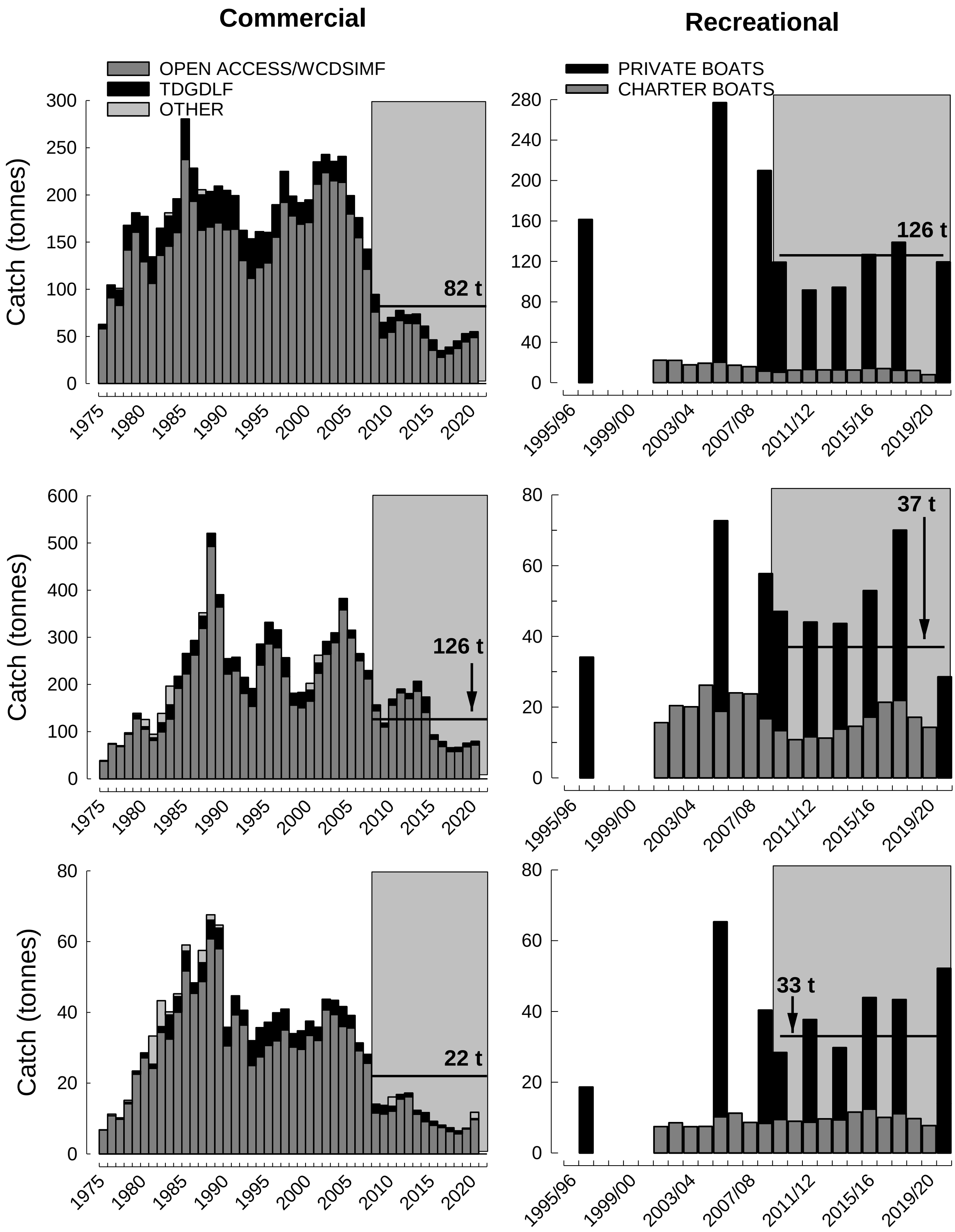
Offshore Demersal

Landings of the dominant offshore demersal scalefish species (Eightbar grouper, Bass groper, Hapuku, Blue-eye trevalla and Ruby snapper) by the WCDSIMF have remained below the nominal sustainable catch range for this suite (20-40 t) since the fishery commenced in 2008. Catches have been variable among years, ranging from 6-14 t between 2008 and 2015, increasing to 15-20 t per year between 2016 and 2019, before falling to 11 t in 2020 and 9 t in 2021. Following a phase of exploratory fishing in the early years of the WCDSIMF, the majority of offshore demersal catch since 2016 (95%) have been landed in the South-West Area and have been dominated by Hapuku (69% of landings).

Offshore demersal species are also caught by the Commonwealth-managed Western Deepwater Trawl Fishery, which operates in the WCB and Gascoyne Coast Bioregion. The number of active vessels in this fishery has been relatively low since 2005/06, with the most recent published report of annual retained catches of offshore demersal species in 2019/20 including 8 t of Ruby snapper (Patterson et al., 2021).

In 2020/21, retained catches of the dominant offshore demersal species by the recreational sector comprised 11 t by boat-based recreational fishers (Ryan et al., 2022) and < 1 t by charter fishers. Catches of offshore species by charter fishers occur predominantly in the Metropolitan Area.

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



WEST COAST DEMERSAL SCALEFISH RESOURCE FIGURE 3.
Commercial and retained recreational catches of the indicator species WA dhufish (top), Snapper (middle) and Baldchin groper (bottom), compared to original recovery benchmarks introduced between 2008 and 2010. Harvest by the recreational sector combine data for each financial year from charter logbooks introduced in 2001/02 and survey year for recreational boats. Private boat-based recreational catches are point estimates of the retained catch and do not show uncertainty (95% CIs), with 2011/12-2020/21 estimates derived from statewide phone diary surveys (Ryan et al., 2022) and prior estimates derived from boat ramp creel surveys (Lai et al., 2019). Open access and WCDSIMF [West Coast Demersal (Interim) Managed Fishery] are hand-line/drop-line fisheries; TDGDLF = Temperate Demersal Gillnet and Demersal Longline Fisheries.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch

Line fishing for demersal species using baited hooks is highly selective for fishes. While other fishes 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 considered a **low** risk.

Protected Species

Mandatory reporting of listed species interactions by commercial WCDSIMF and charter fishers suggest these interactions are relatively rare. No interactions with protected species were reported by WCDSIMF fishers in 2021. In 2020/21, charter fishers caught and released alive two Gold-spotted rockcod that were above the maximum size limit. The level of interactions with these listed species is therefore considered a **negligible** risk.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

Line fishing is the main method used in the commercial and recreational fishery for demersal species. As this fishing method has little physical impact on the benthic environment, the risk to benthic habitats is considered **negligible**.

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 improvements in reporting methods. As there was no evidence of a decline in the trophic level or mean size of catches, the fishery is considered to represent a **low** risk to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

The WCDSR provides high social amenity to fishers and divers, as well as to consumers by providing commercial fish supply to markets and restaurants. The WCDSR Harvest Strategy includes indicators to measure the performance of each sector against social and economic objectives (DPIRD, 2021). These are applied within the constraints of meeting objectives for ecological sustainability, and while having regards to the objectives of other sectors.

In 2021, 32 Licenced Fishing Boats (LFBs) operated in the commercial WCDSIMF and employed between zero and four crew, excluding the skipper. The WCDSIMF utilised 48% of the total avaliable entitlement (fishing hours) in this year, which is well below the target level of 75% specified in the Harvest Strategy.

There were 61 licensed charter operators that reported fishing for finfish in the WCB in 2020/21. The number of people employed in the charter industry has not been estimated. In 2020/21, 31,534 client days were reported by charter operators, which is between the target participation level of 27,901 client days (2009-2018 average) and the upper threshold set at 20% above the target (i.e. 33,481 client days).

The WCDSR is highly accessible to boat-based fishers, with 131,778 Recreational Fishing from Boat Licences (RFBLs) held in WA from September 2020 to August 2021. The estimated private boat-based recreational fishing effort in the WCB was steady in 2020/21 at 791,963 hours fished (SE=51,144), compared to 774,101 (SE= 43,754) in 2017/18 (Ryan et al., 2022). The 2020/21 estimate is below the target participation level of 820,693 hours but above the lower threshold set at 20% below the target (i.e. 656,554 hours).

Given the impending changes to the management of the WCDSR, there is currently a **high** level of risk to these social values.

Economic

The value of commercial fishing and aquaculture to the WA economy was recently estimated at $989 million (Ogier et al., 2020). The estimated gross value of product (GVP) for the WCDSIMF in 2020 was $1-5 million (Level 2).

The value of recreational fishing to the WA economy was recently estimated at $2.4 billion per year (McLeod and Lindner, 2018) with recreational fishing in the Mid-West, Wheatbelt, Metro, Peel and South West regions estimated to be worth over $1.7 billion per year.

Given the impending changes to the management of the WCDSR, there is currently a **high** risk to this level of economic return.

GOVERNANCE SYSTEM

Harvest Strategy

The WCDSR is currently managed using a constant catch strategy, with a formal catch allocation of 64% to the commercial sector and 36% to the recreational sector. The Harvest Strategy for this resource was published in 2021 (DPIRD, 2021), including details of the recovery plan aimed to maintain total fishing mortality (retained catch + post-release mortality) below recovery benchmarks until estimates of *B* and *F* for key indicator species reach acceptable levels, i.e. the threshold reference points (see Fletcher et al., 2016).

Allowable Catch Tolerance Levels

Total retained catches of the demersal suite and indicator species (WA dhufish, Snapper, Baldchin groper) by the commercial sector in the most recent season (2020/21) were maintained below the original recovery benchmarks of 450, 82, 126 and 22 t, respectively. The retained catch levels of the commercial sector are considered **acceptable**.

Harvest ranges for the demersal suite and indicator species (WA dhufish, Snapper, Baldchin groper) by the recreational sector (boat-based private fishers from the most recent statewide survey and charter fishers in the same year, i.e. 2020/21) were each above the respective recovery benchmarks, i.e. 250 t, 126 t, 37 t and 33 t, respectively, and are thus considered **not acceptable**.

As the recently-published WCDSR Harvest Strategy has adopted new recovery benchmarks based on total fishing mortality (DPIRD, 2021), recovery benchmarks will be revised in future resource reports.

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 engages a stakeholder-based Harvest Strategy Reference Group to undertake the annual and periodic review processes outlined in the WCDSR Harvest Strategy (DPIRD, 2021) and provide recommendations to Government on appropriate management responses. Consultation is also undertaken directly with licensees on operational issues. The Department convenes Annual Management Meetings through the West Australian Fishing Industry Council (WAFIC), who are also responsible for undertaking statutory management plan consultation for the Department under a Service Level Agreement. 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

A formal harvest strategy for the WCDSR was published in 2021 (DPIRD, 2021), detailing the total fishing mortality recovery benchmarks and milestones for recovering the resource by 2030. Following the 2021 stock assessment, a review of the current performance against the Harvest Strategy was conducted, recommending that further management action was required to recover the resource (i.e. **high** risk).

In February 2022, consistent with the Harvest Strategy, the Minister for Fisheries approved a 50% reduction in WCDSR recovery benchmarks. DPIRD is undertaking an extensive two-phase consultation process during 2022 to develop and implement management packages for each fishing sector to meet reduced recovery benchmarks and allow the WCDSR to recover by 2030. Phase 1 of the consultation process was undertaken in April 2022 led by peak sector bodies to provide recommendations to DPIRD on preferred management measures to be included in proposed management packages for their sector. DPIRD will lead phase 2 in August 2022 by undertaking public consultation on proposed management packages for each sector using preferred management measures recommended by each sector to the extent required to meet their reduced recovery benchmarks. Management packages for each fishing sector are due to be finalised by late 2022. The next WCDSR stock assessment is due in 2023.

EXTERNAL DRIVERS

Recruitment success of demersal species, such as WA dhufish and Snapper vary annually and are influenced in part by environmental factors. Climate change may impact a range of factors (e.g. increased water temperatures, changes in current strength) that could influence recruitment and the biology of demersal species in the WCB. The risks to some of these species have been ranked as medium-high and high in regards to their sensitivity and exposure to climate change (Caputi et al. 2015). Ongoing industrial development in Cockburn Sound may affect the spawning aggregation behaviour and survival of juvenile Snapper in that area, and thus recruitment to the broader west coast stock.

There is some overlap of demersal species captured in the WCB by state-managed fisheries and by the Commonwealth-managed Western Deepwater Trawl Fishery and Great Australian Bight Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery (>200 m). Recent catches are relatively small.

Exernal factors represent a **medium** risk to the WCDSR.

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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 pink snapper, whiting and tailor, which are temperate species 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.

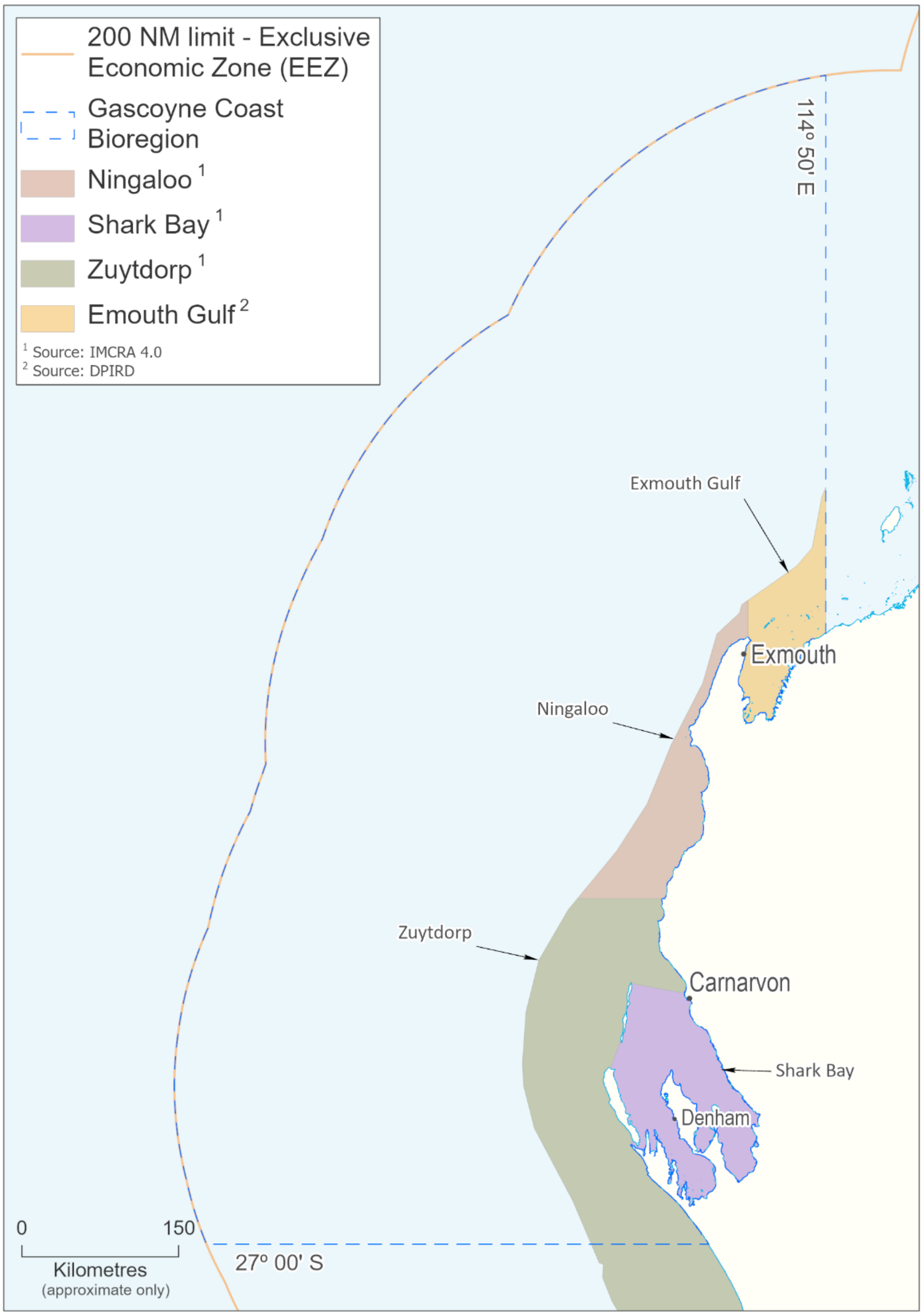
The waters off the Gascoyne Coast are also strongly influenced by the southward-flowing Leeuwin Current, generated by flow from the Pacific through the Indonesian Archipelago. This tropical current becomes evident in the North West Cape area and flows along the edge of the narrow continental shelf where, 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 Leeuwin Current. The inner waters of the embayment are hyper-saline, due 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 seagrass banks of Shark bay are the biggest in the world and twelve of the world’s 60 species of segrass are found in Shark Bay.

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;
- Increases 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 change 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.

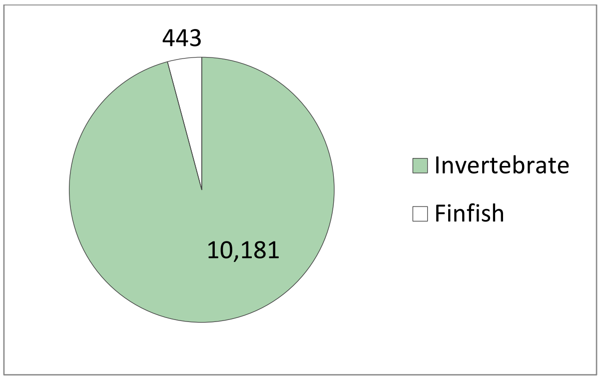
It is apparent that climate change will impact the biological, economic, and social aspects of many fisheries, and both positive and negative impacts are expected. Climate change can influence biological systems by modifying the timing of spawning, range and distribution of species, composition and interactions 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. The Department collaborates in in a national citizen-science program (www.redmap.org.au) that examines changes in the distribution of key species.

Commercial Fishing

Commercial fishing is a significant industry in the region, with catch dominated by invertebrate resources (Gascoyne Coast Overview Figure 2). The Bioregion hosts 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 OVERVIEW FIGURE 2
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 Coast 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; but was recently affected by environmental issues. However, it is now recovering quite well. Other minor commercial fishing activities for invertebrates operating in the Bioregion include collection of 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.

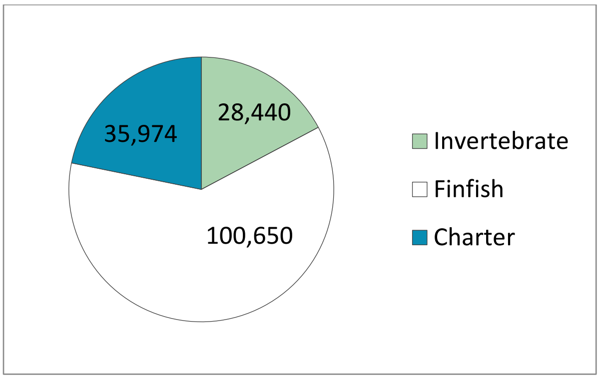
Recreational Fishing

The warm, dry winter climate and accessible fish stocks have made the Gascoyne Coast Bioregion 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 Bioregion 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, as well as 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 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.

Vessel retrievals from key boat ramps have been monitored using remote cameras for previous state-wide surveys[1]. The typical seasonal pattern of vessel retrievals at Exmouth, Denham and Monkey Mia was not observed during the early stages of COVID-19 restrictions from March to August 2020[2]. Activity patterns post COVID-19 travel restrictions are currently being analysed.



GASCOYNE OVERVIEW FIGURE 3
Recreational catches (by number) in the Gascoyne Coast Bioregion. Finfish and invertebrate catches were assessed in the statewide survey of boat-based recreational fishing in 2020/21[1]. Charter boat catch is for the same period. Estimates of shore based recreational catch are unavailable.

Aquaculture

Aquaculture in the Gascoyne focuses on the blacklip oyster *Pinctada margaritifera*. The local aquaculture sector is also focusing on the production of aquarium species, including coral, live rock and edible oysters. There is some recent interest in the production of rock oysters in Exmouth Gulf.

Tourism

The Gascoyne Coast Bioregion is a focal point for winter recreation by the Western Australian community. The typical seasonal tourism pattern was impacted by COVID-19. 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 continues to be significant oil and gas mining activity offshore from North West Cape in the Exmouth Sub-basin, and the Australian Government has also released two areas offshore from 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 (e.g. potential for fish movement / impact arising from seismic surveys), disturbance to marine habitats through drilling and/or dredging activities, introduction of marine pest species, release of produced formation water, shipping and transport activities and oil spill risks.

Shipping and Maritime Activity

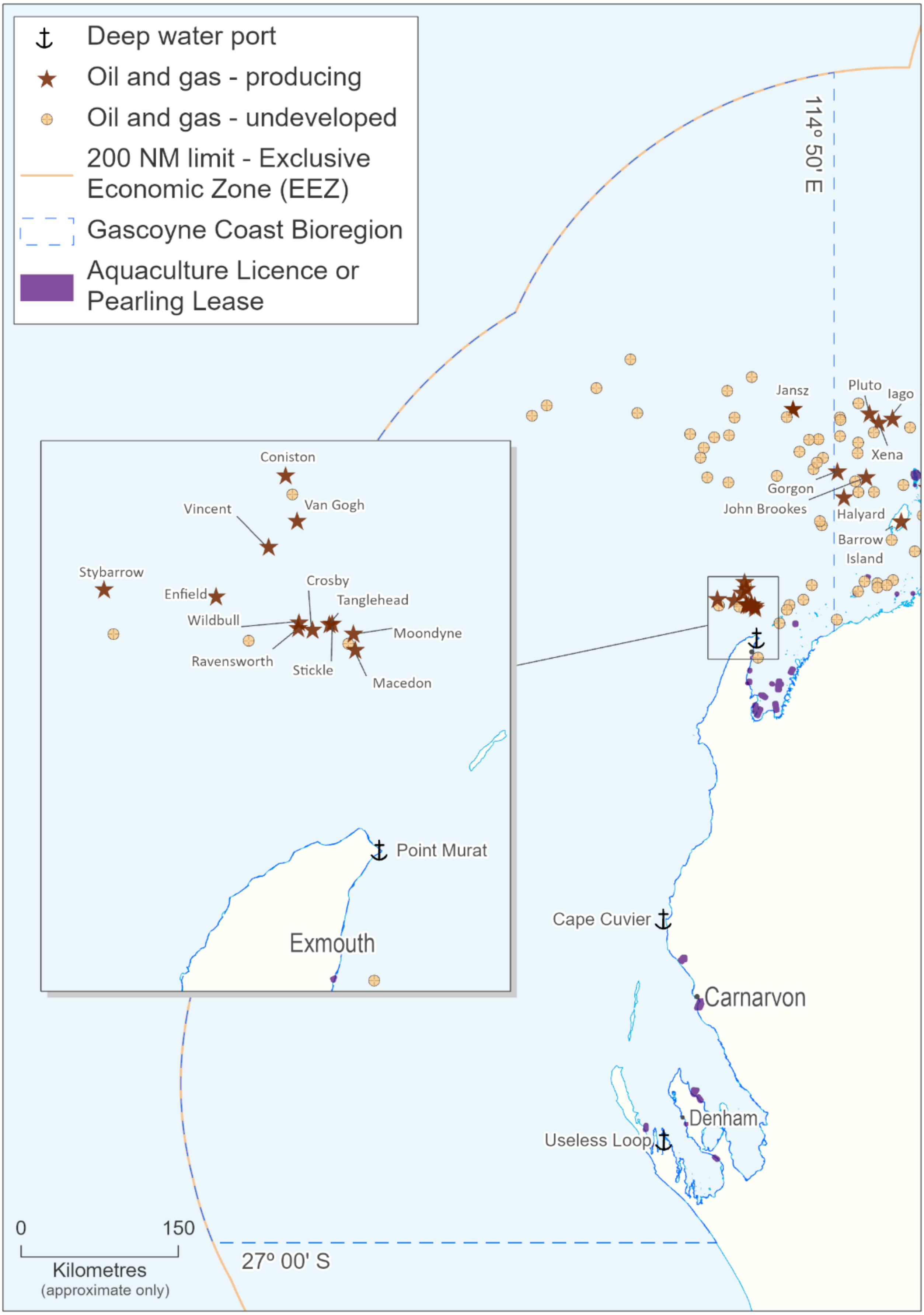
There are three deepwater port facilities currently operating in the Gascoyne Coast Bioregion: Useless Loop, Cape Cuvier (both private facilities servicing salt fields) and Point Murat, a naval port facility at Exmouth. The majority of shipping movements involve coastal cargo vessels, shipping associated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

Other harbours and maritime facilities in the Gascoyne Coast Bioregion include Denham, Carnarvon, Coral Bay and Exmouth, all of which largely service local fishing and charter vessels, as well private vessels. The expansion of oil and gas industries, 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, ship strikes of marine animals and the potential to introduce and spread marine pest species.

1 Ryan KL, Lai EKM, Smallwood CB. 2022. Boat-based recreational fishing in Western Australia 2020/21. Fisheries Research Report No. 327 Department of Primary Industries and Regional Development, Western Australia. 221pp.

2 Ryan KL, Desfosses CJ, Denham AM, Taylor SM, Jackson, G. 2021. Initial insights on the impact of COVID-19 on boat-based recreational fishing in Western Australia. Marine Policy 132: 104646



GASCOYNE OVERVIEW FIGURE 4
Exmouth sub-basin offshore oil and gas production sites, aquaculture licences and pearling leases.

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 are outlined in the following sections.

Spatial Closures

The Department 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 regions 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[1] and Day et al. 2012[2]). There are also a number of other 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 Hamelin Pool Marine Nature Reserve, 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.

In 2019 the State Government announced the 'Plan for Our Parks' initiative to create additional marine parks and terrestrial conservation reserves by February 2024. In December 2021 it was announced that this initiative will include the establishment of a new marine park in the eastern and southern portions of Exmouth Gulf.

The Commonwealth Government implemented an Australian Marine Park for the North-West Marine region (between Shark Bay and the Northern Territory border) in July 2018. This resulted in a network of marine parks off the coast of the Gascoyne Coast Bioregion (see Gascoyne Overview Figure 6).

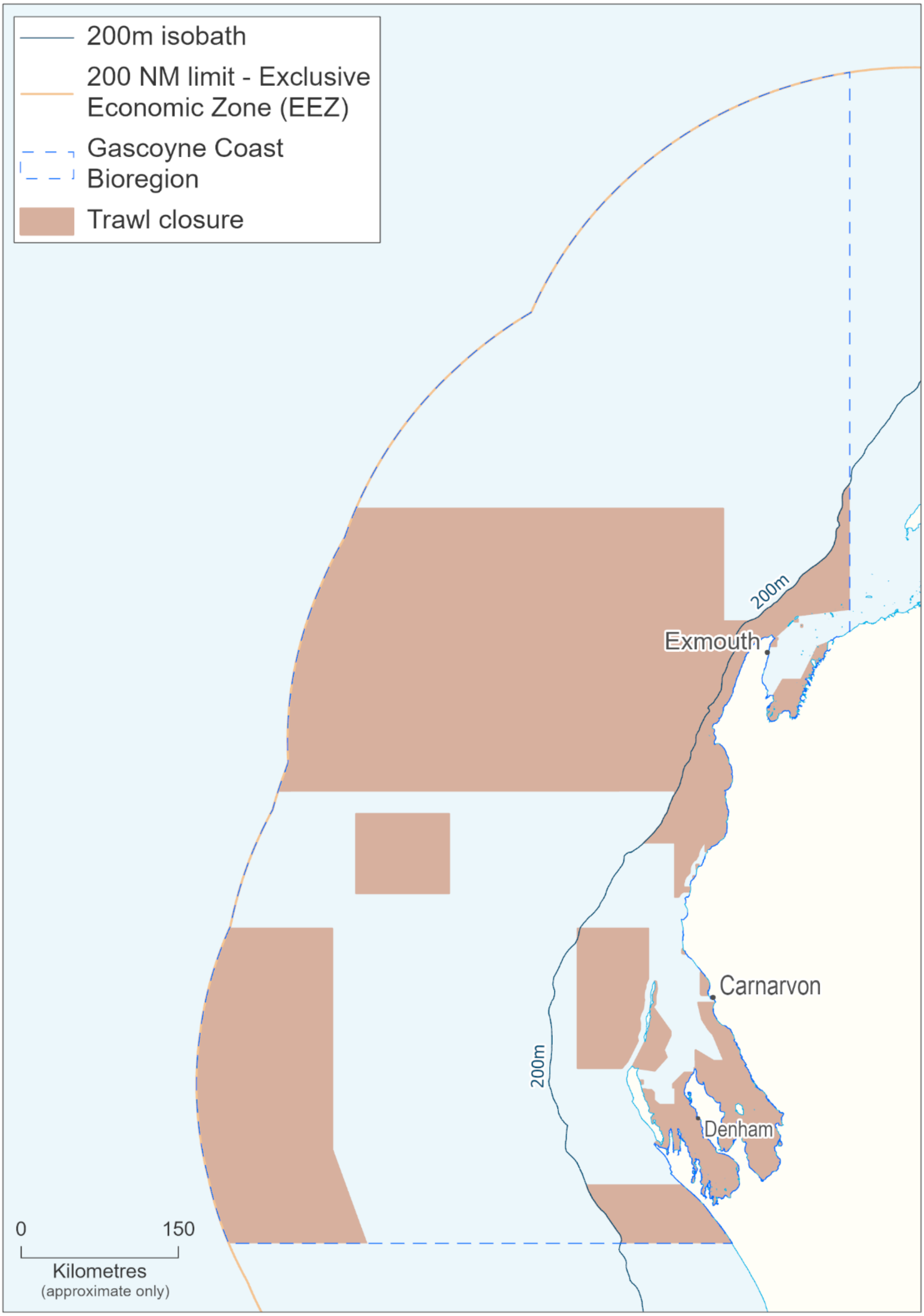
GASCOYNE ECOSYSTEM MANAGEMENT TABLE 1

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. This table does not include State or Commonwealth closures that are currently in the process of implementation. These areas will be included in future volumes, when their respective implementation processes are concluded.

IUCN category or equivalent	State Waters only (24,100 km^2)				All Waters (416,300 km^2 (including State Waters))			
	Fisheries		Existing CALM Act 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.

2 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 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 (see How to Use section for more details) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment.

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

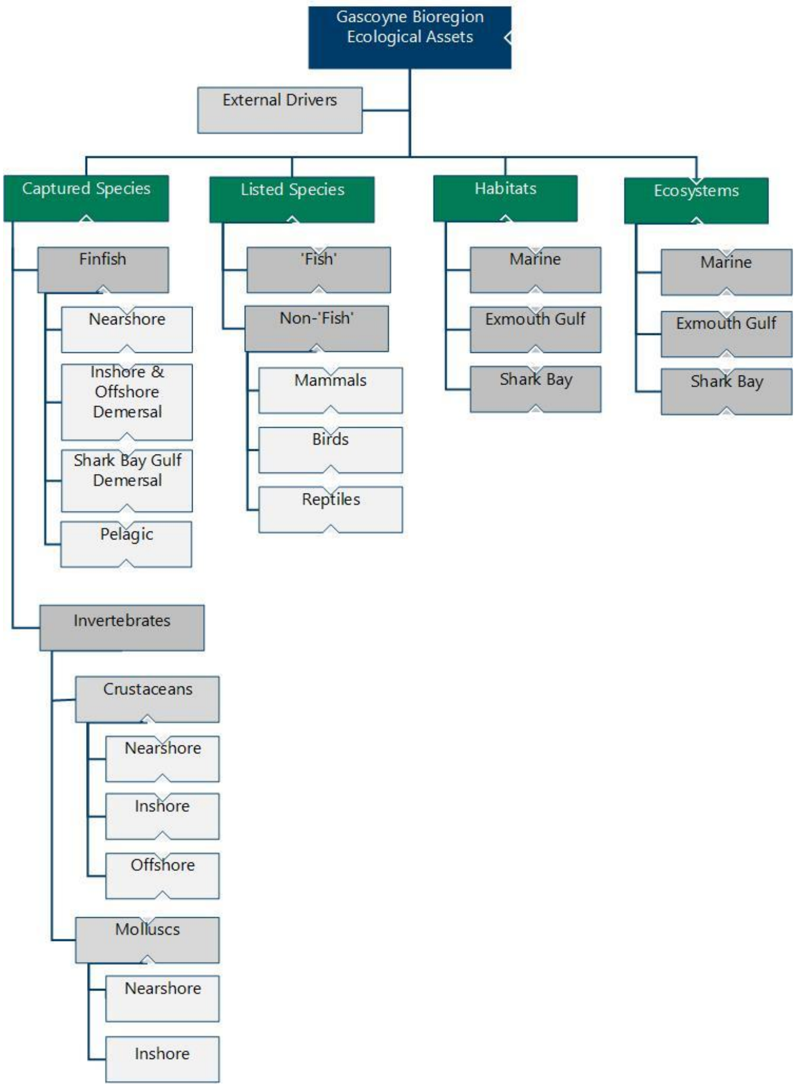
External Drivers

External factors include those impacting at the bioregional level that are likely to affect the ecosystem as a whole and may not fall within the direct control of Fisheries 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 change and introduced pests and diseases[1].

Climate

External Drivers	Current Risk Status
Climate	MEDIUM in short term HIGH in medium term

Being a transition zone between tropical and temperate regions, the biota of the Gascoyne Coast 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, species range and distribution, composition and interactions within communities, exotic species invasions and impacts, community structure and productivity. Waters off the Gascoyne Coast Bioregion 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 increased in the past two decades, driven by changes in the 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.

1 Biosecurity issues are now reported by the Biosecurity pillar of the Department of Primary Industries and Regional Development.

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 and resulting in record high summer sea levels along the mid-west and Gascoyne coasts. The heat wave caused 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 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 (FRDC Project Project 2010/535) 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 effectiveness in mitigating climate change effects.

Captured Species

FINFISH

The Gascoyne Coast Bioregion supports a diverse fish fauna and is noted for its high quality 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.

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 (0-20 m depth)	MEDIUM

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. Annual catch and effort monitoring is continuing.

Inshore and Offshore Demersal

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

The main fishery operating in this region is the Gascoyne Demersal Scalefish Managed Fishery, for which a detailed status report is provided at the end of this chapter. The indicator species for this fishery are pink snapper, spangled emperor, and goldband snapper. Based on the latest stock assessment, the status of the the ocean pink snapper stock was determined as recovering.

Shark Bay Demersal

Captured Species	Aquatic zone	Ecological Risk
Finfish	Shark Bay Gulf Demersal	MEDIUM

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	LOW

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[1]. 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 Coast Bioregion 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	LOW
Molluscs (Scallops)	Inshore	MEDIUM

The stock of pearl oysters in the bioregion (Zone 1 of the Pearl Oyster Managed Fishery) is considered to be Sustainable-Adequate. The low risk reflects minimal levels of fishing mortality.

Catches in the Shark Bay Scallop Managed Fishery vary widely depending on the strength of recruitment. Extreme enviornmental events, such as that observed in 2010/11, also impact on scallop stocks. Current stocks of scallops in northern Shark Bay and Denham Sound are classed as Sustainable-Adequate.

Crustaceans

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

Blue swimmer crab stocks in Shark Bay continue to rebuild following declines in 2011/2012 that were attributed to the impacts of anomalous environmental conditions and heavy fishing pressure from trawl and trap sectors. The current stock assessment indicates that peak spawning recruitment and biomass levels have stablilised since 2018.

Stocks in both the Exmouth and Shark Bay Prawn Managed Fisheries are considered adequate with both fisheries being re-certified by the MSC in 2020.

Stocks in the West Coast Deep Sea Crustacean Managed Fishery, that operates primarily in the Gascoyne Coast Bioregion, are considered adequate with the fishery gaining MSC certification in 2016.

Listed species

A variety of endangered, threatened and protected[2] (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 *Biodiversity Conservation Act 2016*, and the *Fish Resources Management Act 1994*.

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 the early 2000s and have further increased the protection for sharks, rays and 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	MEDIUM

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

Non-Fish

Listed species	Risk
Birds and Reptiles	MEDIUM
Mammals	LOW

While there are a number of listed species in the Gascoyne Coast Bioregion, only sea snakes, low numbers of sawfish and occasionally turtles and dolphins are encountered in trawl catches. Most of these animals are returned alive.

Captures of listed species are recorded and their status at release are monitored and reported. Increasing the understanding of the number and nature of the interaction of trawl fisheries with sea snakes in the bioregion was raised as an issue through the initial MSC process. Research over the last 5 years has focused on increasing the knowledge of sea snake abundance and distribution and improved reporting of interactions by fishers. In recognition of these improvements, in the recent MSC re-certification, there are no conditions for additional research.

1 Kangas, M. et al. 2019. Resource Assessment Report No. 3. Scallop Resource. Department of Primary Industries and Regional Development.

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

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 (Gascoyne 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 resources 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, Zuytdorp and Exmouth Gulf ecosystems (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 is 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. The 2011 marine heatwave event caused significant (35%) losses of seagrass and carbon from the Shark Bay system. The impacts of this are yet to be understood, but medium to long-term changes in productivity of some fisheries species is possible.

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.

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. A new marine park will be established within Exmouth Gulf that will provide greater protection of habitat and the continuation of low impact commercial fishing operations. The main risk to coral habitat is from tourism and other boating related activities. There are no major pressures on seagrass communities, which are in 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 Managed Fishery operates in this ecosystem and is based on using hooks and lines, resulting in no detectable impacts to 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 the establishment of the Ningaloo Marine Park (NMP) which covers a total area of 4,566 km^2 from the shoreline to the 3nm limit of State Waters. Approximately 34% of the current park is zoned as no-take sanctuary areas. A significant level of research and monitoring has been undertaken in the Ningaloo Marine Park by Department of Biodiversity, Conservation and Attractions (DBCA), CSIRO, AIMS and universities.

The ecosystem outside the Mairne Park 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 Coast Bioregion over the past 30 years found no evidence of systematic changes that could indicate an unacceptable impact on this ecosystem from fishing (Hall and Wise, 2011)[1].

Exmouth Gulf

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

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 was a key component of maintaining MSC certification for the Exmouth Gulf Prawn Managed Fishery. Research has focused on increasing the knowledge of benthic habitats (e.g. FRDC project 2015/027) and their overlap with the footprint of the fisheries. In recognition of these improvements, the recent re-certification in 2020 did not contain any requirements for additional research. In a recent ERA[2], the risk level of impacts of the Exmouth Gulf Prawn Managed Fishery on the various types of habitat in Exmouth Gulf was assessed as between negligible and medium.

Ecosystems

Approximately 25% 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 inside and outside the trawl grounds in Exmouth revealed 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.

In a recent ERA[2], the risk level of impacts of the Exmouth Gulf Prawn Managed Fishery on the ecosystem structure in Exmouth Gulf was assessed as between negligable and low. As part of the establishment of a new marine park, the potential cumulative impacts of proposed developments must be compatible with the protection of the environmental, social and cultural values of Exmouth Gulf.

Shark Bay

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

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. These permanent trawl closures also protect the majority of coral habitats in the eastern and western Gulfs. The few unprotected areas where corals 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 and the overlap with the fishery footprint is also a key component of maintaining MSC certification for the Shark Bay Prawn Managed Fishery. Recent research focused on increasing the knowledge of benthic habitats and the overlap with the fishery footprint. In recognition of these improvements, there are no active habitat conditions for this MSC

1 Hall NG, and Wise BS. 2011. Development of an ecosystem approach to the monitoring and management of Western Australian fisheries. FRDC Report – Project 2005/063. Fisheries Research Report No. 215. Department of Fisheries, Western Australia. 112 pp.

2 Department of Primary Industries and Regional Development (DPIRD) 2020. Western Australian Marine Stewardship Council Report Series No. 17: Ecological Risk Assessment of the Exmouth Gulf Prawn Managed Fishery. DPIRD, Western Australia.

certified fishery. In a recent ERA[1], the risk level of impacts of the invertebrate fisheries on the various types of habitat in Shark Bay was assessed as between negligable and low.

Ecosystems

In a recent ERA[2], the risk level of impacts of the invertebrate fisheries on the various types of trophic interactions in Shark Bay was assessed as between negligable and medium. A previous 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)[3].

1 Department of Primary Industries and Regional Development (DPIRD) 2020. Western Australian Marine Stewardship Council Report Series No. 16: Ecological Risk Assessment of the Shark Bay Invertebrate Fisheries. DPIRD, Western Australia.

2 Department of Primary Industries and Regional Development (DPIRD) 2020. Western Australian Marine Stewardship Council Report Series No. 16: Ecological Risk Assessment of the Shark Bay Invertebrate Fisheries. DPIRD, Western Australia.

3Kangas 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.

FISHERIES

SHARK BAY PRAWN RESOURCE STATUS REPORT 2022

M. Kangas, S. Wilkin, and G. Grounds

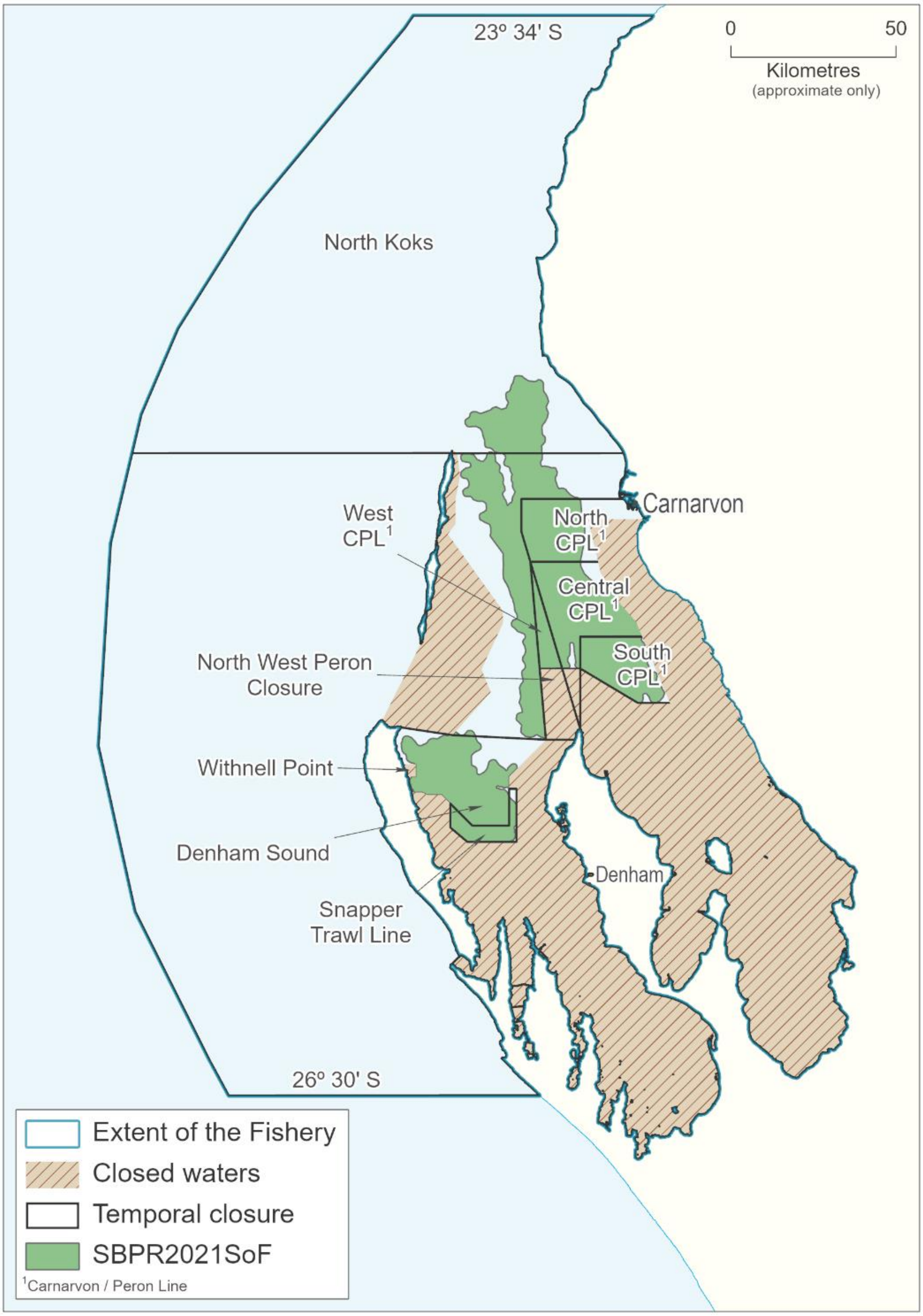
OVERVIEW

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 blue 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) and the *Shark Bay Prawn Managed Fishery Harvest Strategy, 2014-2019* (SBP Harvest Strategy). Management of the SBPMF is based on input controls such as limited entry, gear controls (e.g. maximum headrope units), 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. The fishery was sucessfully recertified in December 2020. It was also accredited for export under the provisions of the EPBC Act (1999) in 2015 for ten years. A more detailed account of the resource is provided in Kangas et al. (2015) (www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_2.pdf).

SUMMARY FEATURES

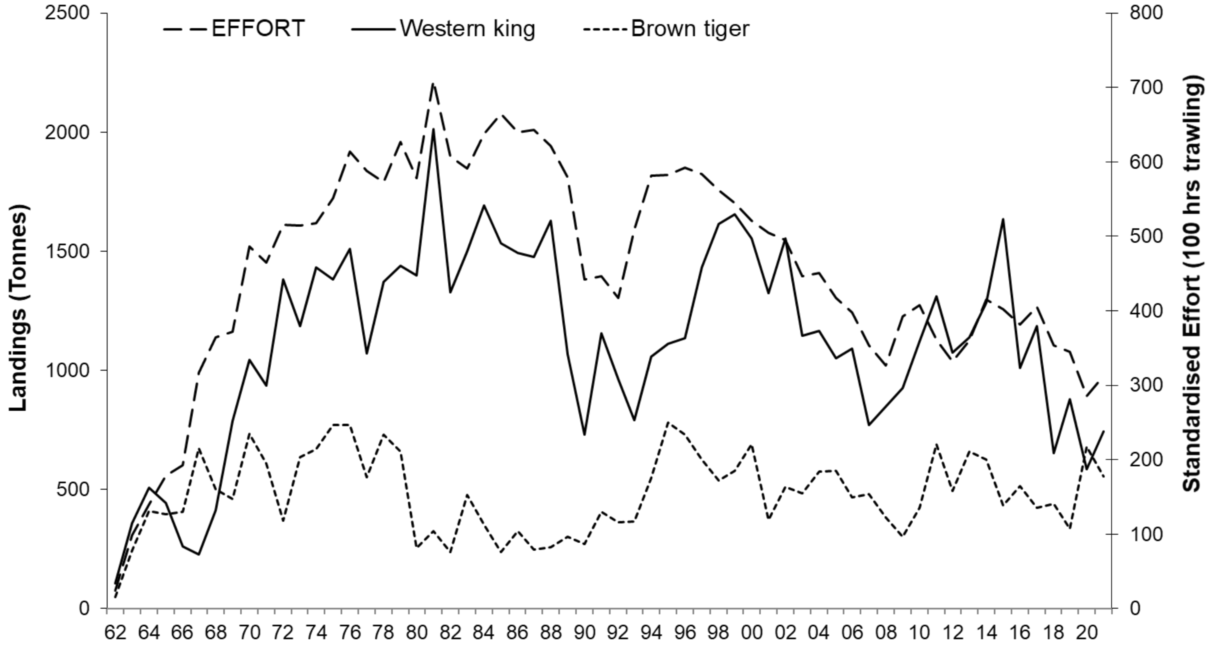
Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (1350-2150 t)	Total Catch 2021: 1,303 t	Acceptable
Recreational fishery	Total Catch 2021: NA	NA
EBFM		
Indicator species		
Western King Prawn	Moderate Risk: Breeding stock: Below target	Adequate
Brown Tiger Prawn	Moderate Risk: Breeding stock: Above target	Adequate
Ecological		
Bycatch	Low Risk	Adequate
Listed Species	Medium Risk	Adequate
Habitat	Low Risk	Adequate
Ecosystem	Medium Risk	Adequate
Economic (GVP $24.2 m)	Moderate Risk	Acceptable
Social (4 amenity)	Low Risk	Acceptable
Governance	Moderate Risk	Acceptable
External Drivers	High Risk	Acceptable



SHARK BAY PRAWN FIGURE 1.
Map showing boundaries of Shark Bay Prawn Managed Fishery for the 2021 fishing season.

CATCH AND LANDINGS

The total landings of target prawns in Shark Bay in 2021 were 1,303 t, with 742 t of western king prawn and 553 t of brown tiger prawn (Shark Bay Prawn Figure 2) and 8 t of blue endeavour prawn. The recorded landings of byproduct were 116 t of coral prawns, 32 t of mixed finfish, 21 t of mantis shrimp, 17 t of cuttlefish, 4 t of squid, 2 t of bugs (*Thenus orientalis*), and <1 t of octopus. Scallop and blue swimmer crab landings are reported in the Saucer Scallop Resource and Shark Bay Blue Swimmer Crab Resource Status Reports.



SHARK BAY PRAWN FIGURE 2
Annual western king and brown tiger prawn landings (t) and fishing effort (total adjusted hours to twin gear units) for the Shark Bay Prawn Managed Fishery 1962-2021.

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 in the harvest strategy (DoF 2014).

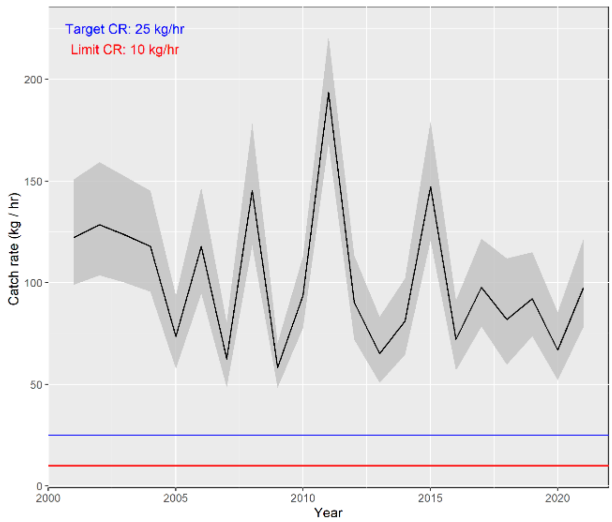
There are 59 years of catch and effort data supporting the assessment that this stock has never been reduced to levels considered to be recruitment overfished (Caputi *et al*. 1998) and current effort levels are below the level of effort applied in the 1970's and 1980's (Shark Bay Prawn Figure 2). Analysis of a stock-recruitment relationship for western king prawns showed that the spring spawning stock, which is the major contributor to recruitment, has never been reduced to levels where it had a significant effect on recruitment. However, there is some uncertainty regarding the level of autumn spawning stock, which also contributes to annual landings and this is currently being examined.

There is no evidence of a declining trend in recruitment in fishery-independent survey indices since 2000 although in the last six years, the higher peaks in recruitment have been absent (Shark Bay Prawn Figure 3). The annual recruitment indices are well above the target reference level each year (25 kg/hr). In 2021 the recruitment index was 98 kg/hr, higher than in 2020. Most of the recruitment variability appears to be driven by environmental factors (e.g. water temperature, Caputi *et al*. 2015, 2016). The fishery-independent recruitment survey in 2021 provided a catch prediction (Caputi *et al.* 2014) of between 775 and 1,160 t with the catch of 742 t just below the lower end of this range.

The recruitment surveys since 2013 have highlighted a declining trend in the size of western king prawns, which may be influencing total catch levels. The possible reasons for this, such as the effect of changes in the water temperature on the spawning and recruitment cycles are being investigated.

In 2021, the mean spawning stock survey index was 20.5 kg/hr, which is well below the reference level. Biomass dynamics modelling of the prawn stocks in the fishery has indicated that the target reference levels are close to MSY biomass levels and therefore a more precautionary harvest regime may be warranted.

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 ranges for this stock at between 950 to 1,450 t, and a mean catch rate of 21 kg/hr (range 16 to 29 kg/hr). The total commercial western king prawn landings in 2021 increased slightly from 2020, however it was still the third lowest catch in over 40 years, and below the target catch tolerance range. The overall mean commercial catch rate of 23.7 kg/hr was higher than in 2020 (20.4 kg/hr) reflecting the increase in recruitment abundance compared to 2020, however it remained lower than the 10-year average of 25.5 kg/hr.



SHARK BAY PRAWN FIGURE 3
Tweedie mean and 95% confidence interval of the western king prawn recruitment index (kg/hr) based on fishery-independent surveys of standard sites during March and April between 2001 and 2021. Target catch rate is in blue and the limit catch rate in red. Catch rates have been adjusted for the difference in gear type and net spread between twin and quad gear.

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 a key management objective (Kangas *et al*. 2015).

The spawning survey catch rate for brown tiger prawns in the northern Carnarvon Peron Line (NCPL) in June when it was closed to fishing was 32.8 kg/hr. In August the catch rate decreased to 27.9 kg/hr with catch rates then remaining at a similar level (26.3 kg/hr) in September. The brown tiger prawn spawning stock levels in the NCPL were therefore above the target reference level of 25 kg/hr between June and August (mean 30.4 kg/hr). Biomass dynamics modelling of the prawn stocks in the fishery has indicated that the target reference levels are close to MSY biomass levels.

The southern Carnarvon Peron Line (SCPL) is the most southern area of the fishing grounds on the eastern side of the fishery. It provides 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 84.6, 27.7 and 13.4 kg/hr respectively in the SCPL. The significant decline between June and August was due to the opening of the SCPL in July for a 10 night fishing period. The short fishing duration was to protect the relatively low western king prawn catch rates that were also observed in this area.

The current harvest strategy has an annual catch tolerance range of 400 to 700 t. The catch prediction based on fishery-independent recruitment surveys was 385 to 575 t, with the total catch (553 t) at the upper end of the catch prediction range and within the catch tolerance range.

The level of overall fishing effort since 2007 when all boats adopted 4 standardised nets (quad gear), has been between 33 to 41 thousand trawl hours (standardised to twin nets). In 2021 fishing effort was 31 thousand trawl hours, the second lowest effort recorded for the fishery, in part due to the reduced allocation of days to fish. 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

Overall bycatch taken in Shark Bay trawl nets is moderate relative to other subtropical trawl fisheries. Bycatch composition is a mixture of small fish species generally not taken by other sectors, significant quantities of small blue swimmer crabs (under commercial size) and other crustacean species which are normally returned alive. At times, quantities of seagrass which have broken off the shallow seagrass banks and not trawled, are moved onto the trawl grounds by tides and currents and are caught in nets.

A study of the bycatch of trawled and untrawled areas of Shark Bay in 2002/03 indicated a 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. Bycatch composition for a subset of sites sampled in 2002/03 have been resampled in 2015,2017 and 2021 as part of the bycatch action plan for this fishery. The majority of the 20 most common species of fish and invertebrates recorded in 2002/03 were still generally amongst the top 20 in the recent samples with no major change in faunal species composition in almost 20 years of trawling. Bycatch reduction devices have been fully implemented since 2003, with all boats required to fish with a 'grid' and a secondary fish escape device (FED) fitted in each net. An ecological risk assessment[1] identified that the risk

1 Department of Primary Industries and Regional Development. 2020. Ecological Risk Assessment of the Shark Bay Invertebrate Fisheries. Western Australian Marine Stewardship Council Report Series No. 16. Department of Primary Industries and Regional Development, Western Australia.

level of impacts of the SBPMF on bycatch was **Low**.

Protected species

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 six 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 implementation of bycatch reduction devices (grids) in the fishery has reduced the occasional capture of turtles in trawl nets (Shark Bay Prawn Table 1). An ecological risk assessment[1] identified that the risk level of impacts of the SBPMF on protected species was **Medium** risk.

SHARK BAY PRAWN TABLE 1.
Protected species interactions recorded in the daily logbooks during 2021.

Species	Alive	Dead	Unknown
Turtles	51	0	0
Syngnathids	351	7	0
Sea Snakes	2947	221	17
Saw Fish	1	0	0
Dolphin	0	0	0

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

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/mud/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 impacts relate to the spatial extent of trawling within the SBPMF. In 2021 the total area trawled, at approximately 761 square nautical miles, was 16% of the inner Shark Bay, and 6% of the total fishery. The likely fishery impacts overall on habitats within Shark Bay are therefore considered to represent a **low** risk.

Ecosystem interactions

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 due to the high natural mortality of prawns, the large 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 gear modifications to reduce unwanted catch, have further lessened the impact the fishery has on the wider Shark Bay food chain. Any interaction of discarding and provisoning over the long term likely representes a steady-state ecosystem structure and function. The fishery impacts overall on the ecosystem are therefore considered to represent a **Medium** risk.

SOCIAL AND ECONOMIC OUTCOMES

Social

This industry is a significant contributor to regional employment. During 2021, approximately 100 skippers and crew were employed in the fishery. There are also 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. A further eight 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, boat stores and fuel. **Low** risk.

Economic

The value of the fishery including coral prawns, cuttlefish, squid, octopus and bugs is $24.2 million. This value excludes scallops and blue swimmer crabs which are separate Managed Fisheries (see the Saucer Scallop Resource and Blue Swimmer Crab Resource Status Reports) and low quantities of various finfish species that are retained. 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 2021 were generally higher than in 2020. **Moderate** risk.

1 Department of Primary Industries and Regional Development. 2020. Ecological Risk Assessment of the Shark Bay Invertebrate Fisheries. Western Australian Marine Stewardship Council Report Series No. 16. Department of Primary Industries and Regional Development, Western Australia.

GOVERNANCE SYSTEM

Harvest Strategy

The fishery is managed in accordance with the SBP Harvest Strategy (DPIRD, 2015). 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.

Annual Catch Tolerance Levels

The total landings of brown tiger prawns were within their annual catch tolerance range. The western king prawn landings were below their annual catch tolerance range and just below the predicted range. Due to the lower recruitment level of western king prawns and the spawning index being lower than the threshold reference level, the SCPL area was only opened for ten days to reduce overall fishing effort.

The annual fishing levels adopted in 2021 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

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 (the 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

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

Season arrangements are developed each year in consultation between the Department and licensees. During the season, the Department and licensees undertake collaborative 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 fishery received recertification through MSC in December 2020.

The Department continued using a set of guidelines for in-season decision making in 2021, to complement the SBP harvest straegy. The guidelines provide transaprency and guidance for in season operational decision making.

The SBP Harvest Strategy and Bycatch Action Plan were reviewed in 2021 and submitted for public comment in 2022.

In 2021, there was one scallop protection area in northern Shark Bay for the entire season restricting trawl effort, to aid scallop stock recovery. The area was closed to all trawl fishing.

An external review of the research and management of the Shark Bay trawl fisheries was undertaken in April 2019. The Department has developed a workplan, which is being implemented to address and incorperate findings of the review in the management and science programs.

EXTERNAL DRIVERS

Economic

The major impact in 2021 continued to be due to Covid-19, however the fishing industry continued to operate and markets improved during the year with moderate to high demand for local product. Traditional export markets were impacted during this time but some exports have resumed.

Industry has sought to maximise the return from byproduct species in the fishery where possible. **Moderate** risk.

Environmental

The major environmental factors influencing these stocks appears to be: i) water temperature, which is influenced by the Leeuwin Current strength which is positively correlated with growth and catchability of prawns; and ii) turbidity during flood events is likely to increase production due to lower natural mortality. A decreasing trend and earlier onset of winter water temperatures and increasing summer temperatures are being monitored, and their effect on egg production and recruitment is being assessed. **High** risk.

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SAUCER SCALLOP RESOURCE STATUS REPORT 2022

M. Kangas, S. Wilkin, R. Leaversuch, G. Grounds

OVERVIEW

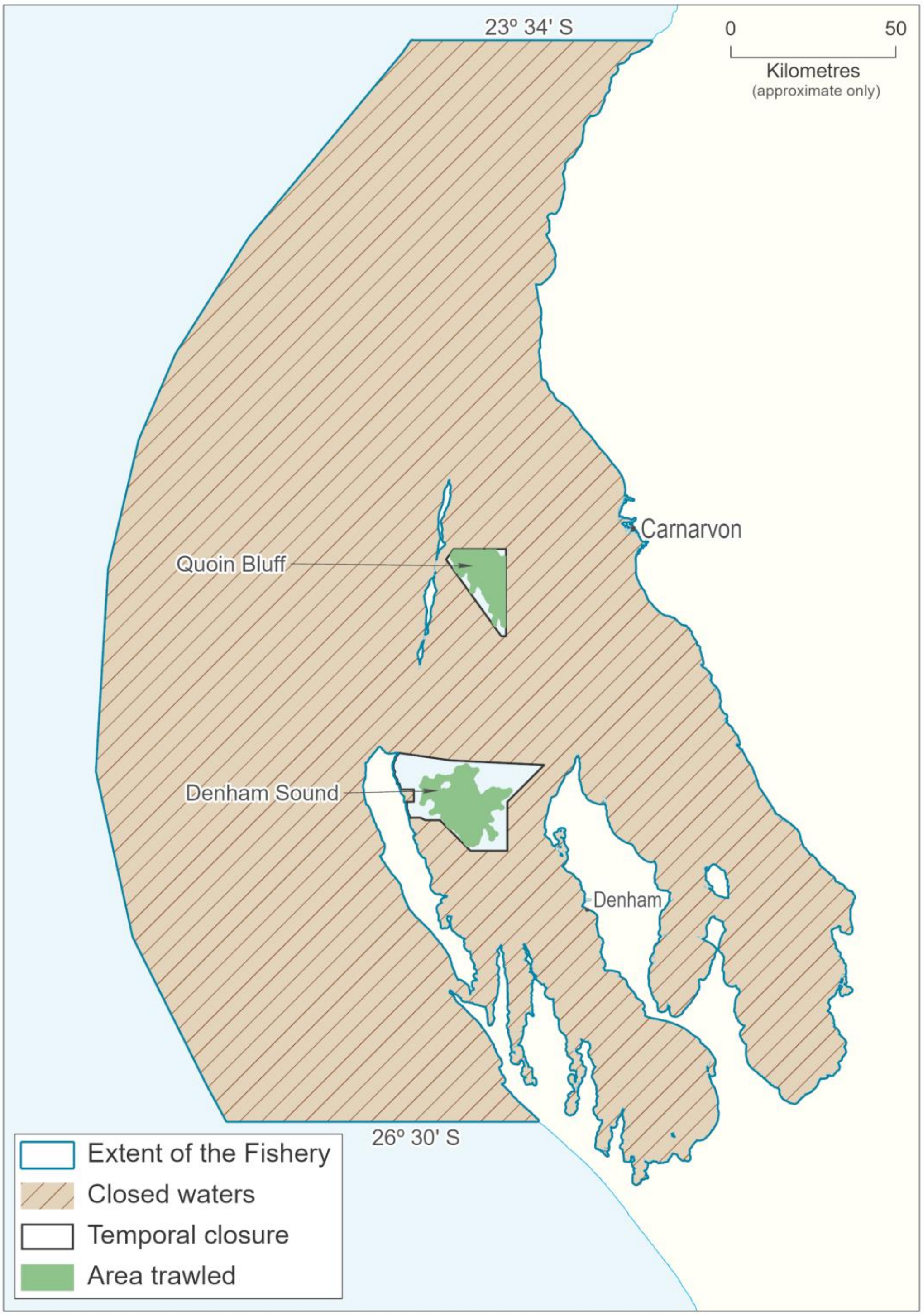
Saucer scallops, *Ylistrum balloti* (formerly *Amusium balloti*), are fished using otter trawls in four separate fisheries in Western Australia. The Shark Bay Scallop Managed Fishery (SBSMF) is usually Western Australia's most valuable scallop fishery with boats licensed to take only scallops (11 Class 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) (10 licenses), while the South Coast Trawl Fishery (SCTF) targeting scallops on the south coast has only 4 licenses. The South West Trawl Managed Fishery (SWTMF) is a multi-species trawl fishery that primarily targets scallops. Management for all fisheries is generally based on limited entry, gear controls and seasonal closures. However, the SBSMF has been managed through a seasonal total allowable commercial catch (TACC) since the fishery reopened in 2015 with an allocation between the Class A and B sectors.

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

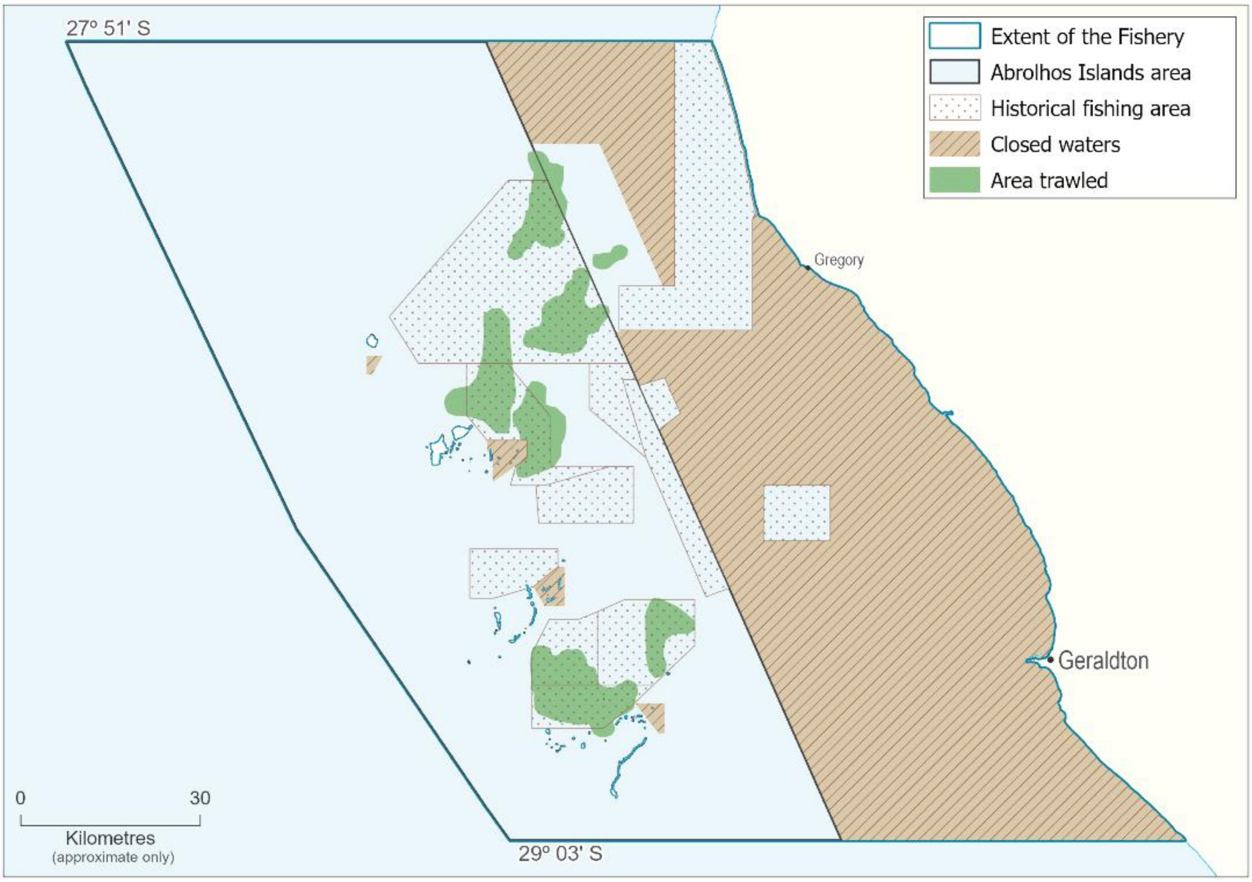
Further details on the resource assessments are provided at: http://www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_20.pdf and https://www.fish.wa.gov.au/Documents/resource_assessment/resource_assessment_report_003.pdf

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (2021)	Total Catch 2021/22: 247 t meat weight (1234 t whole weight)	Acceptable
Recreational fishery (N/A)		
EBFM		
Indicator species		
Saucer Scallop	Shark Bay – northern Shark Bay	Adequate
	Shark Bay – Denham Sound	Adequate
	Abrolhos	Adequate
	South-west	Adequate
	South coast	Adequate
Ecological		
Bycatch	Low risk	Adequate
Listed Species	Low risk	Adequate
Habitat	Low risk	Adequate
Ecosystem	Low risk	Adequate
Economic (GVP $5.7 m)	High risk	Acceptable
Social (3 amenity)	Moderate risk	Acceptable
Governance	Moderate risk	Acceptable
External Drivers	High risk	Acceptable



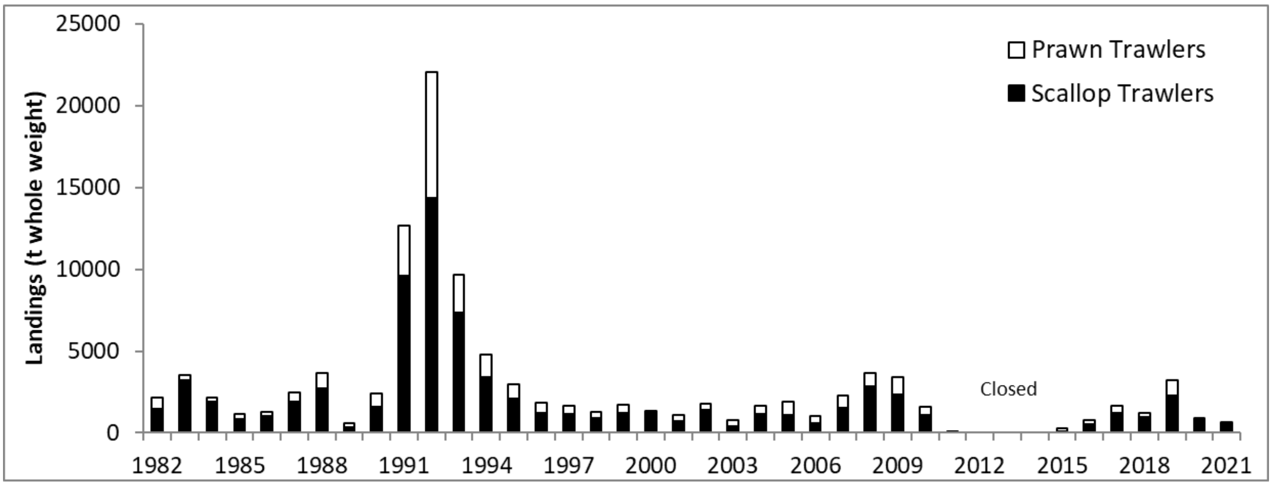
SAUCER SCALLOP FIGURE 1.
Map showing boundaries of Shark Bay Saucer Scallop Managed Fishery for the 2021/22 fishing season.



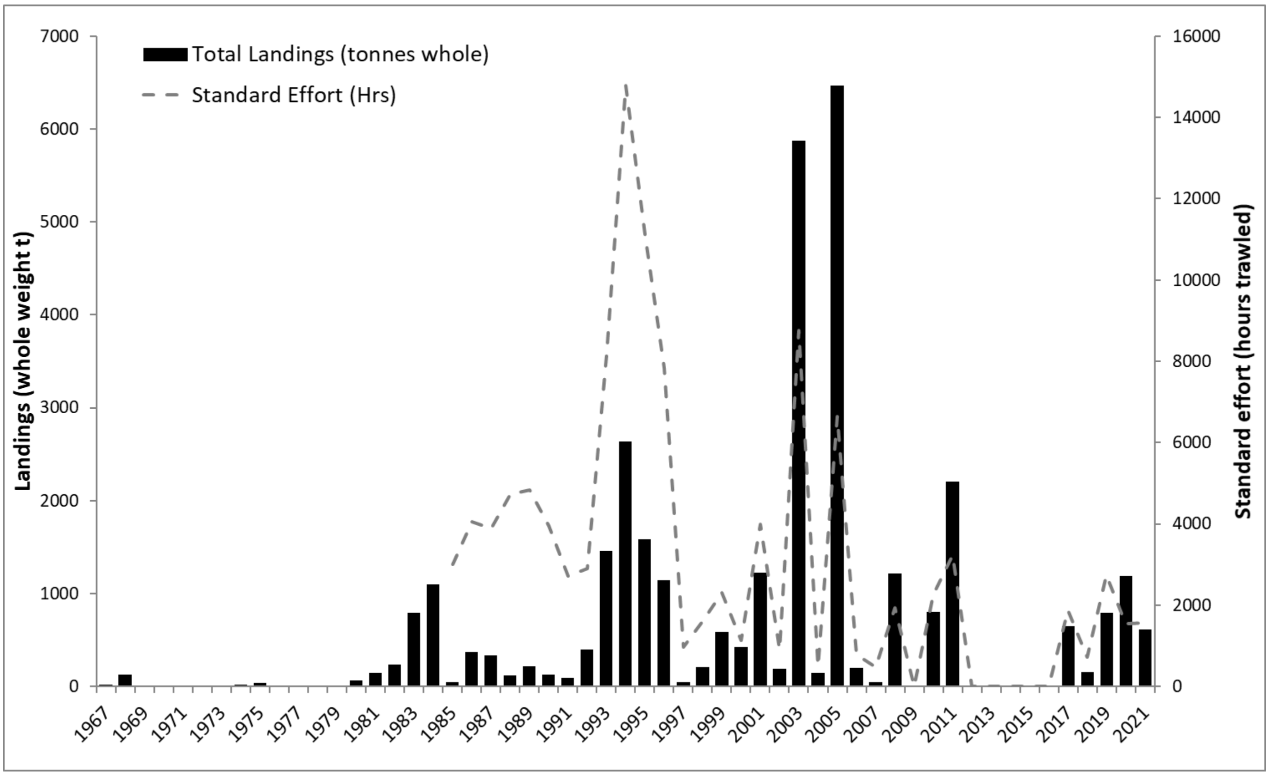
SAUCER SCALLOP FIGURE 2.
Map showing boundaries of Abrolhos Islands and Mid-West Trawl Managed Fishery for the 2021 fishing season.

CATCH AND LANDINGS

The total scallop landings in WA in 2021 was 247 t meat weight (1234 t whole weight). There was 123.6 t meat weight (618.2 t whole weight) taken from Shark Bay, which was 99% of the total quota of 125 t (season 1 May 2021 to 30 April 2022; Saucer Scallop Figure 3). The scallop landings in the AIMWTMF were 123.1 meat weight (615.5 t whole weight; Saucer Scallop Figure 4). Minimal by-product was retained by Class A boats in Shark Bay and vessels in the Abrolhos Islands. Only one boat fished in the SWTMF, and two boats on the South Coast.



SAUCER SCALLOP FIGURE 3.
Annual scallop catch (t whole weight) for the Shark Bay scallop fishery, 1982 to 2020/21. The fishery was closed between 2012 and 2014 and has operated under quota since 2015.



SAUCER SCALLOP FIGURE 4.
Annual scallop catch (t whole weight) and standardised trawl hours fished for the AIMWTMF 1967 to 2021. The fishery was closed in 2009, and from 2012 to 2016.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Shark Bay Scallop Managed Fishery (Sustainable-adequate)

The status of the stock in Shark Bay is determined from the annual fishery-independent survey of recruitment (0+) and residual (1+) stock carried out in November–December since the 1980s (Caputi et al. 2014). Additional multi-species surveys have been conducted in recent years during February/March and June which are now used to inform the Total Allowable Commercial Catch (TACC) and scallop season management arrangements. These surveys infuence the management arrangements to maintain adequate levels of breeding stocks and set a conservative TACC for the fishery.

The annual survey in November 2021 indicated a continued improvement in the abundance of scallops in northern Shark Bay at levels above the threshold, which were first observed in November 2020. One area of higher abundance contained large individuals and therefore this area opened to fishing with a TACC of 85 t made available to the end of the 2021/22 season.

The scallop abundance in Denham Sound in November 2020 was similar to 2019 and a quota of 132 t was set for 2021/22. However, feedback from commercial fishers and the February 2021 survey indicated that the abundance of 1+ individuals was low and therefore the quota was reduced to 40 t for 2021/22.

Abrolhos Islands and Mid-West Trawl Managed Fishery (Sustainable-adequate)

The AIMWTMF is managed using a constant escapement approach in the Harvest Strategy (DPIRD 2020). The impact on the spawning biomass is limited by fishing after the peak spawning period; setting the duration of fishing according to catch predictions (based on pre-season surveys); closing the fishery at a minimum catch rate threshold (150 kg meat weight per day); avoiding areas of high concentrations of small scallops and by not opening the fishery if scallop abundance is considered too low (below a specified limit reference point).

The annual scallop survey index was 676 sc/nm, just below the threshold (750 sc/nm) and the commencement of the season was delayed until the results of the February 2021 survey. In February, the index had improved to be 1502 sc/nm well above the threshold and the season was opened on 15 March 2021.

South West Trawl Managed Fishery (Sustainable-adequate)

Effort in the SWTMF has been related to either the abundance of western king prawn or saucer scallop, which can be highly variable due to sporadic scallop recruitment. One to four vessels have operated in the fishery since 2005, and have covered approximately 1-3% of the allowable fishery area. Only one boat fished in the SWTMF in 2021 for a total of 5 boat days. This level of fishing pressure is unlikely to adversely impact the spawning biomass.

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 % of the allowable fishery area. Two vessels went to the SCTF in 2021 for a total of 72 fishing days.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch

Bycatch and protected species interactions for Class B Shark Bay Scallop vessels is discussed in the status report for the Shark Bay Prawn resource. Owing to the legislated 100 mm mesh size of the nets and the reduced number of boats operating since quota was implemented, the total bycatch landed is minimal.

Bycatch reduction devices (BRDs) are mandatory in the SBSMF, AIMWTMF and SCTF, with all boats required to fish with a 'grid' with specific management conditions, and grids have been fully implemented in these fisheries since 2003.

Protected species

Protected species are occasionally captured in the SBSMF but are generally released alive due to the relatively short duration of trawls. For 2021, there were 36 sea snakes, and four turtles recorded in the logbooks, all were reported as being returned to the sea alive by Class A vessels (nets). **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 toward 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 with the compulsory use of grids in the AIMWTMF, their capture has been minimised. No protected species interactions were reported in the AIMWTMF or the SWTMF in 2021. **Low** risk.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

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 a low impact on the substrate (Laurenson et al. 1993); the overall habitat effects are considered to be **low**. In Shark Bay, only 10.5% of the allowable trawl area was fished in 2021. Only 6.9% of the allowable area was trawled in the AIMWTMF and <1% in the SWTMF and SCTF.

Ecosystem

The ecosystem impacts of scallop fisheries are considered to be **low risk**, due to the relatively low total biomass taken by these operations. 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 30-40 skippers and other crew were employed in scallop fishing in WA in 2021, with support staff in Geraldton and Fremantle. In Shark Bay, an additional 100 crew are employed in the prawn fishery (Class B) that can also retain scallops. The overall GVP for the fisheries that operated in 2021 (including scallop landings for Class B boats in Shark Bay) was $5.7 million.

GOVERNANCE SYSTEM

Harvest Strategy

The harvest strategies for Shark Bay and the Abrolhos Islands fisheries are based on the abundance of scallops during the annual recruitment/spawning stock surveys with limit and threshold levels based on the stock recruitment relationships established for each fishery (Caputi et al. 2021). For Shark Bay, the harvest strategy is based on a quota management framework, in consultation with industry (DPIRD 2021). A formal harvest strategy for the Abrolhos Islands was published in July 2020 (DPIRD 2020). This outlines the long and short-term management objectives for the fishery, the performance indicators, reference levels and harvest control rules required to achieve these objectives.

For Shark Bay, a quota management system with a conservative TACC, in-season review triggers and a recovery plan was implemented in 2015 to provide protection for the breeding stock and aid in recovery. Catch predictions in Shark Bay for 2021/22 for the two separate stocks are used in determining the conservative TACC for each part of the fishery in a Departmental/industry consultative framework. In 2021/22, TACCs were set for both stocks. Additional conservative management measures have been implemented each year since 2015, including a limit on the level of scallop harvest pre-spawning complemented by small scale spatial closures.

According to the HS, scallop catch rates in the Abrolhos Islands in February 2021 were above the threshold level. Fishers ceased fishing at a catch rate above the target (150 kg/24 hours).

Annual Catch Tolerance Levels

Shark Bay: A catch limit of 625 t (whole weight) (equivalent to 125 t meat weight) was set for 2020/21 and 618 t (whole weight) was achieved.

Abrolhos Islands: The landings (616 t whole weight) were within the target range (95-1830 t whole weight).

South West: Catch range not developed.

South Coast: Catch range not developed.

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 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. Regular vessel inspections are also conducted to ensure fishing is being undertaken in accordance with the governing legislation (e.g., gear requirements, catch reporting).

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

Consultation

Management Meetings are held between the Department and licensees, in conjunction with the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC). These meetings provide an opportunity for the Department, WAFIC and industry to discuss research outcomes and initiatives, management of the fishery and industry issues. A Shark Bay Scallop Working Group was established in 2016 to provide advice on the TACC, conduct in-season TACC reviews and assist in the development of a Shark Bay Scallop resource harvest strategy.

Skippers briefings are also conducted prior to the commencement of each season.

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

Management Initiatives

Measures to aid recovery of scallops in northern Shark Bay were implemented in 2021/22 and included two scallop protection areas closed to all trawl fishing. The Department continues to follow a management and science workplan to address and incorperate the findings of a science review (Haddon 2019, unpublished).

The AIMWTMF completed MSC assessment during early 2021 and achieved MSC accreditation with no conditions.

A FRDC project involving the collection of scallop broodstock from the SWTMF to trial hatchery rearing of scallops with growth and development in situ, aiming for subsequent release back into the fishery and for potential contributions to stock enhancements was to commence in 2020/21 but has been delayed to 2022/23.

EXTERNAL DRIVERS

Strong La Niña events that typically result in strong Leeuwin Currents and warm sea-surface temperatures often result in below-average scallop recruitment in Shark Bay and the Abrolhos Islands, whilst these warmer conditions are better for recruitment in the SCTF (Chandrapavan et al. 2020). Between 2012 and 2014, the SBSMF was closed due to the 2011 marine heatwave event (associated with a strong La Niña), which resulted in the reduction of breeding stock and subsequent very poor recruitment for a number of years (Caputi et al. 2015, 2016). Cooler conditions in the following three years (Feng et al. 2021) improved scallop recruitment. The Abrolhos Islands were adversely affected by the 2011 marine heatwave, closing the AIMWTMF from 2012 to 2016. However, cooler water temperatures in this region has assisted the fishery to recover. A La Niña event was experienced in the latter part of 2020 and 2021, with potential impacts to the fisheries to be assessed and reported in 2022/23. **Significant** risk.

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SHARK BAY BLUE SWIMMER CRAB RESOURCE STATUS REPORT 2022

A. Chandrapavan, M. Kangas, S. Wilkin, and G. Grounds

OVERVIEW

The blue swimmer crab (*Portunus armatus*) resource in Shark Bay is harvested commercially by the Shark Bay Crab Managed Fishery which consists of Shark Bay crab trap, Shark Bay prawn trawl and Shark Bay scallop trawl operators. This crab stock also supports a regionally important recreational fishery (<5 t). Management of the commercial sector moved from an effort-controlled system to an Individual Transferable Quota (ITQ) management system 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).

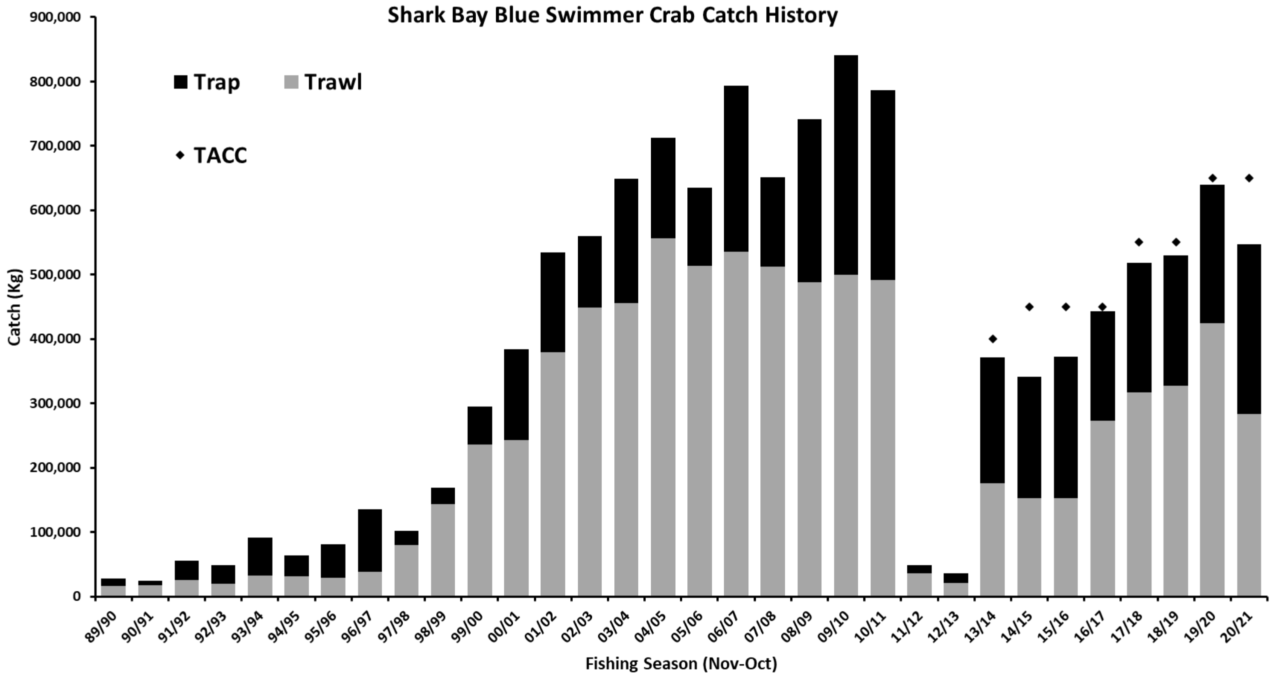
SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (650 t TACC)	Total Catch 2020/21: 549 t	Acceptable
Recreational fishery	Total Catch 2020/21: ~3 t (boat-based only)	Acceptable
EBFM		
Indicator species		
Blue Swimmer Crab	CPUE above target	Adequate
Ecological		
Bycatch	Negligible risk (trap) Low risk (trawl)	Adequate
Listed Species	Low risk	Adequate
Habitat	Low risk	Adequate
Ecosystem	Low risk	Adequate
Economic (GVP $5.12million)	GVP Level 3 – ($5 - 10 million)	Acceptable
Social	Amenity Score 3	Acceptable
Governance	Moderate risk	Acceptable
External Drivers	Environment – Risk Level 5 (climate)	Ongoing monitoring

CATCH AND LANDINGS

A Total Allowable Commercial Catch (TACC) of 650 tonnes was set for the 2020/21 fishing season (1 November 2020 to 31 October 2021). The total catch landed for the 2020/21 season was 549 t (~84% of the TACC), where the underachievement of quota was influenced by operational changes and quota leasing arrangements among the trap and trawl sectors (Shark Bay Blue Swimmer Crab Figure 1). The prawn trawl sector's quota allocation increased from 33.8% to 56% as a result of leasing arrangements and they landed a total of 265 t using a combination of prawn, scallop and trap gears. The trap sector's total catch was 284 t. The scallop trawl sector retained a negligible quantity of crabs.

The boat-based recreational catch of blue swimmer crab in the Gascoyne Coast was 2.6 t in 2020/21 compared to 5.1 t in 2017/18 (Ryan *et al*. 2022).



SHARK BAY BLUE SWIMMER CRAB FIGURE 1.
Commercial catch (kg) 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 2013/14 and this was increased to 450 tonnes for the 2014/15, 2015/16, 2016/17 fishing seasons, it was then increased to 550 tonnes for the 2017/18, 2018/19 fishing seasons, and was further increased to 650 tonnes for the 2019/20 and 2021/21 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, particularly the 2011 extreme marine heatwave (MHW). The fishery was closed for a period of 18 months in 2012 and 2013 to promote stock recovery. Limited commercial fishing resumed under a notional quota management system for the 2013/14 (400 t) season, and continued for the 2014/15, 2015/16 and 2016/17 seasons with a TACC of 450 t. An increase of 100 tonnes was deemed appropriate for the 2017/18 season with a TACC of 550 tonnes, which was maintained for the 2018/19 season. A further increase of 100 tonnes was deemed appropriate for the 2019/20 season with a TACC of 650 tonnes and maintained for the 2020/21 season.

Shark Bay crab stocks are assessed as part of a multi-species fishery-independent survey conducted in February, June and November each year. The current stock assessment indicates that peak spawning, recruitment, and biomass levels have stablised since 2018, supporting catch levels between 500 and 650 t. This has been largely achieved under favourable environmental conditions between 2016 and 2019. However, a decline in the November 2021 legal biomass index to below the threshold level and a decline in catch rates of all other size classes of crabs by the end of the 2020/21 season, indicated some uncertainty in biomass levels supportive of maintaining a 650 t TACC. As such, the TACC review process undertaken by the Shark Bay Crab Working Group agreed to revise the 2021/22 TACC to 600 t. A revised biomass dynamics model for this resource is also currently under development.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch

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).

Traps used in the commercial trap fishery are purpose-designed to minimise capture of bycatch species. The traps also minimise the amount of damage that bycatch species incur during setting and retrieval, which increases the survival rate of discards. Trap operations have been assessed as having a **negligable** risk to bycatch.

Protected Species

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 trap 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.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

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 and therefore poses a **low** risk. The impacts of interactions specific to the trawl sectors are described in the relevant status reports.

Ecosystem

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.

SOCIAL AND ECONOMIC OUTCOMES

Social

The trap sector employs approximately 8-10 people as skippers and crew on vessels fishing for blue swimmer crabs in the Gascoyne Coast Bioregion, as well as additional employment for 10-20 workers for the post-harvest processing of the crab catch.

For the trawl sector, approximately 100 skippers and crew were employed in the fishery. There are also approximately 35 processing and support staff employed at Carnarvon. One of the large operators with 10 licensed fishing boats is based in Carnarvon with administration, wharf, coldstore and engineering staff based at the small boat harbour. 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 $9.33/kg. The estimated value of the commercial blue swimmer crab resource from Shark Bay for the 2020/21 season was $5.12 million.

GOVERNANCE SYSTEM

Harvest Strategy

The harvest strategy for the Shark Bay blue swimmer crab resource outlines the long and short-term management objectives for the fishery, the performance indicators, reference levels and harvest control rules required to achieve these objectives (DPIRD 2020).

The capacity for the SBCMF is specified in the SBCMF Management Plan as 650 tonnes, based on estimates from 2018 of the long-term maximum sustainable yield (MSY) for the blue swimmer crab resource under normal environmental conditions.

DPIRD and industry have implemented a co-management arrangement whereby industry will abide by a TACC that may be less than the legislated capacity. This voluntary agreement provides DPIRD with the flexibility to decrease or increase the TACC up to the capacity in accordance with fluctuations in the crab stock.

A constant catch harvesting strategy is applied to the commercial fishery. Noting the short-lived and dynamic nature of blue swimmer crabs, the TACC is reviewed each year in April/May. To support the TACC setting process, a weight-of-evidence approach is adopted to assess the stock relative to specific reference levels. 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 dynamics model.

Annual Catch Tolerance Levels

A TACC of 650 t was set for the 2020/21 fishing season of which 549 t was achieved (~84% of TACC). Although this catch level is below the annual catch tolerance range of >90%, the catch achieved is still deemed at an **acceptable** level given that operational changes highly influenced catches.

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, 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 the relevant legislation.

Consultation

A Shark Bay Crab Working Group was established in early 2017 to provide a transparent and inclusive decision making process between the Department, licensees and the recreational sector, that supports the review of the annual TACC for the Fishery and development of the Shark Bay crab resource harvest strategy. Annual Working Group meetings convened by the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC) are also used as an opportunity for the Department, WAFIC and industry to discuss research outcomes and initiatives, management of the fishery and industry issues. The Department undertakes consultation directly with commercial licensees on operational issues.

Focused recreational consultation occurs with Recfishwest, and broader recreational consultation processes are facilitated by Recfishwest.

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

Management Initiatives/Outlook Status

The Department conducts annual reviews of the SBCMF in accordance with the Harvest Strategy to monitor impacts to the stock and other ecological components.

EXTERNAL DRIVERS

Blue swimmer crabs are ranked "high risk" under the current climate change scenario with Shark Bay now considered at "High Risk" from climate change impacts (National Environmental Science Program (NESP) 2018). While recent decadal cooler summer water temperatures pose a low risk to crab recruitment, the peak spawning period appears to be shifting to earlier in the season as a response to the shifting winter season and cooler water temperatures. Earlier spawning is consistent with the increased juvenile recruitment biomass occurring in November in recent years.

Inside Shark Bay, average peak summer SST ranges are 25 to 26°C since 2010, which is almost 1°C warmer than temperatures between 1980-2000. Since 2016, summer SST's have been average to below-average, which is most favourable for recruitment and has likely contributed to increased landings in recent years including the 2017/18, 2018/19 and 2019/20 seasons. The summer of 2019/20 saw the return to above average summer SSTs, including a widespread moderate marine heatwave (MHW) across the north-west shelf of WA, which raised the SSTs to ~1.4°C above average inside Shark Bay during December 2019. Thus, uncertainty from environmental variability continues to pose high risk to this stock.

The greatest shift in water temperatures in Shark Bay is occurring over the autumn/winter period which has been cooling since 2000 and more rapidly since 2015. This unique phenomenon that persists within Shark Bay is associated with the shift in the position of the subtropical ridge that drives climatic conditions at this latitude (Chandrapavan *et al.* 2019). The winter of 2020 was slightly warmer than winters between 2016-2019 and is indicative of the influence of La Niña on WA ocean conditions.

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EXMOUTH GULF PRAWN RESOURCE STATUS REPORT 2022

M. Kangas, S. Wilkin, I. Koefoed and G. Grounds

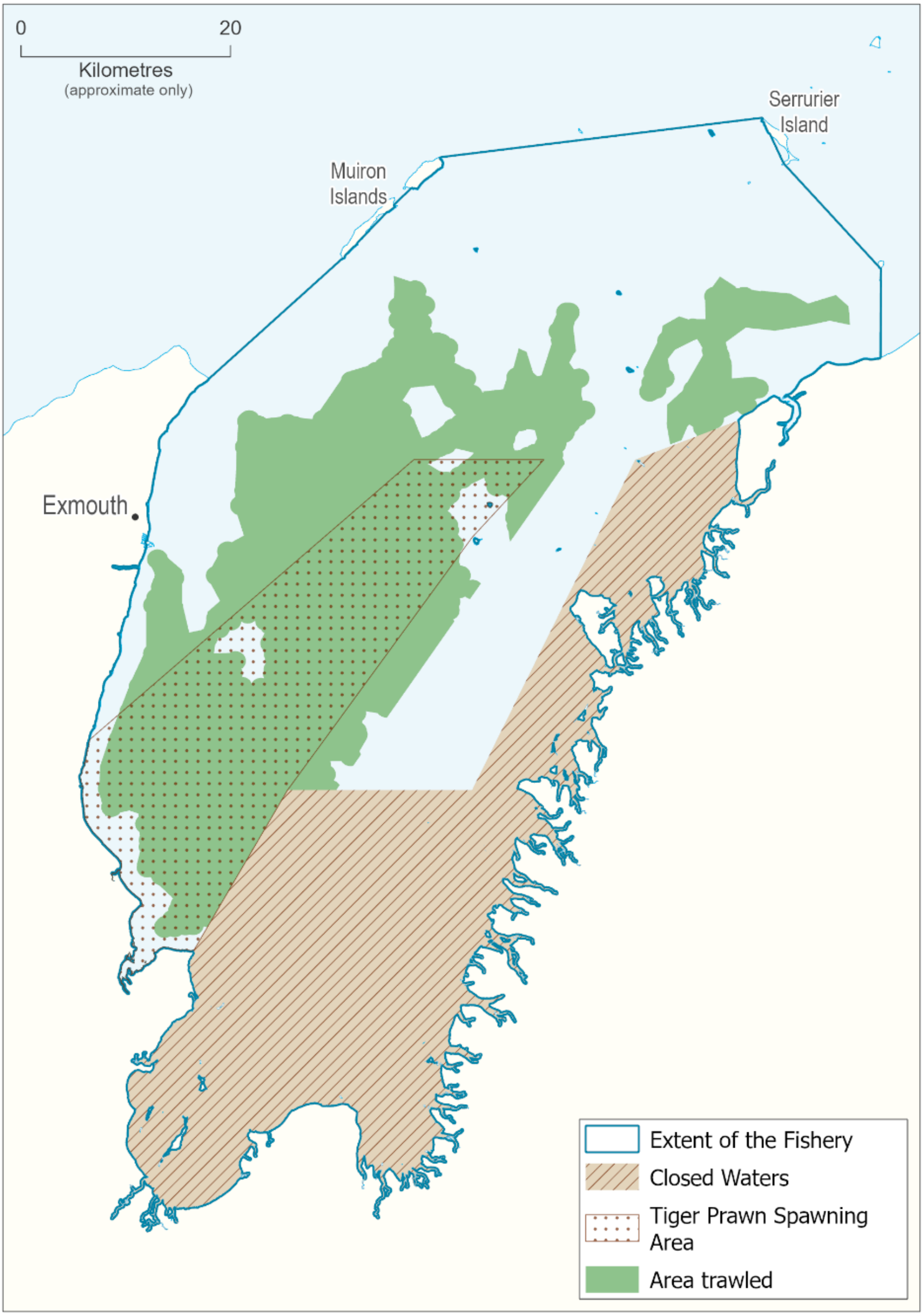
OVERVIEW

The Exmouth Gulf Prawn Managed Fishery (EGPMF) 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*), blue endeavour prawns (*Metapenaeus endeavouri*) and banana prawns (*Penaeus merguiensis*). Management of this fishery is in accordance with the *Exmouth Gulf Prawn Managed Fishery Harvest Strategy 2021 – 2026* (EGP Harvest strategy) and 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 and was recertified in December 2020 for another five years. The Commonwealth Government Department of the Environment and Energy (now known as the Department of Agiculutre, Water and the Evironment (DAWE)) 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). A more detailed account of the resource is provided in Kangas *et al*. (2015) (www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_1.pdf).

SUMMARY FEATURES

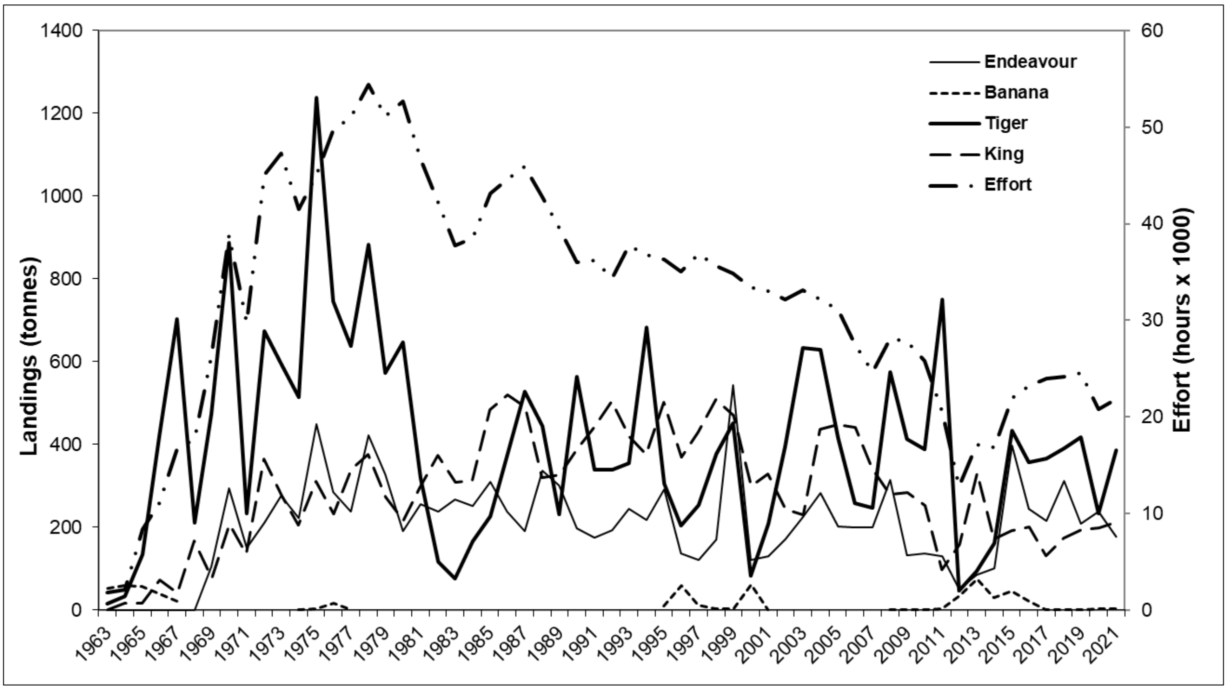
Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (436–1,347 t)	Total Catch 2021: 777 t	Acceptable
Recreational fishery (NA)		
EBFM		
Indicator species		
Brown Tiger Prawn	Breeding stock above target	Adequate
Western King Prawn	Breeding stock above target	Adequate
Blue Endeavour Prawn	Breeding stock above target	Adequate
Ecological		
Bycatch	Low Risk	Adequate
Listed Species	Medium Risk	Adequate
Habitat	Medium Risk	Adequate
Ecosystem	Low Risk	Adequate
Economic (GVP $10.1 m)	Moderate Risk	Acceptable
Social (3 amenity)	Moderate Risk	Acceptable
Governance	Moderate Risk	Acceptable
External Drivers	High Risk	Acceptable



EXMOUTH GULF PRAWN FIGURE 1.
Map showing boundaries of the Exmouth Gulf Prawn Managed Fishery and the area trawled in 2021.

CATCH AND LANDINGS

The total landings of prawns in 2021 were 777 t, comprising 386 t of brown tiger prawns, 211 t of western king prawns, 177 t of blue endeavour prawns and 2 t of banana prawns (Exmouth Gulf Prawn Figure 2). Recorded landings of by-product were; 8 t of coral prawns, 4 t of cuttlefish, 10 t of blue swimmer crab (*Portunus armatus*), 3 t of squid, 2 t of bugs (*Thenus orientalis*) and <1 t octopus. Historical landings are provided in Kangas *et al*. (2015).



EXMOUTH GULF PRAWN FIGURE 2.
Annual prawn landings (t) and fishing effort (total adjusted hours) for the Exmouth Gulf Prawn Managed Fishery 1963-2021.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

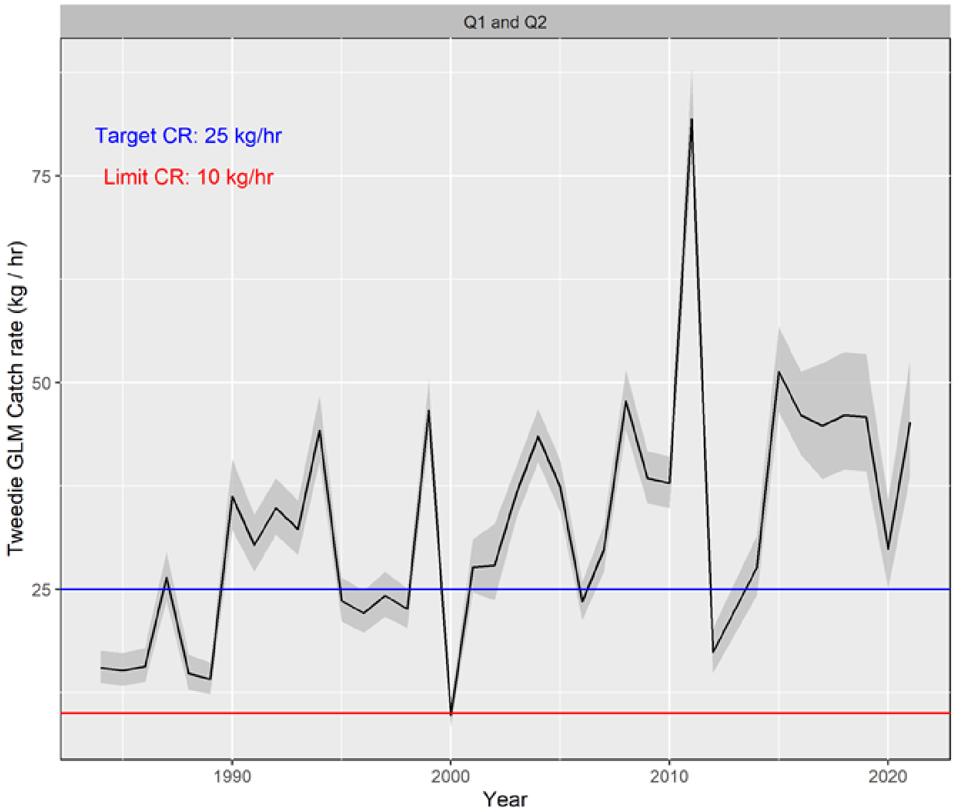
Brown tiger prawns (Sustainable-Adequate)

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

The management objective for brown tiger prawns is to maintain the spawning biomass above the historically determined biological reference points, with a target of 25 kg/hr and a limit of 10 kg/hr in the spawning stock surveys (DPIRD 2018). The standardised spawning stock surveys that were carried out from August to October 2021 had an average catch rate of 44.3 kg/hr, above the target level (Exmouth Gulf Prawn Figure 3), indicating that the stock is unlikely to be recruitment overfished. Biomass dynamic modelling of the brown tiger prawn stocks in the fishery has indicated that the target reference levels are close to MSY biomass levels. The fishery has fully recovered from the effects of the 2010/2011 marine heat wave (Caputi *et al*. 2016) that may have affected the structured inshore nursery habitat.

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 (DPIRD 2018). With a catch prediction range of 285 to 425 t for 2021 (this revised prediction was derived using the lower historical landings in recent years) the total catch (386 t) was within the catch tolerance range and within the prediction range.

The standardised fishing effort in 2021 was 21.9 thousand trawl hours. This is a reduction from historical levels (35 to 50 thousand hours standardised to twin gear) and the seond lowest effort in the last six years in line with an expected lower catch, and in line with ceasing fishing at the target catch rate. 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 3.
Brown tiger prawn spawning stock mean catch rate (kg/hr) and 95% confidence interval (shaded area) for August, September and October combined for two areas (Q1 and Q2) and target (upper line) and limit (lower line) reference levels. The blue line indicates the target reference point (25 kg/hr) and the red line indicates the limit reference point (10 kg/hr). The dotted line indicates catch rates that have not been adjusted for the difference in net spread between twin and quad gear.

Western king prawns (Sustainable-Adequate)

Fishery-independent recruitment surveys are undertaken each year to assess the abundance and size structure of prawns and are used for catch predictions (Caputi *et al*. 2014) and management decisions, such as spatio-temporal opening of fishing areas. In 2021, the recruitment index was 37.7 kg/hr, above the target (30 kg/hr), however fishing was restricted in key western king prawn grounds until August, similar to what has occurred since 2017. The spawning stock index for 2021 (commercial catch rates in key western king prawn fishing grounds in August and September) was 32.1 kg/hr, which was above the target (25 kg/hr). Fishery-independent surveys of western king prawn grounds during August and September in 2021 indicated a mean catch rate of 40.4 kg per hour in August and 25.2 kg per hour in September with an average over that period of 32.8 kg per hour, well above the target reference level. Biomass dynamic modelling of the western king prawn stocks in the fishery has indicated that the target reference levels are close to MSY biomass levels.

Catch and catch rate levels from 2001 to 2016 are now used as the basis for calculating the catch tolerance range (100 – 450 t) and mean catch rate range (8-16 kg/hr), due to the negative impacts of increased water temperatures on western king prawn recruitment (Caputi *et al.* 2015 a and b), and with the level of effort having declined as a result of fleet reductions and targeting larger prawns. The commercial catch for 2021 was 211 t and is within the revised target range with a mean catch rate (9.5 kg per hour) at the lower end of the target catch rate 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. Stock levels are considered **adequate**.

Blue endeavour prawn (Sustainable-Adequate)

In 2018, the Harvest Strategy for the Exmouth Gulf Prawn Managed Fishery was modified to include blue endeavour prawns (DPIRD 2018) with specific limit (4.5 kg/hr) and target (9 kg/hr) reference levels for the spawning stock. Overall the stock assessment of this species is based on a weight of evidence approach. Fishery-independent spawning stock and recruitment surveys of brown tiger and western king prawns record the abundance of blue endeavour prawns and provide an annual spawning stock and recruitment abundance index expressed in terms of a survey catch rate. In 2021, the mean survey catch rate for the blue endeavour prawn spawning stock was 27.1 kg/hr, well above the target. Biomass dynamics modelling of the blue endeavour prawn stocks in the fishery has indicated that the target reference levels are close to MSY biomass levels.

A secondary performance indicator is the annual recruitment survey catch rate, which indicates recruitment strength. A catch prediction has been developed based on the mean annual recruitment index and landings since 2012, when blue endeavour prawns began to be retained more consistently due to improved markets. The recruitment catch rate index in 2021 of 17.0 kg/hr was inline with the 10-year mean (2007–2016) of 16.7 kg/hr. The catch prediction was 155 – 230 t and landings (177 t) were within this range. There has been no declining trend in the fishery-independent survey catch rates over the periods sampled for either the spawning stock or recruitment. The above evidence indicates that the biomass of the stock is unlikely to be recruitment overfished.

A target catch range is set at 120–300 t, based on historical catches between 1989 and 1998, a period when the stock was considered to be moderately exploited (Gaughan and Santoro 2018) and retention rates varied due to the abundance of the key target species (brown tiger and western king prawns) as well as market demand. Total catch in 2021 was within the target catch range.

A significant portion of the breeding biomass is protected by the brown tiger prawn spawning closures and an additional portion of the blue endeavour prawn biomass occurs inshore of the key fishing grounds for brown tiger prawns, which are permanently closed.

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. Stock levels are considered **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch

Bycatch levels for Exmouth Gulf are relatively low by tropical trawl fisheries standards, with few species of significance to other fishing sectors being taken. Bycatch reduction devices (BRDs) are mandatory, with all boats required to fish with a ‘grid’ and a secondary fish escape device (FED) fitted in each net. 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. An examination of bycatch composition in 2015, 2017 and 2021 was undertaken as part of MSC annual audits for this fishery. This examination compared a subset of the sites sampled in 2004 in both trawled and untrawled areas. The results indicated that the majority of the most common 20 species of fish and invertebrates recorded in 2004 were still generally amongst the top 20 in these recent samples. There also was no major change in overall faunal species composition. A recent ecological risk assessment[1] identified that the risk level of impacts of the Exmouth Gulf Prawn Managed Fishery on bycatch was **Low**.

Protected species

Sea snakes, sawfish, syngnathids and turtles are encountered in the trawls (Exmouth Gulf Prawn Table 1). Most are typically returned alive (Kangas *et al*. 2015). Grids keep captures of turtles and other large animals to low levels. The increase in reported numbers in recent years, in particular sea snakes and sawfish is due to an increase in awareness, education and commitment from both crew and skippers to improve reporting. A recent ecological risk assessment identified that the risk level of impacts of the Exmouth Gulf Prawn Managed Fishery on protected species was **Medium** risk.

EXMOUTH GULF PRAWN TABLE 1.
Protected species interactions recorded in the daily logbooks during 2021

Species	Alive	Dead	Unknown
Turtles	11	1	0
Sea Snakes	788	49	34
Syngnathids	0	0	0
Sawfish	5	4	1

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

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

1 Department of Primary Industries and Regional Development. 2020. Ecological Risk Assessment of the Exmouth Gulf Prawn Managed Fishery. Western Australian Marine Stewardship Council Report Series No. 17. Department of Primary Industries and Regional Development, Western Australia.

fishery. In 2021, the total area trawled, at approximately 333 square nautical miles (29.2%) of trawlable grounds in Exmouth Gulf, was well below the 50% target level. A **Medium** risk was assigned to habitat during a recent ecological risk assessment for the Exouth Gulf Prawn Managed Fishery[1].

Ecosystem

The impact of the catch on local food chains is unlikely to be significant given the high level of natural mortality, extent of the non-trawled areas and, variable biomass levels of prawns resulting from changing environmental conditions such as cyclone events. A **Low** risk was assigned to the ecosystem in the recent ecological risk assessment.

SOCIAL AND ECONOMIC OUTCOMES

The estimated employment in the fishery in 2021 was 18 people including skippers and other crew. Additional support staff are based in Exmouth and Fremantle. 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 $10.1 million for 2021.

GOVERNANCE SYSTEM

Harvest Strategy

The fishery is managed in accordance with the EGP Harvest Strategy with a revised version published in July 2021 following its' five year review. The EGP Harvest Strategy now incorporates the Bycatch Action Plan, which was previously a standalone document.

The primary management objective for the Harvest Strategy 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 were above their respective target levels for 2021.

Annual Catch Tolerance Levels

Total landings of blue endeavour prawns were within the catch tolerance range whilst brown tiger prawns were just below. The western king prawns were within the revised catch tolerance range. The annual fishing level is considered **acceptable**.

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

Total Prawn Catch	436–1,347 t
Western King Prawns	100-450 t
Brown Tiger Prawns	250–550 t
Blue Endeavour Prawns	120–300 t
Banana Prawns	1–60 t

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

Consultation

The Department, in conjunction with the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC), holds Management Meetings (MM) for this fishery. The MM is an opportunity for the Department, WAFIC and industry to discuss research outcomes, initiatives, management of the fishery and industry issues. Season arrangements are developed each year in consultation with the licence holder. During the season, the Department and the licence holder undertake collaborative in-season management to ensure the protection of smaller prawns and to maintain the spawning stock biomass. Skipper's briefing meetings are held annually prior to the season commencing, which are attended by skippers and other industry members and the Department.

The Department has an industry/department steering group for managing MSC recommendations and conditions.

1 Department of Primary Industries and Regional Development. 2020. Ecological Risk Assessment of the Exmouth Gulf Prawn Managed Fishery. Western Australian Marine Stewardship Council Report Series No. 17. Department of Primary Industries and Regional Development, Western Australia.

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

Management Initiatives

Management initiatives in 2021 included works to support MSC accreditation.

EXTERNAL DRIVERS

External drivers for this fishery include economic and environmental factors.

There was a continued impact of Covid-19, however the fishing industry operated throughout the season in 2021 and markets improvded during the year with moderate to high demand for local product. Traditional export markets were impacted during this time but some exports have resumed.

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*. 2015a and b). Heat wave events appear to contribute to a reduced abundances of brown tiger prawns in Exmouth Gulf. The causes of low recruitment periods appear to be related to impacts on nursery habitats (Loneragan *et al*. 2013) and environmental factors (including temperature).

Higher than average water temperatures also appear to be having a negative effect on western king prawn catches (Caputi *et al.* 2015a and b) and will continue to be investigated.

Higher than average water temperatures were experienced in early 2022 due to the La Niña and a marine heatwave event. Potential impacts of any increased temperatures will continue to be monitored into 2022.

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WEST COAST[1] DEEP SEA CRUSTACEAN RESOURCE STATUS REPORT 2022

J. How and L. Wiberg

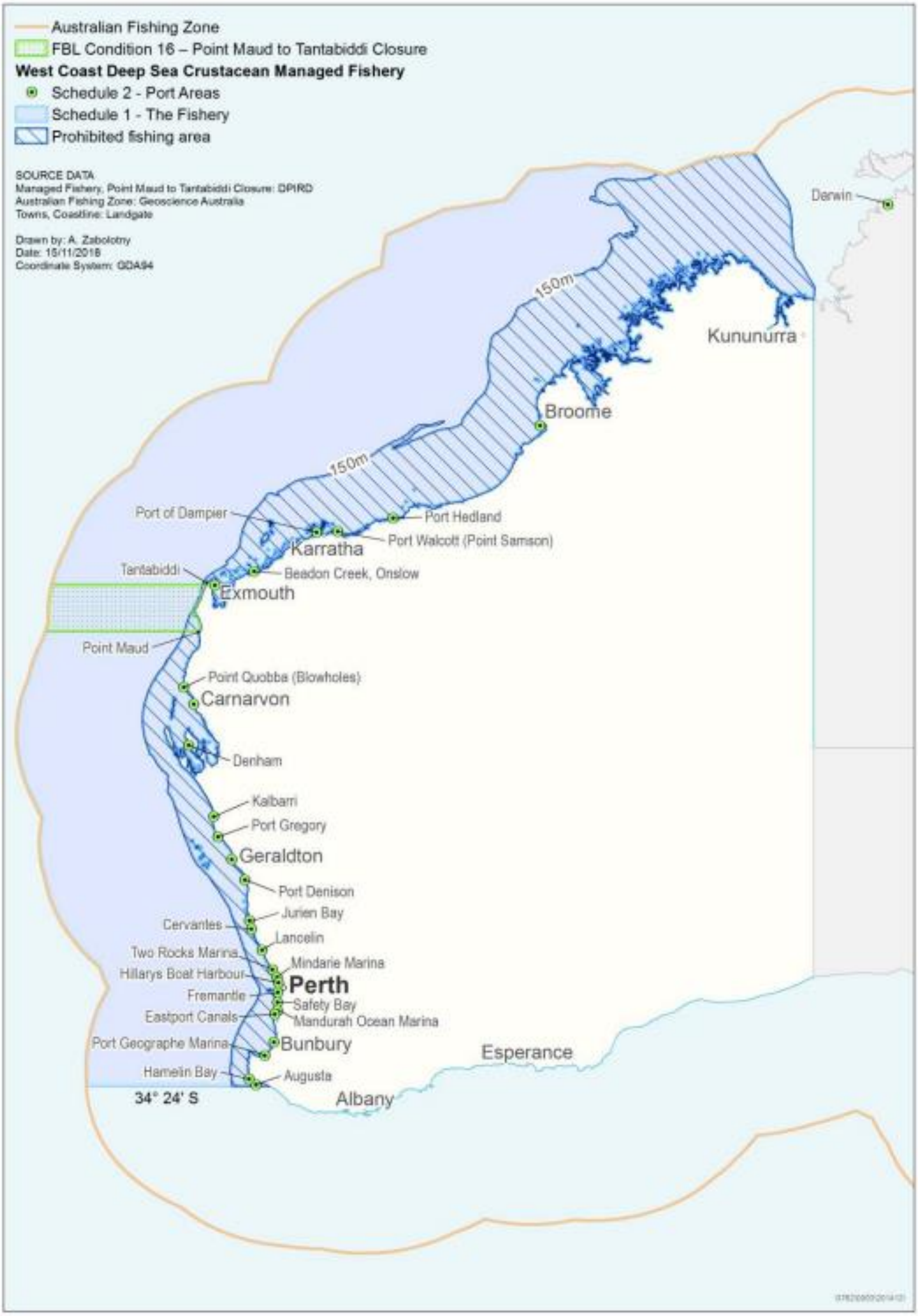
OVERVIEW

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 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 (TAC). In 2016, the WCDSCMF achieved Marine Stewardship Council certification, confirming the sustainability credentials of the fishery. For more details on the fishery and assessment methodology see How *et al*. (2015) http://www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_4.pdf.

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery: Crystal crab 154 t TAC (voluntary industry TAC 140 t) Champagne crab 20 t TAC Giant crab 1 t TAC	Total Catch 2021: 139 t crystal crab 14 t champagne crab (+1.5 t WCRLMF) <0.1 t giant crab	Acceptable
Recreational fishery (NA)		N/A
EBFM		
Indicator species		
Crystal crab (*Chaceon albus*)	Below threshold	Adequate
Ecological		
Bycatch	Negligible Risk	Adequate
Listed Species	Low Risk	Adequate
Habitat	Low Risk	Adequate
Ecosystem	Negligible Risk	Adequate
Economic (GVP $9.6 m; 2020/21)	Moderate Risk	Acceptable
Social (low amenity)	Low Risk	Acceptable
Governance	Medium Risk	Acceptable
External Drivers	Low Risk	Acceptable

1 This is the official name of the fishery. Boundaries include Gascoyne.



DEEP SEA CRUSTACEAN FIGURE 1.
Location and boundaries of the West Coast Deep Sea Crustacean Managed Fishery and specified Port Areas

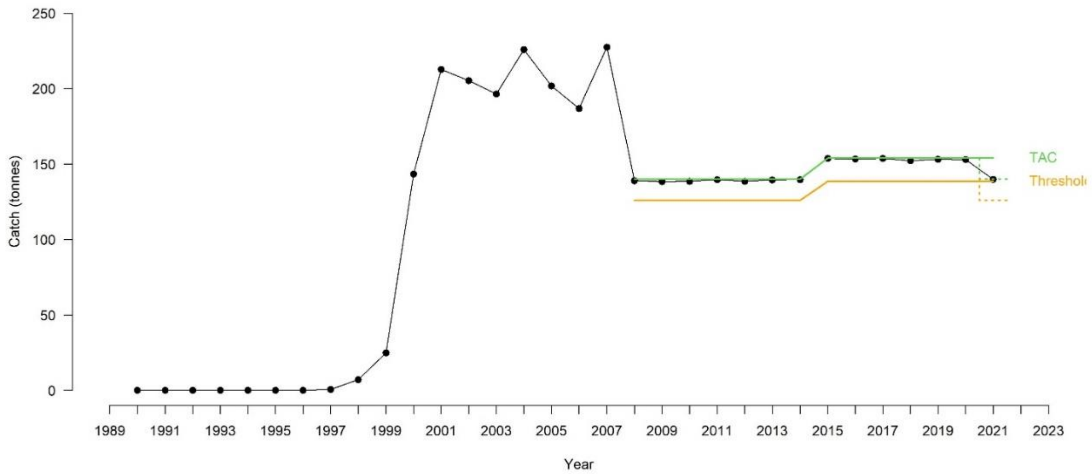
CATCH AND LANDINGS

The total landings from this west coast offshore resource in 2021 as targeted by the WCDSCMF was 155.5 t. Catches are dominated by crystal crabs at 139.9 t, comprising 90.1% of their TAC and 99.9% of their voluntary TAC was landed (Deep Sea Crustacean Figure 2). In addition, 14.0 t of champagne crabs were landed by the WCDSCMF, with and additional 1.5 t landed by the WCRLMF. Less than 0.1 t of giant crab was also landed in 2021. Landings of crystal, champagne and giant crabs also occur off the south coast, as accessed by the South Coast Crustacean Managed Fishery (SCCMF). For more information on SCCMF landings see South Coast Crustacean Resource Status Report.

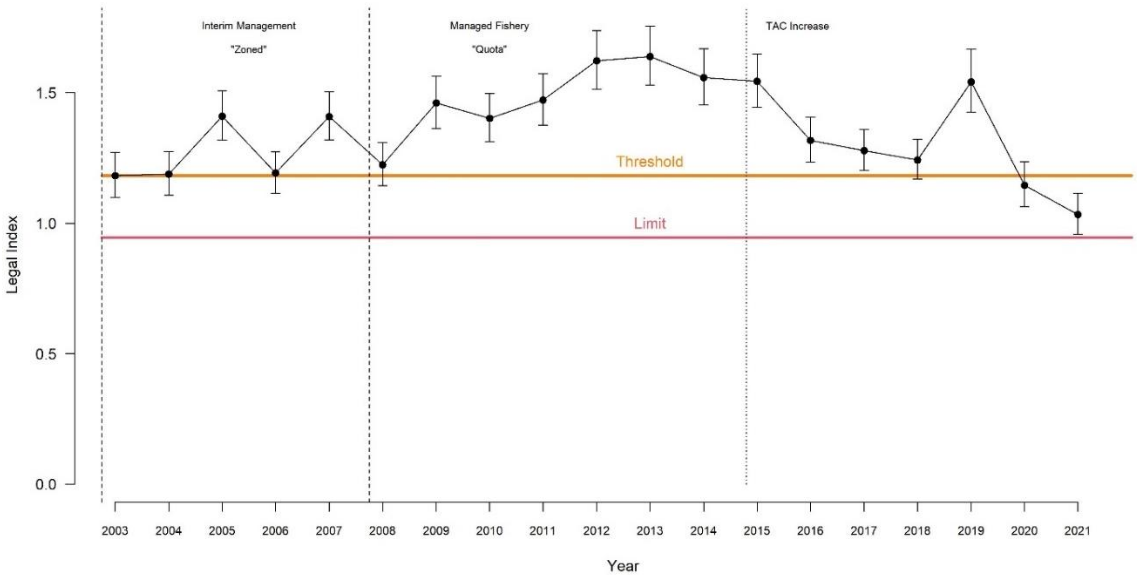
INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Crystal crab

Most lines of evidence indicate that it is likely the stock biomass of crystal crabs is near / below its threshold level, but above its limit level and is therefore **adequate**. The standardised catch rate of legal crystal crabs in 2021 was 1.03 kg/pot-lift (Deep Sea Crustacean Figure 3), which is above the limit reference level of 0.95 kg/pot-lift.



DEEP SEA CRUSTACEAN FIGURE 2.
Annual landings of crystal crab in the West Coast Deep Sea Crustacean Fishery and its associated total allowable catch (TAC, solid) and catch threshold level (dotted). Dotted green and orange lines line indicate the voluntary TAC and associated threshold levels implemented by fishers for the 2021 season.



DEEP SEA CRUSTACEAN FIGURE 3.
Annual standardised catch rate (kg / pot-lift) of legal crystal crabs (± 95 CI) with their associated threshold (orange) and limit (red) reference points.

BYCATCH AND PROTECTED SPECIES INTERACTION

Bycatch

The gear used in this fishery generates minimal bycatch. Therefore the level of bycatch is considered to pose a **negligible** risk.

Protected Species

There was one reported interaction of WCDSC gear with protected species in 2021. A humpback whale became entangled in gear and subsequently died. There have been two interactions with humpback whales in the last two years, however the low number of vertical lines (~70) and the location of fishing relative to humpback whale migration still results in the risk of interactions with protected species being a **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 endangered, threatened or protected (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 and is therefore deemed a **Low** risk. However, recent MSC recertification noted a lack of detailed information on the fishery's interactions with habitat. A project has been initated to address this condition.

Ecosystem

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

The habitat and ecosystem performance measures for the fishery are that:

- Fishing impacts are considered to generate an acceptable level of risk to ecological processes within the ecosystem, i.e. moderate risk or lower;
- Fishing impacts on each ecological resource / asset impacts are considered to generate an acceptable level of risk, i.e. moderate risk or lower.
- The area fished is ≤ 125 (10' x 10') blocks; and
- 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 six vessels operating in 2021. **Low** risk.

Economic

The GVP (gross value of production) for the fishery was approximately $9.6 million in 2020/21, with the majority of the catch sold live to Asian markets both locally and internationally. **Moderate** risk.

GOVERNANCE SYSTEM

Harvest Strategy

The West Coast Deep Sea Crustacean Harvest Strategy 2020-2025 (see Fisheries Management Paper No. 302) is the basis for the setting of the Total Allowable Catch (TAC) for the WCDSCMF.

For 2021:

- The standardised catch rate of legal crystal crabs was below the threshold level.
- The catch of champagne and giant crab were both within their respective target ranges.

Fishery-independent surveys have been initiated in collaboration with fishers to obtain improved estimates of undersize and berried females as well as the legal size catch.

Annual Catch Tolerance Levels

For the 2021 season (1 January – 31 December 2021), the crystal crab (A Class Units) quota was set at 154 t. However, due to sustainability concerns, fishers implemented a voluntary 140 t TAC. With an annual tolerance range of > 90%, and based on the catch of 139.9 t, the annual catch is **acceptable**. The quota of champagne (B

Class Units) and giant crab (C Class Units) was set at 20 t and 1 t respectively. The catch of these two species was 14.0 t and <0.1 t respectively.

Compliance

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

Consultation

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

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

Annual surveillance audits are conducted by MSC and are attended by licence holders, the Department and WAFIC.

Management Initiatives

Management initiatives in 2022 will focus on responding to sustainability concerns of crystal crab stocks. This will include consultation regarding the TAC, along with minor administrative changes to the management plan, and initiation of consultation with industry regarding an updated harvest strategy and decision rules.

EXTERNAL DRIVERS

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

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GASCOYNE DEMERSAL SCALEFISH RESOURCE STATUS REPORT 2022

G. Jackson and S. Walters

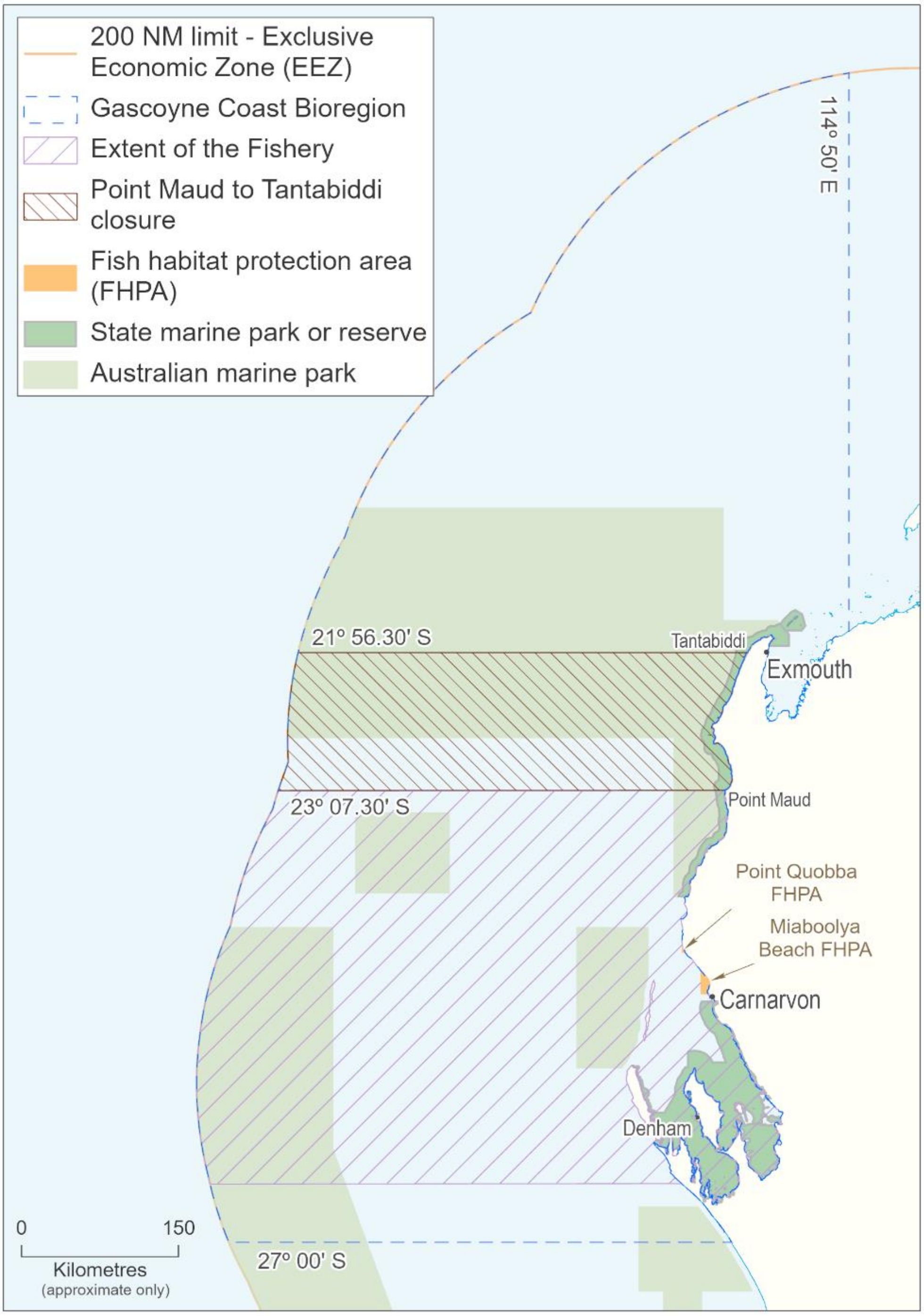
OVERVIEW

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, including spangled emperor (*Lethrinus nebulosus*). More details on this resource can be found in Jackson *et al*. (2020).

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (Pink snapper 51 t, Other demersals 227 t)	Total Catch 2021: Pink snapper 39 t, Other demersals 125 t	Pink snapper = Acceptable Other demersals = Acceptable
Recreational fishery	Total Catch 2020/21: 74–112 t (boat-based only)	Acceptable
EBFM		
Indicator species		
Pink snapper	Biomass around Threshold (2022)	Recovering
Goldband snapper	Fishing mortality below & female spawning biomass above Threshold (2022)	Adequate
Spangled emperor	Fishing mortality below Threshold (2012)	Adequate
Ecological		
Bycatch	Negligible Risk	Not an issue
Listed Species	Negligible Risk	Not an issue
Habitat	Negligible Risk	Not an issue
Ecosystem	Low Risk	Acceptable
Economic (GVP $1-5 m)	Moderate Risk	Acceptable
Social (High amenity)	Moderate Risk	Acceptable
Governance	High Risk	Acceptable
External Drivers	High Risk	Acceptable

*Top 15 demersal species only from 2020/21 statewide survey (Ryan *et al*. 2022); ** Pink snapper and Goldband stocks only.



GASCOYNE DEMERSAL SCALEFISH FIGURE 1.
Waters of Gascoyne Coast Bioregion including Gascoyne Demersal Scalefish Fishery, 'Point Maud to Tantabiddi Well' fishing closure and state and Commonwealth marine parks.

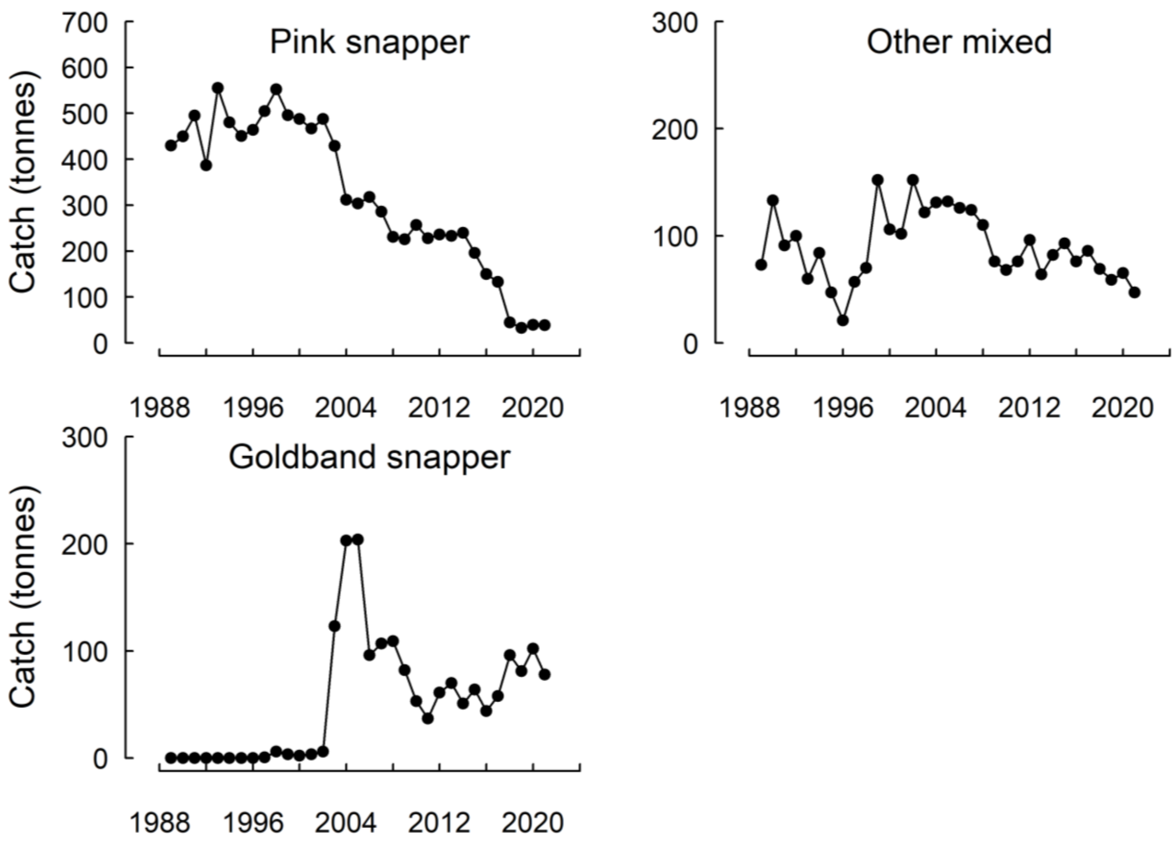
CATCH AND LANDINGS

In 2020/21, the total commercial catch reported by the GDSMF was 164 t, comprising 39 t pink snapper, 78 t goldband snapper and 46 t of other mixed species (Gascoyne Demersal Scalefish Table 1).

The top 15 demersal species in the Gascoyne Coast represented 78% of the boat-based recreational catch (kept by numbers) in 2020/21. The recreational harvest range for the top 15 demersal species (or groupings) in the Gascoyne Coast were steady at 93 t (95% CI 74–112) in 2020/21 compared with 86 t (95% CI 69–103) in 2017/18, 100 t (95% CI 80–120) in 2015/16, 94 t (95% CI 76–112) in 2013/14, but lower than the 143 t (95% CI 120–166) in 2011/12 (Ryan *et al*. 2022). The catch of pink snapper and goldband snapper in oceanic waters off the Gascoyne Coast reported by charter vessels in 2021 was 10 t and 19 t, respectively.

GASCOYNE DEMERSAL SCALEFISH TABLE 1.
Total catches of scalefish (excluding mackerel and tunas) taken by GDSMF in the previous five years.

Species	2016/17	2017/18	2018/19	2019/20	2020/21
Pink Snapper	133.3	45.1	33.2	39.7	38.9
Goldband Snapper	58.2	95.7	80.6	102.0	77.9
Other Jobfish	6.2	9.4	9.2	7.4	4.3
Red Emperor	13.5	10.0	9.2	5.1	8.7
Ruby Snapper	1.8	2.6	2.5	2.7	2.5
Other Snappers	2.5	1.4	1.3	2.2	1.2
Spangled Emperor	2.3	1.2	1.3	1.7	1.3
Redthroat Emperor	9.3	6.6	4.6	5.1	3.6
Other Emperors	<1.0	<0.5	<0.5	<0.5	<0.5
Rankin Cod	10.8	6.8	6.9	7.7	6.6
Other Cods	12.1	9.5	6.3	7.3	3.3
Eightbar Grouper	2.2	2.4	0.9	2.1	1.0
Mulloway	4.6	2.7	3.3	2.7	1.0
Trevallies	2.4	<1.0	0.8	1.0	1.0
Other Species	17.2	15.2	12.3	13.6	12.3
Total	277.2	209.5	172.8	207.0	163.9



GASCOYNE DEMERSAL SCALEFISH FIGURE 1.
Commercial catches of Pink snapper, Goldband snapper and other mixed demersal species taken by GDSMF vessels in oceanic waters of the Gascoyne Coast Bioregion from 1988-2021.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Pink snapper Oceanic Stock (Recovering)

The most recent Level 5 integrated assessment (2022), that incorporated commercial catch, catch rate and age composition data up to 2020/21, indicated that the relative female spawning biomass has rebuilt to around the threshold reference level (i.e. 30%). Based on this assessment and the combined weight of evidence information, the status of the oceanic pink snapper stock was determined as **recovering.**

Goldband snapper (Adequate)

The most recent Level 3 assessment (2022) that included age composition data collected during the period from 2018-2020, indicated that fishing mortality was below the threshold level and the relative female spawning biomass was well above the threshold level. Based on this assessment and the associated weight of evidence information, the status of the goldband snapper stock in the Gascoyne was determined as **sustainable.**

Spangled emperor (Adequate)

A Level 3 assessment (2012) that included age composition data collected during 2007-2008, indicated that while depletion was occuring in the northern area of the bioregion (i.e. north of Point Maud outside of the Ningaloo sanctuary zones), fishing mortality for the stock overall was below the threshold level.

Based on this assessment, the status of the spangled emperor stock in the Gascoyne was determined as **adequate.**

BYCATCH and PROTECTED SPECIES INTERACTIONS

Bycatch

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

Protected Species

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

HABITAT and ECOSYSTEM INTERACTIONS

Habitat

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

Ecosystem

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 impacts overall on the ecosystem are therefore considered to represent a **low risk**.

SOCIAL AND ECONOMIC OUTCOMES

Social

In 2021, nine GDSMF vessels fished at some point during the season (10 in 2020), seven of which fished for more than 10 days during the traditional peak (pink snapper) season, typically with a crew of 2-3. Commercial fishing and associated fish processing remain as 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 boat-based recreational fishing effort in the Gascoyne Coast was steady in 2020/21 (55,327 boat days, SE=6,054) compared with 2017/18 (42,367 boat days, SE=4,428), 2015/16 (42,511 boat days, SE=4,442) and 2013/14 (50,810, SE=4,957), but lower than 2011/12 (58,378, SE5,391) (Ryan *et al*. 2022).

Vessel retrievals at a key boat ramp in the Gascoyne (Exmouth) were significantly higher from March to August 2020, where COVID-19 measures relevant to recreational fishers included various travel restrictions, and social and physical distancing measures (Ryan et al. 2021). The latest statewide recreational fishing survey (from 1 September 2020–31 August 2021) will provide an opportunity to review the medium-term impact of COVID-19 on recreational fishing in the Gascoyne and elsewhere.

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

Economic

The estimated GVP of GDSMF was in the range $1-5 million in 2020, which represents a **moderate risk.** All the product from this fishery supplies domestic fish markets, mostly in Perth.

The value of recreational fishing to the WA economy was recently estimated at $2.4 billion per year (McLeod and Lindner 2018) with recreational fishing in the Gascoyne region estimated to be worth $27.5 million per year.

GOVERNANCE SYSTEM

Harvest Strategy

A formal harvest strategy for the Gascoyne Demersal Scalefish Resource (GDSR) was developed by a stakeholder based working group in 2016/17. The GDSR Harvest Strategy was approved by the Minister for Fisheries in 2017. It defines the ecological, economic and social objectives and establishes the explicit rules that determine the appropriate catch levels for the GDSR.

A recovery plan for GDSR oceanic pink snapper has been in place since 2020. This established explicit performance levels that represent an appropriate rate of recovery for the Gascoyne oceanic pink snapper spawning stock. This rate of recovery is consistent with the vulnerability and productivity of oceanic pink snapper and the dynamics of the commercial, recreational and charter fisheries that target the GDSR.

The primary ecological objective of the 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 harvest 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. 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.

Allowable Catch/Catch Rate Tolerance Levels

Commercial

Pink snapper – Based on the 2017 assessment that indicated that the spawning biomass was around the limit level and therefore at **high risk**, substanial additional management measures were introduced in May 2018 that included an 81% reduction in the TACC (from 277 t to 51 t). This combined with recreational catches (including charter) and additional cyptic sources of mortality (e.g. related to barotrauma, shark depredation) seeks t achieve a catch (total mortality) of <100 t.

In 2020/21, the landed commercial pink snapper catch was 38 t, i.e. well within the revised TACC, and is therefore considered **acceptable**.

Goldband snapper – Within the combined TACC for other mixed demersal species (227 t) there is a maximum limit of 100-120 t for goldband. In 2020/21, the landed goldband catch was 78 t, and is therefore considered **acceptable**.

Spangled emperor – Within the combined TACC for other mixed demersal species (227 t) there is a target catch range of 2-15 t for spangled emperor that historically has not been a commercial target species and thereby only a very minor component of the commercial mixed species demersal catch. Within the combined TACC for other mixed demersal species (227 t), the landed spangled emperor catch was <2 t, and is therefore considered **acceptable**.

Recreational

Catch tolerance levels and total mortality limits for the recreational and charter pink snapper catch are under development. It is likely these will be included in the GDSF Harvest Strategy when next reviewed.

The seasonal pink snapper spawning closure (1 June-31 August) adjacent to northern Bernier Island also applies to recreational and charter fishers.

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 Denham and Kalbarri on the final trip for the quota season only).

Consultation

Following its implementation, a GDSR Harvest Strategy Reference Group (reference group) was formed to provide advice on strategies aimed at meeting the objectives of the GDSR Harvest Strategy and ocenaic pink snapper recovery plan. The reference group meets at least once each year.

Management meetings between the Department and and licensees are coordinated by 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 Service Level Agreement (SLA).

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

Management Initiatives/Outlook Status

The Department continues to engage the reference group to review the performance of the GDSR against the Harvest Strategy and oceanic pink snapper Recovery Plan on at least an annual basis. The current stock assessment indicated that the oceanic pink snapper stock recovery is on track.

In 2022/23, the Department will work with the reference group to review the 2022 stock assessment against the Harvest Strategy and recovery plan. Following the review, recommendations on the appropriate mangament response will be provided to the Minister for Fisheries for cosnideration.

The GDSR harvest strategy is due for review in 2023.

EXTERNAL DRIVERS

Under the Offshore Constitutional Settlement, commercial vessels licensed by the Commonwealth may operate in waters off the Gascoyne coast, outside the 200 m isobath, as part of the Western Deepwater Trawl Fishery (WDWTF), which in these waters targets deepwater bugs (*Ibacus* spp.) and eteline snappers (e.g. ruby snappers, *Etelis spp.*) (Blake et al. 2021). While no fishing activity in these waters had been recorded by WDWTF vessels since the early 2000s, there was some limited activity in 2018/19 and 2019/20 with 53 and 42 fishing days reported (Blake et al. 2021).

Pink snapper were previously assessed as being at high risk due to the effects of climate change, particularly in the Gascoyne (Caputi *et al.* 2015). These external drivers therefore are considered to represent a **high risk**.

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GASCOYNE INNER SHARK BAY SCALEFISH RESOURCE STATUS REPORT 2022

G.Jackson, S. Blazeski and S.Walters

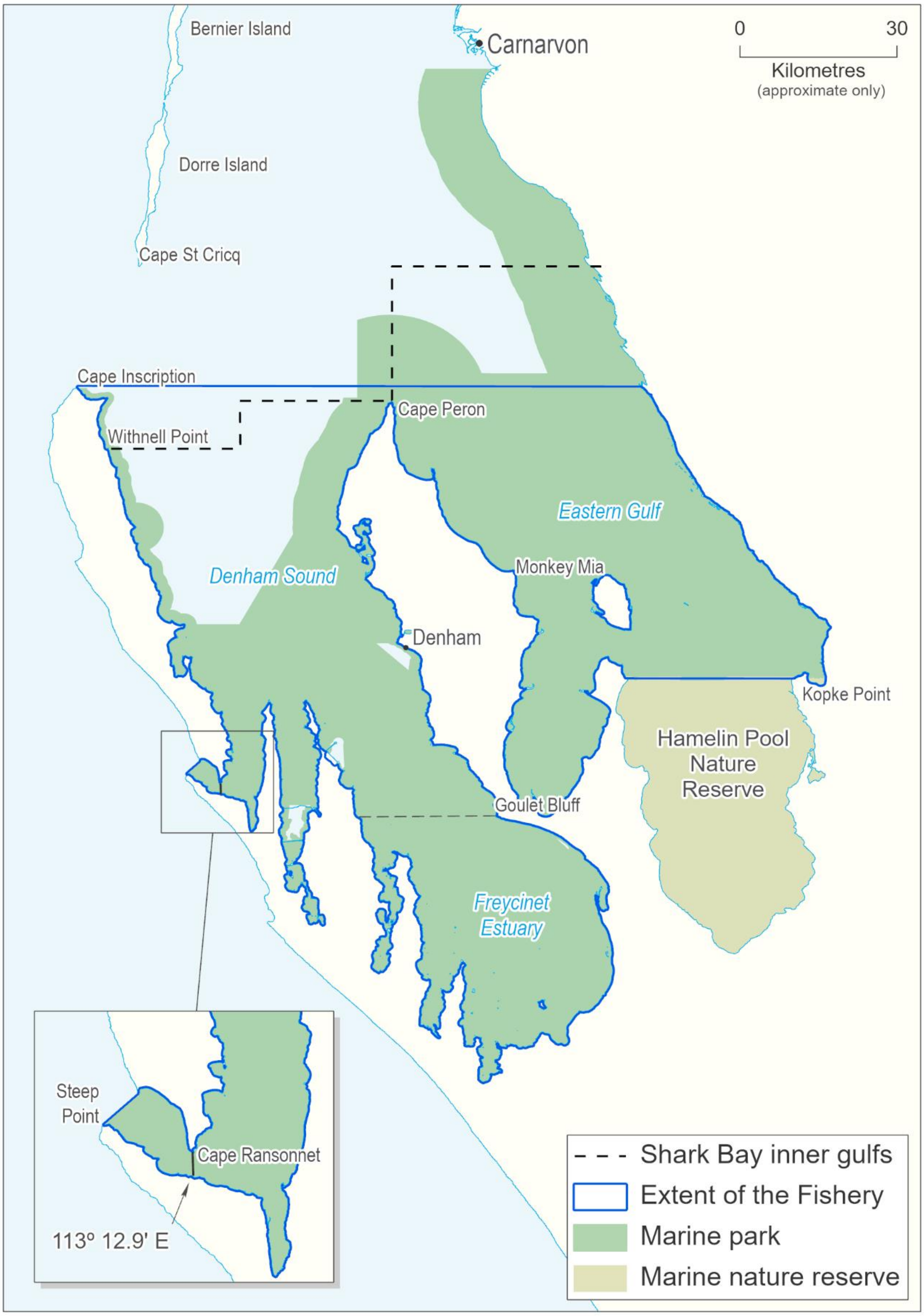
OVERVIEW

The Inner Shark Bay Scalefish Resource comprises 20-30 scalefish species taken by commercial and recreational fishers in the waters of the Eastern Gulf, Denham Sound and Freycinet Estuary in inner Shark Bay. The commercial Shark Bay Beach Seine and Mesh Net Fishery (SBBSMNF) uses mainly beach seine netting to target four species/groups: whiting (mostly yellowfin whiting, *Sillago schomburgkii*), 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*), whiting (*Sillago spp.*), mackerel (*Scomberomorus* spp., *Grammatorcynus bicarinatus*), blackspot tuskfish (*Choerodon schoenleinii*), goldspotted rockcod (*Epinephelus coioides*), western butterfish (*Pentapodus vitta*) and tailor. A limited number of licensed charter vessels operate out of Denham and Monkey Mia.

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (235-335 t)	Total Catch 2021: 135 t	Acceptable
Recreational fishery (Pink snapper, 26 t)	Total Catch 2018: Pink snapper only, 22 t* (boat-based only, includes charter)	Acceptable in Eastern Gulf, Denham Sound Unacceptable in Freycinet Estuary
EBFM		
Indicator species		
Commercial fishery - Whiting	Fishing mortality below threshold (2014)	Adequate
Recreational fishery – Pink snapper (3 stocks)	Biomass of all 3 stocks above target (2015)	Adequate
Ecological		
Bycatch	Low Risk	Acceptable
Listed Species	Negligible Risk	Not an issue
Habitat	Negligible Risk	Not an issue
Ecosystem	Low Risk	Acceptable
Economic (GVP $1-5 m)	Moderate Risk	Acceptable
Social (High amenity)	Moderate Risk	Acceptable
Governance	Moderate Risk	Acceptable
External Drivers	High Risk	Acceptable

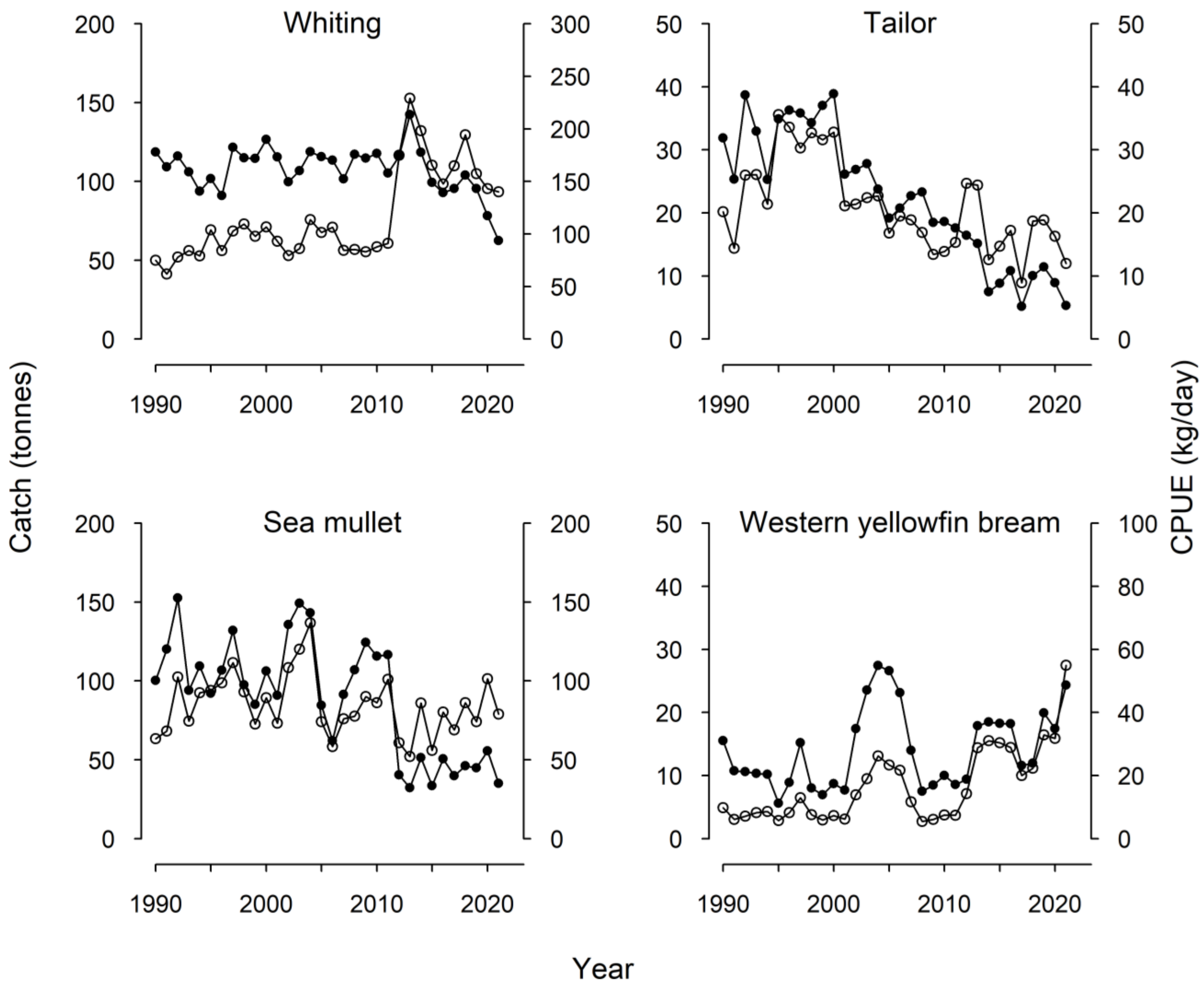
*Based estimates from on-site boat ramp survey conducted 2018/19 (Taylor et al. 2019)



GASCOYNE INNER SHARK BAY FIGURE 1.
Commercial and recreational fishing areas of inner Shark Bay.

CATCH AND LANDINGS

In 2021, the total commercial catch reported by the SBBSMNF was 135 t, comprising 62 t of whiting, 35 t of sea mullet, 24 t of western yellowfin bream, 5 t of tailor and 8 t of other mixed species including <1 t of pink snapper. The total catch of pink snapper reported by charter vessels fishing in inner Shark Bay in 2021 was 3.2 t (all three areas combined). The recreational catch of pink snapper in 2021, in the absence of more recent information, was assumed to be similar to that in 2018 (i.e. 18 t, all three areas combined) (Taylor *et al*. 2019).



GASCOYNE INNER SHARK BAY FIGURE 2.

Commercial catches (●) and CPUE (○) of whiting, tailor, sea mullet and western yellowfin bream taken by SBBSMNF 1990-2021.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Pink snapper Inner Gulf Stocks (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 (<1–2 t) and limited to bycatch taken by the SBBSMNF.

Recreational fishing in inner Shark Bay steadily increased from the 1960s through to the 1990s with all three snapper stocks becoming over-exploited. Reductions in catch levels were generated by the additional management arrangements progressively introduced from 1998 onwards, this included notional Total Allowable Recreational Catches (TARCs) implemented in each area in 2003.

Stock assessments (2015) that incorporated age composition data up to 2013 indicated that the spawning biomass of all three stocks was estimated to be above the target level (40% unfished level) in 2015. More recently, Catch-MSY analyses (2020) indicated that all three stocks have continued to build under existing management arrangements and that stocks are well above target levels. On the basis of the evidence available, these pink snapper stocks are considered to be **adequate.**

Whiting (Adequate)

The commercial catch of whiting taken by the SBBSMNF is mostly (~70-90%) yellowfin whiting combined with smaller quantities of goldenline (*S. analis*), western trumpeter (*S. burrus*) and western school whiting (*S. vittata*). In 2021, the commercial catch of all whiting species taken by the SBBSMNF decreased to 62 t (78 in 2020), which is the lowest whiting catch on record and well outside the target catch range (93-127 t). However, Catch Per Unit Effort (CPUE) at 140 kg/boat day remained well above the threshold catch rate (75 kg/boat day). The commercial catch of whiting in inner Shark Bay had been relatively stable at ~90-120 t from 1990 to ~2018 (Inner

Shark Bay Figure 2), but there has been a decline in catches since ca. 2013 principally due to the decline in overall fishing effort (see Annual Catch/Effort Tolerance Levels). Whiting (mostly yellowfin) are the third most retained scalefish species group taken by boat based recreational fishers in inner Shark Bay (Taylor *et al*. 2019).

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

Sea mullet (Adequate)

In 2021, the commercial catch of sea mullet taken by the SBBSMNF decreased to 34 t (55 t in 2020) and remained well below the target catch range (77-144 t). This maintains the trend in lower catches observed since 2000, down from the higher levels reported from 1990-2010 that typically ranged from 100–150 t. The CPUE in 2021 decreased to 79 kg/boat day (101 kg/boat day in 2020), but continued to be maintained above the threshold catch rate (62 kg/boat day). While the low landings of sea mullet in recent years reflect higher levels of fishing effort directed at the more valuable whiting, there may also be some effect of changing environmental conditions, on sea mullet stock abundance.

The sea mullet catch in inner Shark Bay represents approximately a quarter of the total commercial catch taken in WA with the majority taken in the West Coast Bioregion (West Coast Nearshore and Estuarine Finfish Resource Status Report).

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

Tailor (Adequate)

In 2021, the commercial catch of tailor taken by the SBBSMNF decreased to 5 t (9 t in 2020), and remained well below the target catch range (25-40 t). This maintains the declining trend in tailor catches observed since 2000. The CPUE in 2021 decreased to 11 kg/boat day (16 kg/boat day in 2020) which is well below the threshold level (21 kg/boat day). While the low landings of tailor that have been a feature of the fishery in recent years are partly attributed to local processing restrictions, there may also be some effect of changing environmental conditions on tailor stock abundance.

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 Estuarine Finfish Resource Status Report).

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

Western yellowfin bream (Adequate)

In 2021, the commercial catch of western yellowfin bream taken by the SBBSMNF substantially increased to 24 t (17 t in 2020), which is well above the target catch range (7-15 t). The CPUE at 55 kg/boat day had also increased to well above the threshold catch rate (5 kg/boat day), as has been the case since 2013. Large variation in catches of yellowfin bream have been observed since 1990 and are attributed to highly variable recruitment, which is typical of this species and is mostly environmentally driven. The recent increase in both catch and CPUE reflect another strong year class moving through the fishery as was previously observed in 2002-2007, 2013-2016, and more recently, since 2019.

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

BYCATCH and PROTECTED SPECIES INTERACTIONS

Bycatch

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

Protected species

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, therefore the level of interactions with protected species is considered a **negligible risk**.

HABITAT and ECOSYSTEM INTERACTIONS

Habitat

Seine netting occurs over shallow sand banks and other naturally dynamic nearshore environments. These fishing activities in association with the low frequency of fishing in any one location is considered to represent a **negligible risk.**

Ecosystem

Food chain effects are considered to be low due to the low frequency seine net fishing.

The juvenile components of these harvested 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 impacts overall on the ecosystem are therefore considered to represent a **low risk**.

SOCIAL AND ECONOMIC OUTCOMES

Social

In 2021, six vessels operated in the SBBSMNF, employing around ~12-14 fishers. Commercial fishing and associated fish processing are still important sources of employment and income in Denham.

Shark Bay is a very popular recreational fishing destination especially during the winter months and school holidays. The annual total boat-based recreational fishing effort in inner Shark Bay between March 2018 and February 2019 was estimated at 8,596 boat trips which is within historical levels observed since 2000 (Taylor *et al*. 2019).

Vessel retrievals at key boat ramps in Shark Bay (Monkey Mia and Denham) were significantly higher from March to August 2020, where COVID-19 measures relevant to recreational fishers included various travel restrictions, and social and physical distancing measures (Ryan et al. 2021). The latest statewide recreational fishing survey (from 1 September 2020–31 August 2021) will provide an opportunity to review the medium-term impact of COVID-19 on recreational fishing in Shark Bay and elsewhere.

The Inner Shark Bay Scalefish Resource therefore provides a high social amenity and is considered to represent a **moderate risk.**

Economic

The estimated GVP of the SBBSMNF in 2021 was in the range $1-5 million that represents a **moderate risk**. Product from this fishery supplies domestic fish markets (Perth and Sydney). The value of recreational fishing to the WA economy was recently estimated at $2.4 billion per year (McLeod and Lindner 2018) with recreational fishing in the Gascoyne region estimated to be worth $27.5 million per year.

GOVERNANCE SYSTEM

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 (TACC and TARC, set in 2003): 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).

Annual Catch/Catch Rate Tolerance Levels

Commercial:

Total fishing effort in the SBBSMNF was 455 boat days in 2021, the lowest level on record. While the total commercial catch in 2021 at 135 t was well below the target catch range (235–335 tonnes), when viewed against the historically low levels of current effort, the commercial catch level can be considered **acceptable**.

In 2021, the commercial catch of snapper taken by the SBBSMNF was <1.0 t, well within the notional TACC (9 t all three areas combined).

Recreational:

Recreational (includes charter) catch tolerance levels are currently in place for pink snapper only.

Recreational catches of pink snapper in 2021 were assumed (in the absence of moreso recent data) to be similar to those in 2018 that were estimated at 2.1 t [95% CI 0.8-3.4] in the Eastern Gulf, 4.6 t [95% CI 3.4-5.9] in Denham Sound, and 11.5 t [95% CI 4.3-18.7]) in Freycinet Estuary (Taylor *et al*. 2019).

In 2021, a total of ~3 t were reported by charter vessels (Eastern Gulf <0.5 t, Denham Sound 1.3 t, Freycinet ~1.1 t).

Recreational catches of snapper in **Eastern Gulf** and **Denham Sound** were assumed to be within the respective notional TARCs, and are therefore **acceptable**. However the recreational catch in **Freycinet** was assumed to be well above the TARC and is therefore **unacceptable.**

Compliance

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

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.

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 formal harvest strategy for the nearshore scalefish resource in the Gascoyne Coast Bioregion which would include the main species targetted by the SBBSMNF, the Exmouth Gulf Beach Seine Fishery and the Carnarvon Open Access Fishery (but would exclude demersal scalefish species such as pink snapper) is yet to be developed, however, it is noted as a future management initiative.

EXTERNAL DRIVERS

The Inner Shark Bay system has been considered relatively stable as a result of its typically low-rainfall and arid environment. However, extreme but occasional events including cyclone-related riverine floods (occurred in the Gascoyne and Wooramel Rivers in 2010-2011 and more recently in 2018) and a marine heatwave (summer of 2010/11) had significant impacts on some marine habitats (e.g. temperate seagrasses) (Arias-Ortiz *et al.* 2018) 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.

Pink snapper had previously been assessed as high risk, and grass emperor and tailor as medium risk due to the effects of climate change, particularly in the Gascoyne (Caputi *et al.* 2015).

These external drivers represent a **high risk**.

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NORTH COAST BIOREGION

ABOUT THE BIOREGION

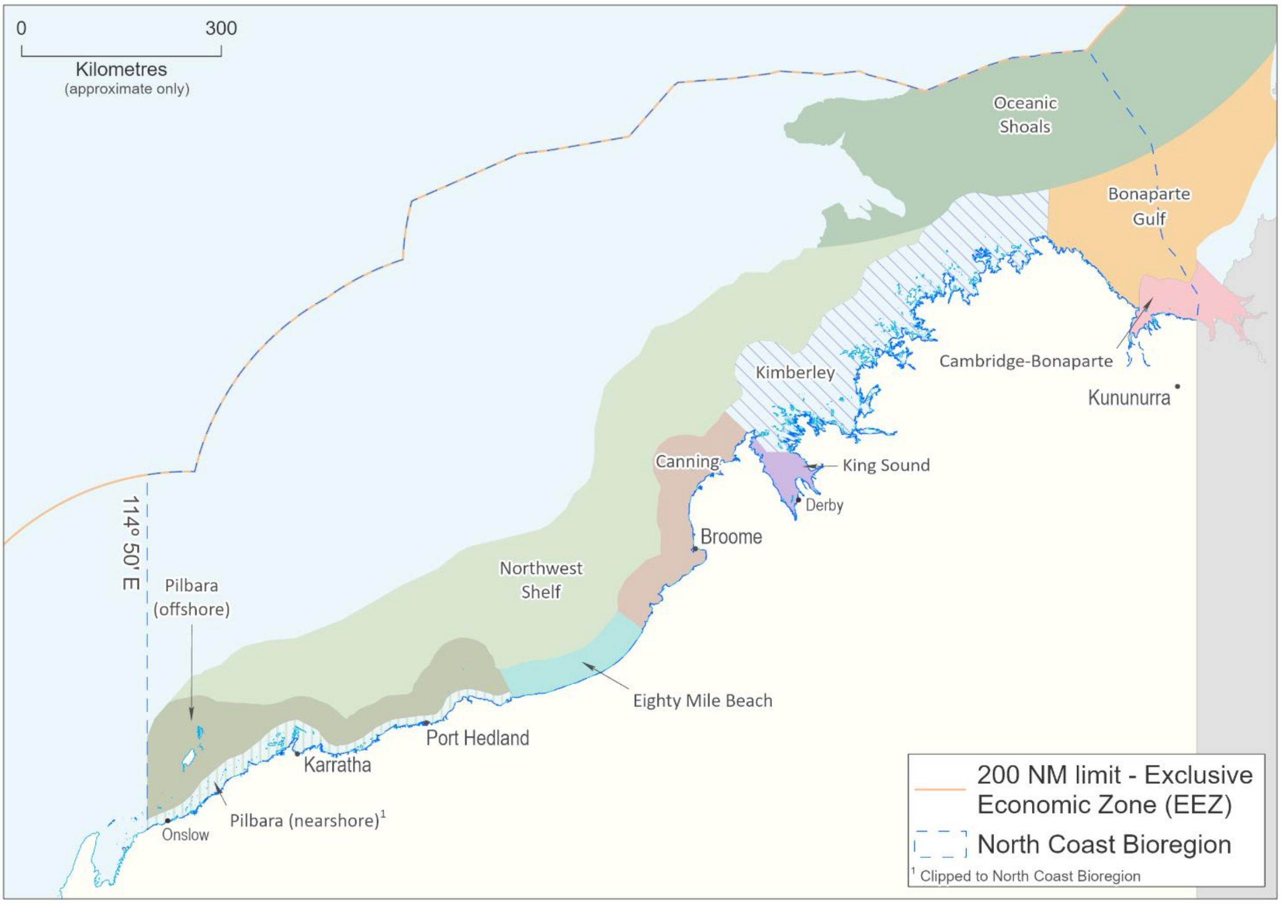
The North Coast Bioregion extends from Onslow to the WA/NT border. The oceanography of this bioregion (North Coast Bioregion Overview Figure 1) includes waters of Pacific Ocean origin that enter through the Indonesian Archipelago bringing warm, low salinity waters polewards via the Indonesian Throughflow 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 10 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 heavily influenced by macro-tides and are seasonally influenced by 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 monsoonal rainfall over summer.

Significant river run-off and associated localised coastal productivity is associated with cyclone events, with run-off ceasing during winter. Despite localised areas of high productivity, the region is generally oligotrophic and large areas of the coastline receive no riverine input. The entire North Coast Bioregion is subject to very high evaporation rates (3 metres per year), although the Pilbara coastline is more arid than the Kimberley.

The macro-tidal regime is a result of 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 to more than 2 metres in the West Pilbara.



NORTH COAST BIOREGION OVERVIEW FIGURE 1
Map showing the North Coast Bioregion and IMCRA (V 4.0) meso-scale regions: Pilbara nearshore, 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 large adjacent 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 clearer, low productivity waters more typical of the tropics.

The geography of the various sections of the coastline also differs. The Kimberley Coast is complex, with bays and estuaries backed by a hinterland of high relief. 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;
- increases 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 (e.g. cyclones and tropical storms).

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 of species, 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.

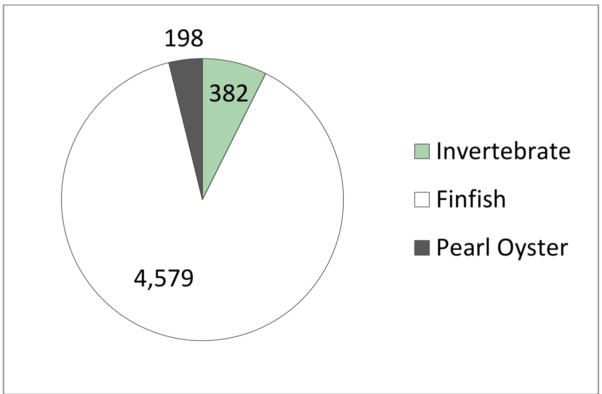
Commercial Fishing

There are a diverse range of resources within the North Coast Bioregion (e.g. Pearl Oyster; Northern Demersal Scalefish; Northern Estuarine, Nearshore and Embayment Scalefish and Invertebrates; Hand Collection; Northern Invertebrates) that support a wide range of State-managed commercial fisheries. These fisheries target a variety of species including finfish, crustaceans, molluscs and echinoderms (North Coast Bioregion 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 up to 3,000-4,000 t annually, making these fisheries the most valuable finfish sector in the State, with an estimated annual value of more than $20 million. A number of other finfish fisheries operate in the Bioregion, including near-shore beach seining and gillnetting for barramundi and threadfin (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. 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 200-500 t annually. 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 Bardi Jawi and Mayala Traditional Owners, who have traditionally collected trochus in this area.

A traditional artisanal fishery targeting sea cucumbers also exists in an area south of Roti Island, encompassing Scott Reef, Browse island, Cartier Island and Ashmore Reef known as the MOU box. The MOU Box within the Australian EEZ was established as part of 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.



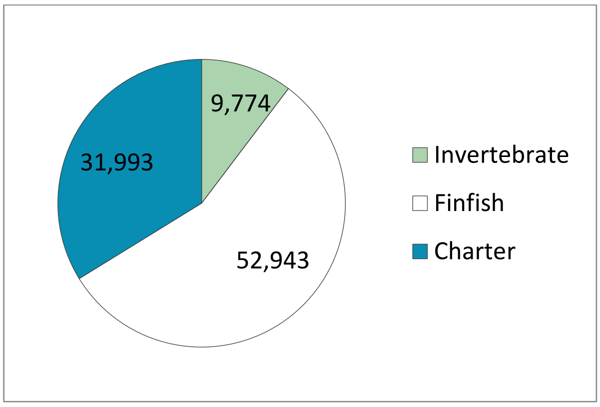
NORTH COAST BIOREGION OVERVIEW FIGURE 2

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 (Overview Table 1, North Coast).

Recreational Fishing

Recreational fishing in the North Coast Bioregion typically has a distinct seasonal peak in winter when the population is increased by significant numbers of intra- and inter-state tourists travelling through the area visiting the Onslow, Dampier Archipelago and Broome sections of the coastline. This adds to the increased recreational fishing effort resulting from people employed in the 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.

Vessel retrievals from key boat ramps have been monitored using remote cameras for previous state-wide surveys[1]. The typical seasonal pattern of vessel retrievals at Broome was not observed during the early stages of COVID-19 restrictions from March to August 2020[2]. Activity patterns post COVID-19 travel restrictions are currently being analysed.



NORTH COAST BIOREGION OVERVIEW FIGURE 3

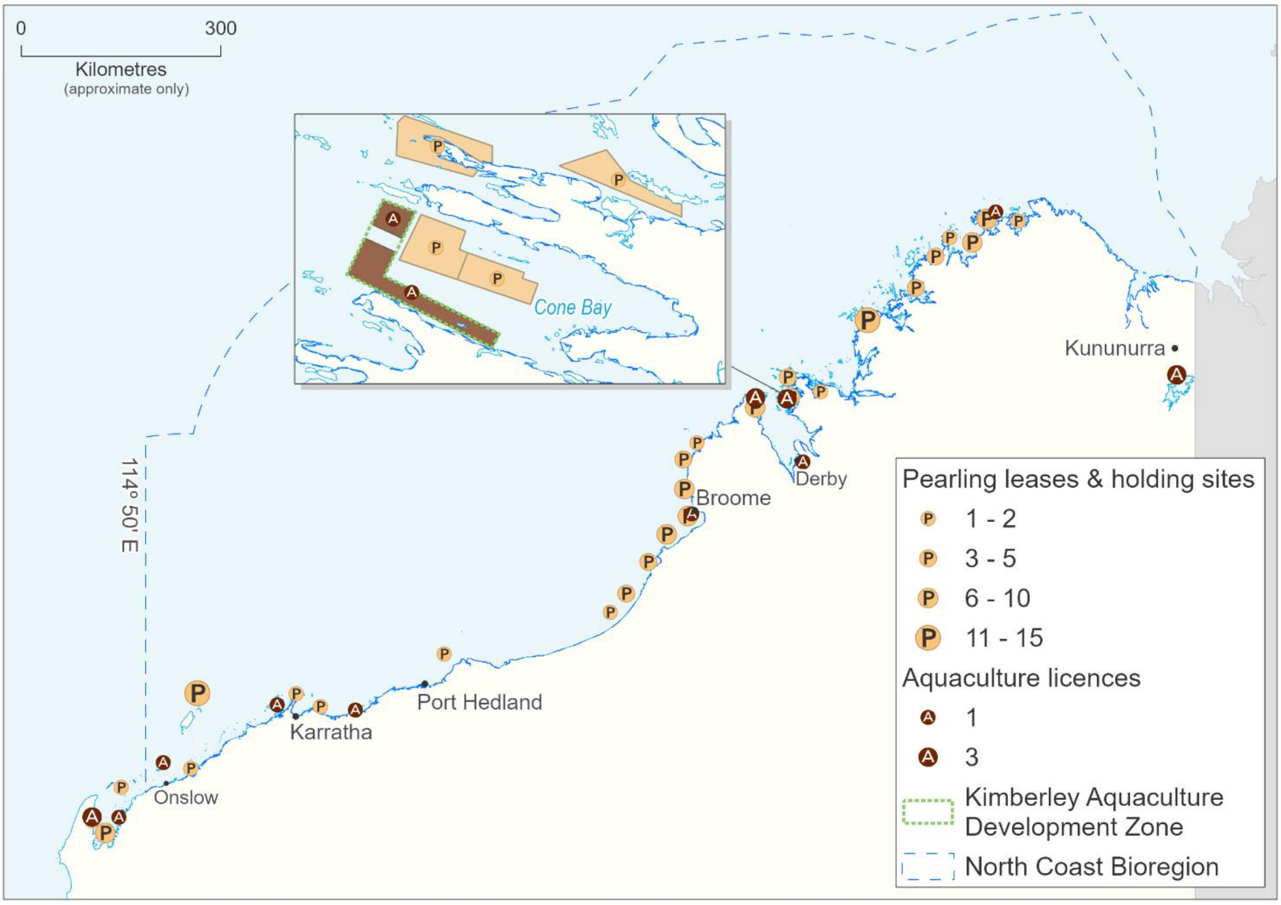
Recreational catches (by number) in the North Coast Bioregion. Finfish and invertebrate catches were as assessed in the statewide survey of boat-based recreational fishing in 2020/21. Charter boat catch is for the same period. Estimates of shore based recreational catch are unavailable.

1 Ryan KL, Lai EKM, Smallwood CB. 2022. Boat-based recreational fishing in Western Australia 2020/21. Fisheries Research Report No. 327 Department of Primary Industries and Regional Development, Western Australia. 221pp.

2 Ryan KL, Desfosses CJ, Denham AM, Taylor SM, Jackson, G. 2021. Initial insights on the impact of COVID-19 on boat-based recreational fishing in Western Australia. Marine Policy 132: 104646

Aquaculture

Aquaculture in the North Coast Bioregion is dominated by the production of pearls from the oyster species *Pinctada maxima*. An overview of aquaculture activities in the Bioregion is detailed in North Coast Bioregion 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, 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.

Finfish aquaculture in the Kimberley region is dominated by barramundi farming within the Kimberley Aquaculture Development Zone, which was declared in August 2014. Located about 200 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. Barramundi Group, 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.

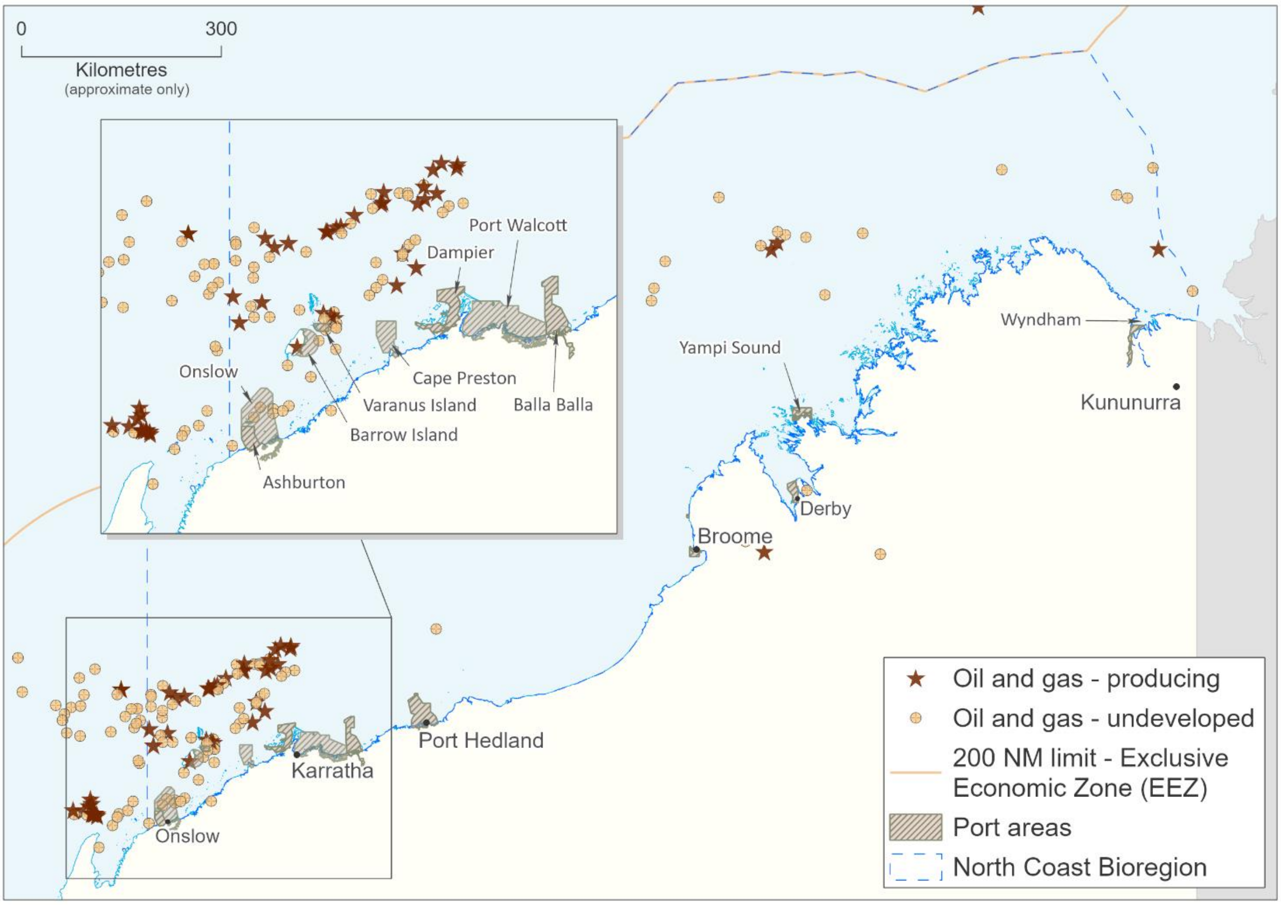
Barramundi Group is seeking additional sites in the Buccaneer Archipelago to increase its production capability. Rock oyster trials are nearing completion in the Pilbara Region near Karratha but there is no commercial production of the species in the bioregion at this stage.Aquaculture development is supported by the Department’s Broome Tropical Aquaculture Park (BTAP), which houses a commercial pearl oyster hatchery and the North Regional TAFE aquaculture training facility. The Government is investing in upgrading the BTAP to enable it to better support aquaculture development for species including barramundi and seaweed.

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 Wyndham. 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 BIOREGION 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 Bioregion Overview Figure 5). The upcoming decommissioning of older facilities is leading to proposed projects on the value of this infrastructure to commercial and recreational fisheries. 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, introduction of marine pest species, release of produced formation water, shipping and transport activities and oil spills.

Shipping and Maritime Activity

The Kimberley Ports Authority and Pilbara Ports Authority occur in the North Coast Bioregion. The largest ports being 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. 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 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. The Department has surveillance in place for marine pests in key port areas to aid in the early detection of any unwanted aquatic species from other locations.

BIOREGION 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 was undertaken by Caputi *et al*. (2015a, b) assessing the effects of climate change on the marine environment and key fisheries, as well as potential 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).

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 a substantial part 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 trawl closures, the Bioregion has a number of marine protected areas with various management objectives (summarised in North Coast Bioregion Overview Figure 7). These include the Montebello Islands, Barrow Island, Rowley Shoals, Eighty Mile Beach, Yawuru Nagulagun / Roebuck Bay, Lalang-garram / Horizontal Falls, North Lalang-garram, Lalang-garram / Camden Sound and North Kimberley marine parks; the Barrow Island Marine Managament Area proclaimed under the *Conservation and Land Management Act 1984*; 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).

In 2019 the State Government announced the 'Plan for Our Parks' initiative to create additional marine parks and terrestrial conservation reserves by February 2024. This initiative included the establishment of a new marine park in the Buccaneer Archipelago. The Department participated in the marine park planning process for the Buccaneer Archipelago Marine Park, which was formally created in July 2022. The Buccaneer Archipelago Marine Park consists of the Bardi Jawi Gaarra, Mayala and Lalang-gaddam marine parks. The Lalang-gaddam marine park is an amalgamation of the existing Lalang-garram / Camden Sound, Lalang-garram / Horizontal Falls, North Lalang-Garram and the newly created Maiyalam marine parks.

The Department has established baseline and ongoing monitoring and research to underpin ecosystem management in this Bioregion. The Department continues to work closely with relevant agencies and stakeholders to develop strategies to minimise environmental impacts in the marine environment. This includes continuing to work with Department of Biodiversity, Conservation and Attractions (DBCA) and Traditional Owners on the management of marine parks and reserves and collaboration on relevant Western Australian Marine Science Institute (WAMSI) Kimberley Marine Research Program projects.

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

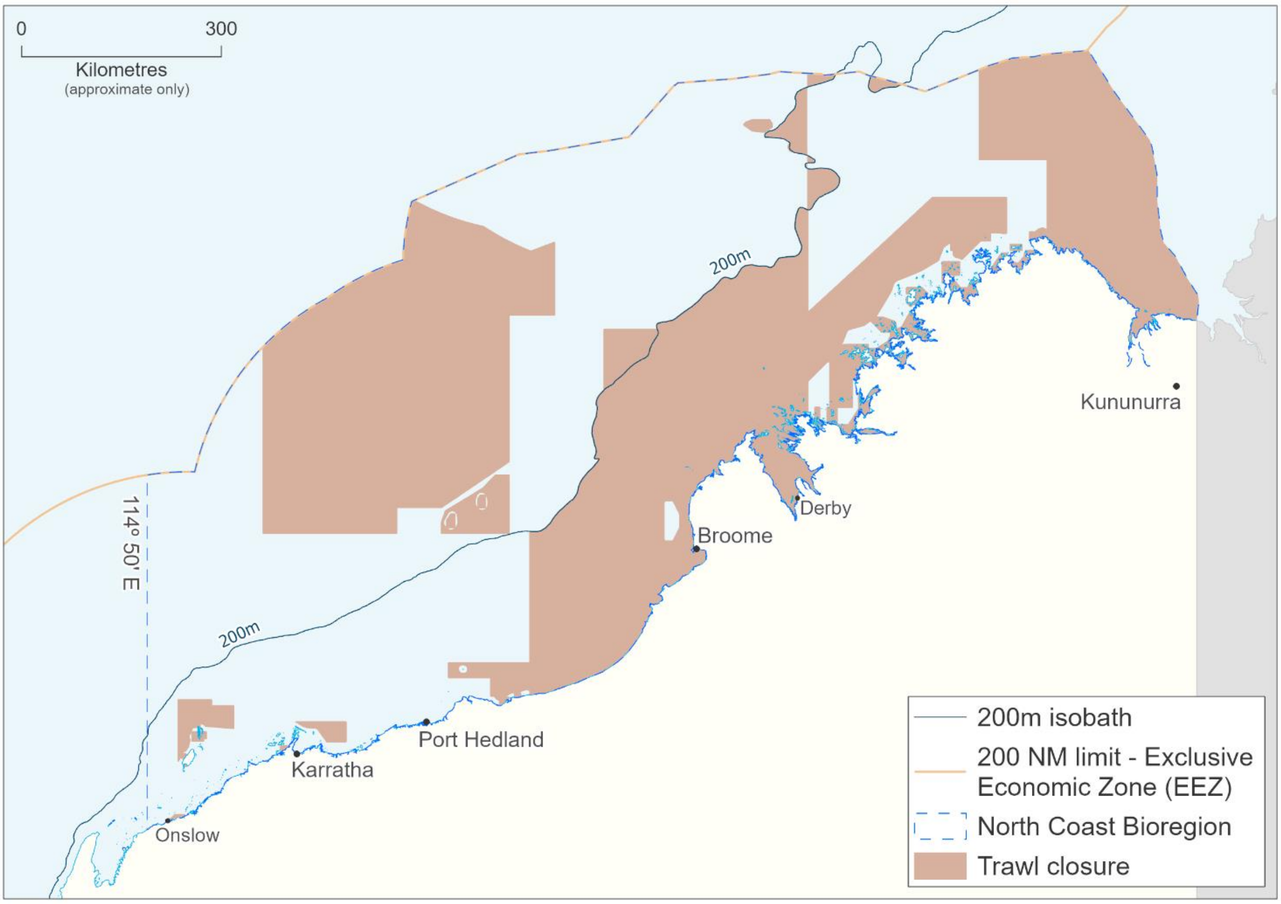
Day J, Dudley N, Hockings M, Holmes G, Laffoley D, Stolton S, and Wells S. 2012. Guidelines for applying the IUCN Protected Area Management Categories to Marine Protected Areas. IUCN. Gland, Switzerland: 36pp.

The Commonwealth Government implemented an Australian Marine Park for the North-West Marine region (between Shark Bay and the Northern Territory border) in July 2018. This resulted in a network of marine parks off the coast of the North Coast Bioregion (see North Coast Overview Figure 7).

NORTH COAST ECOSYSTEM MANAGEMENT TABLE 1

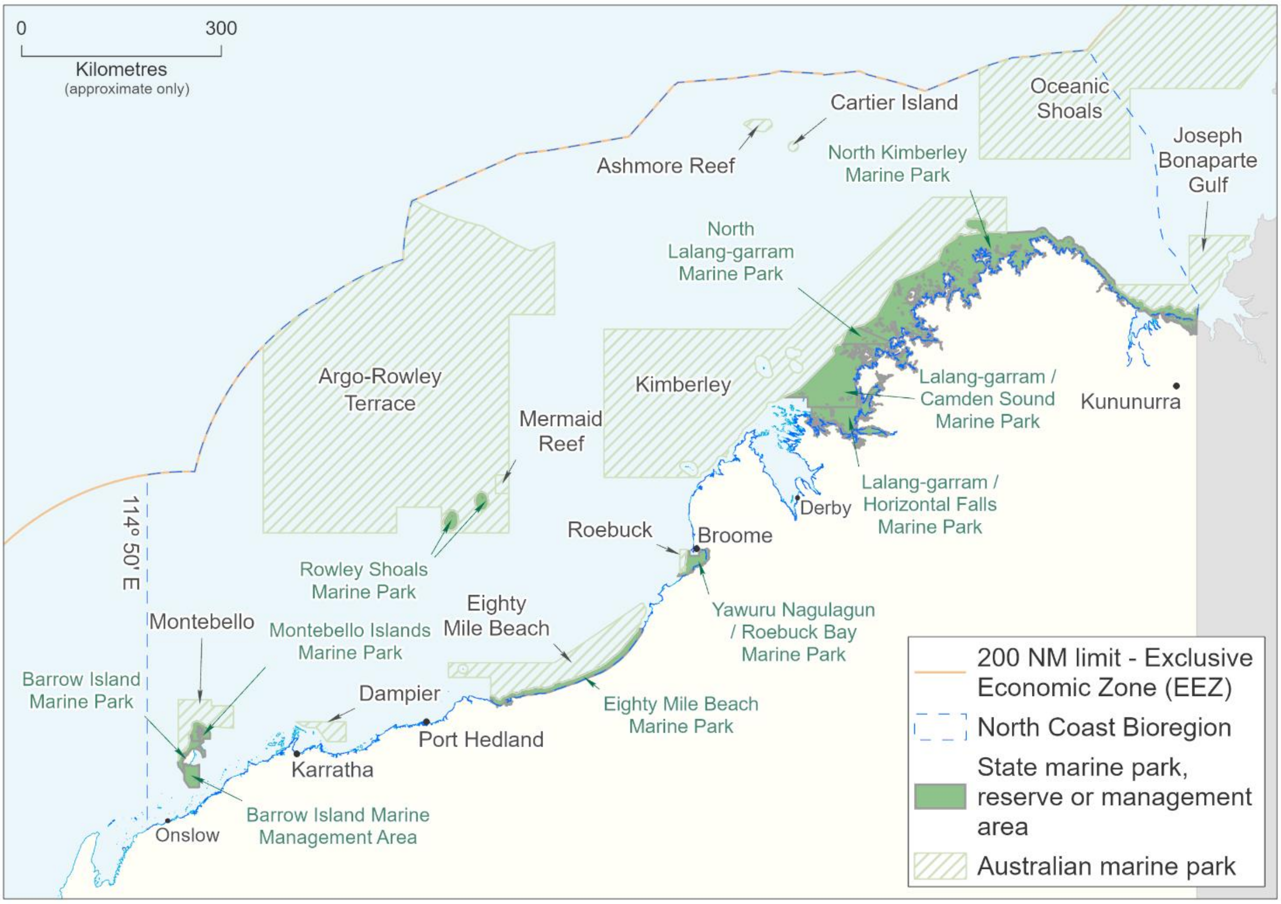
The areas and proportions of the North Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which are consistent with the IUCN criteria for classification as marine protected areas. This table does not include State or Commonwealth closures that are currently in the process of implementation. These areas will be included in future volumes, when their respective implementation processes are concluded.

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	8,000	8	0	0	8,400	1
III	0	0	0	0	0	0	0	0
IV	19,100	19	8,800	9	149,200	16	9,300	1
V	0	0	440	< 1	0	0	0	0
VI	36,800	37	25,200	26	677,500	71	112,500	12



NORTH COAST BIOREGION OVERVIEW FIGURE 6

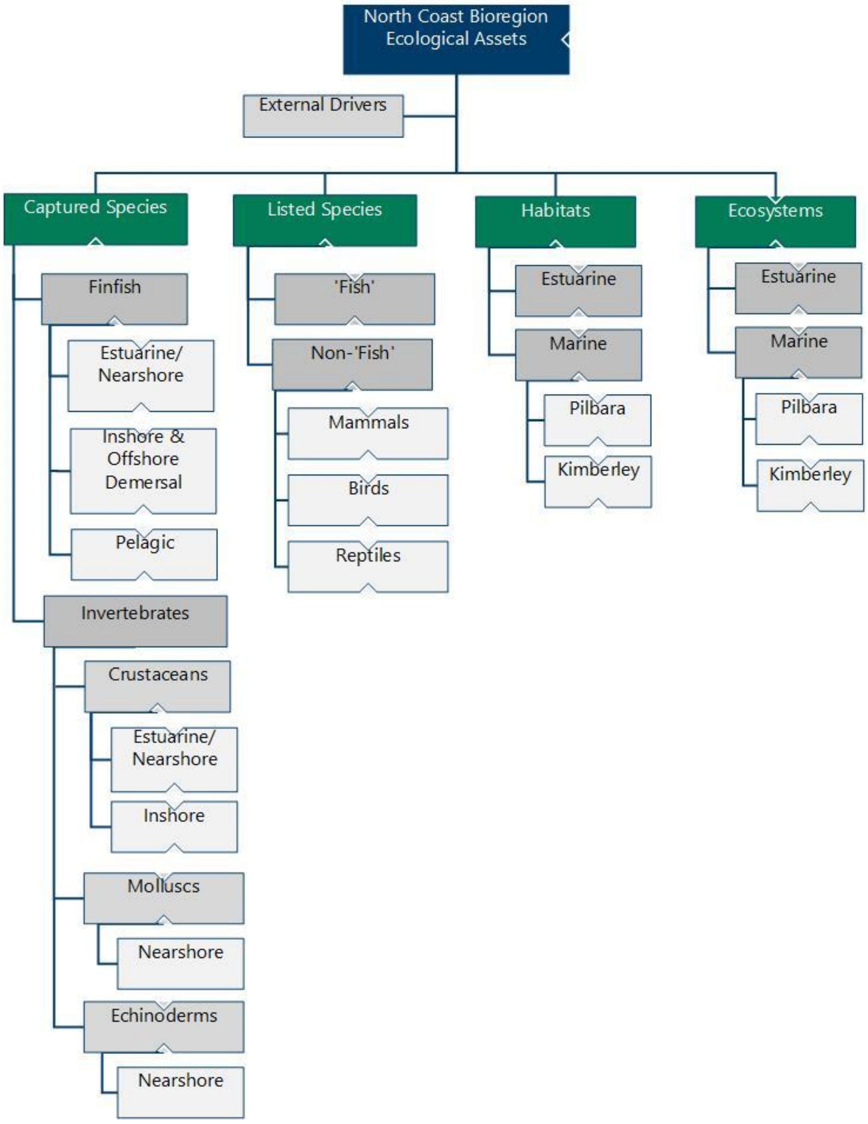
Map showing the North Coast Bioregion and areas closed to all trawling. The areas permanently closed to trawling are consistent with IUCN marine protected area category IV.



NORTH COAST BIOREGION OVERVIEW FIGURE 7
Map showing the North Coast Bioregion and 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). The key ecological assets identified for the North Coast Bioregion are identified in North Coast Bioregion Overview Figure 8 and their current risk status are reported on in the following sections.



NORTH COAST BIOREGION 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 a whole and may not fall within the direct control of Fisheries 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[1] and oil and gas development activities.

Climate

External Drivers	Current Risk Status
Climate	MEDIUM

The North Coast Bioregion is predicted to have relatively minor impacts from climate change in the coming decade, compared to more southerly bioregions.

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. In addition, State and Commonwealth marine protected areas, including totally protected zones, are currently in place or planned.

1 Biosecurity issues are now reported by the Biosecurity pillar of the Department of Primary Industries and Regional Development.

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 3000–5,000 t annually at an estimated annual value of more than $20 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 (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 (0-20 m depth)

Captured Species	Aquatic zone	Ecological Risk
Finfish	Estuarine/Nearshore	MEDIUM

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. Stocks of barramundi and threadfin are considered to be at acceptable levels. Implementation of marine parks in the bioregion may have affected some commercial fishing activities.

Inshore and Offshore Demersal

Captured Species	Aquatic zone	Ecological Risk
Finfish	Inshore and Offshore demersal	MEDIUM

There are four State-managed commercial fisheries 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 Ecosystem and are collectively referred to as the Pilbara Demersal Scalefish Fisheries (PDSF) and Northern Demersal Scalefish Fishery (NDSF). The trawl fishery lands the largest component of the catch, comprising more than 50 scalefish species.

Pelagic

Captured Species	Aquatic zone	Ecological Risk
Finfish	Pelagic	MEDIUM

There are a large number of species in the pelagic suite in this Bioregion. The main commercial catch is Spanish Mackerel which is targeted by the Mackerel Managed Fishery. This stock is considered to be at an acceptable level. Few other pelagic species are exploited at any significant levels and these stocks are lightly impacted by fishing.

INVERTEBRATES

The Pearl Oyster Managed Fishery is a significant commercial invertebrate fishery in this Bioregion, 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, typically producing approximately 500 t annually, valued at more than $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 Bardi Jawi and Mayala Traditional Owners, who have traditionally collected trochus in this area.

Crustaceans

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

There is a small amount of fishing for mud crabs and blue swimmer crabs in some estuarine and inshore areas. Stocks of mud crabs are considered to be of significant value to the recreational sector and for social amenity.

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	MEDIUM
Molluscs (Trochus)	Nearshore	MEDIUM

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. Legislative structures for this fishery are currently being updated with the primary legislative instrument changing from the *Pearling Act 1990* to the *Aquatic Resources Management Act 2016*.

The North Coast Trochus Fishery in King Sound is a traditional owner run fishery targeting the commercially important gastropod shell *Tectus niloticus*. It is a hand collection fishery open to nominated fishers from the traditional owner community.

Echinoderms

Captured Species	Aquatic zone	Ecological Risk
Sea cucumbers	Nearshore	MEDIUM

The majority of the effort for sea cucumbers has been expended in the Kimberley region, although there have been several years with substantial effort directed into the Pilbara region. In 2019, the Pilbara portion of the fishery for sandfish (*Holothuria scabra*) and redfish (*Actinopyga echinites*) achieved Marine Stewardship Council certification.

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, 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)[1];

The Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds 2007 (ROKAMBA)[1]; 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 *Biodiversity Conservation Act 2016* (BC 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 (PFTF)) and the Kimberley Gillnet Barramundi Fishery (KGBF). ETP interactions with trawl fisheries are few, due to fishing arrangements, such as the use of bycatch reduction devices and the exclusion of trawling activities from most ETP species' primary habitat. Similarly, fishers in the KGBF actively avoid capturing ETP species; however, a small number of interactions have been reported with crocodiles and sawfish.

Fish

Listed species	Risk
Fish	MEDIUM

The sawfish (Pristidae), speartooth shark (*Glyphis glyphis*) and 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. There are requirements for increased resolution regarding the nature and consequence of interactions with ETP elasmobranchs.

Sea horses (Syngnathids) and pipefish (Solenostomids) 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*),

1 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

a totally protected species, rarely enter fish traps due to their large size and girth limiting their capacity to pass through the entrance funnel.

Non-Fish

Listed species	Risk
Mammals	LOW
Reptiles and Birds	MEDIUM

Dolphins are incidentally captured by the Pilbara Fish Trawl Fishery (PFTF). 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 %. BRDs were highly effective in reducing turtle bycatch and moderately so for seasnakes, but ineffective for the few sawfish (n = 13) that became 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 finfish through the BRDs was also very rare (1.3 % of day trawls)[1]. The study also provided evidence that the subsurface expulsion of megafauna in poor condition is negligible. The PFTF operates under WTO with conditions around dolphin and sawfish interactions and monitoring.

Turtles are occasionally encountered in trawl catches but are typically returned to the sea alive. Grid BRDs are now compulsory on trawl nets, which has largely eliminated the capture of any turtle or other large animal.

Sea snakes are the largest component of the ETP bycatch in the trawl fisheries of this bioregion. Programs for identifying and reporting these interactions are currently in development and implementation stages with these and other fisheries.

Crocodiles are occasionally captured in nearshore/ estuarine fisheries' nets and are typically released alive.

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). Major habitats include:

Mangroves: Mangroves occur throughout the Bioregion, and within the Kimberley, and 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 found in the Bioregion are mainly comprised of 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. 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 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 recording 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 intertidal flats

1 Wakefield, C. B., Blight, S., Dorman, S. R., Denham, A., Newman, S. J., Wakeford, J., Molony, B. W., Thomson, A. W., Syers, C. and O'Donoghue, S. 2014. Independent observations of catches and subsurface mitigation efficiencies of modified trawl nets for endangered, threatened and protected megafauna bycatch in the Pilbara Fish Trawl Fishery. Fisheries Research Report No. 244. Department of Fisheries, Western Australia. 40 pp.

and the majority of the offshore area is dominated by soft sediment seabeds. These 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 fishing 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 preceding "spatial closures" section.

The Department identifies and monitors trends in the condition of ecosystems and their associated habitats to ensure the long term sustainability of both 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	MEDIUM

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 is 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	MEDIUM
Pilbara	Marine	MEDIUM

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 unacceptably changing the regional level community structure. 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[1)]. 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. Slight increases to the risk ratings for Kimberley marine ecosystems are a reflection of increased monitoring and reporting requirements ensuing from implementation of marine protected areas in the region.

1 Hall, N.G. and Wise, B.S. 2011. Development of an ecosystem approach to the monitoring and management of Western Australian fisheries. FRDC Report – Project 2005/063. Fisheries Research Report No. 215. Department of Fisheries, Western Australia. 112 pp.

FISHERIES

NORTH COAST PRAWN RESOURCE STATUS REPORT 2022

M. Kangas, S. Wilkin, M. Shanks, and R. Leaversuch

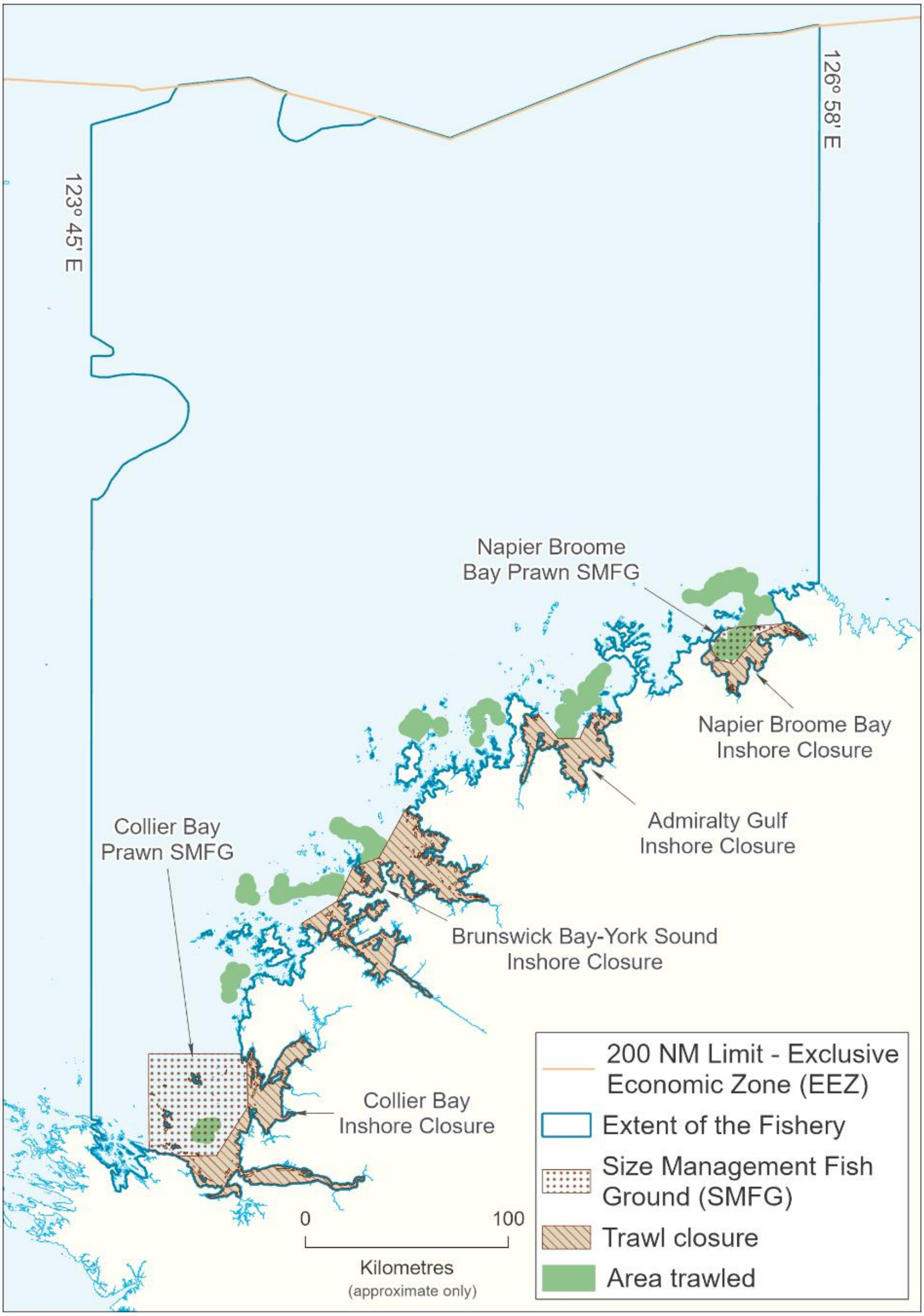
OVERVIEW

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 blue endeavour prawns (*Metapenaeus endeavouri*). High opening, otter trawl systems are also used when targeting banana prawns (*Penaeus merguiensis*) which is the target species for the Kimberley and Nickol Bay fisheries. Management of the north coast prawn managed fisheries is based on input controls, including limited entry, gear controls (maximum headrope units), seasonal and area openings and closures.

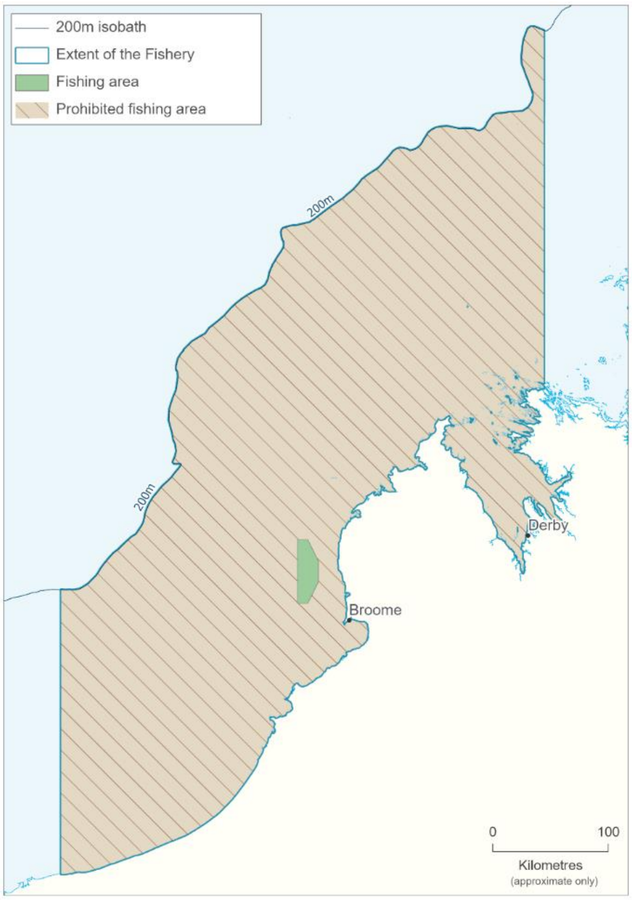
The fisheries have Commonwealth export approval until 2025 (under Part 13 of the *Environment Protection and Biodiversity Conservation Act 1999* [EPBC Act]).

SUMMARY FEATURES

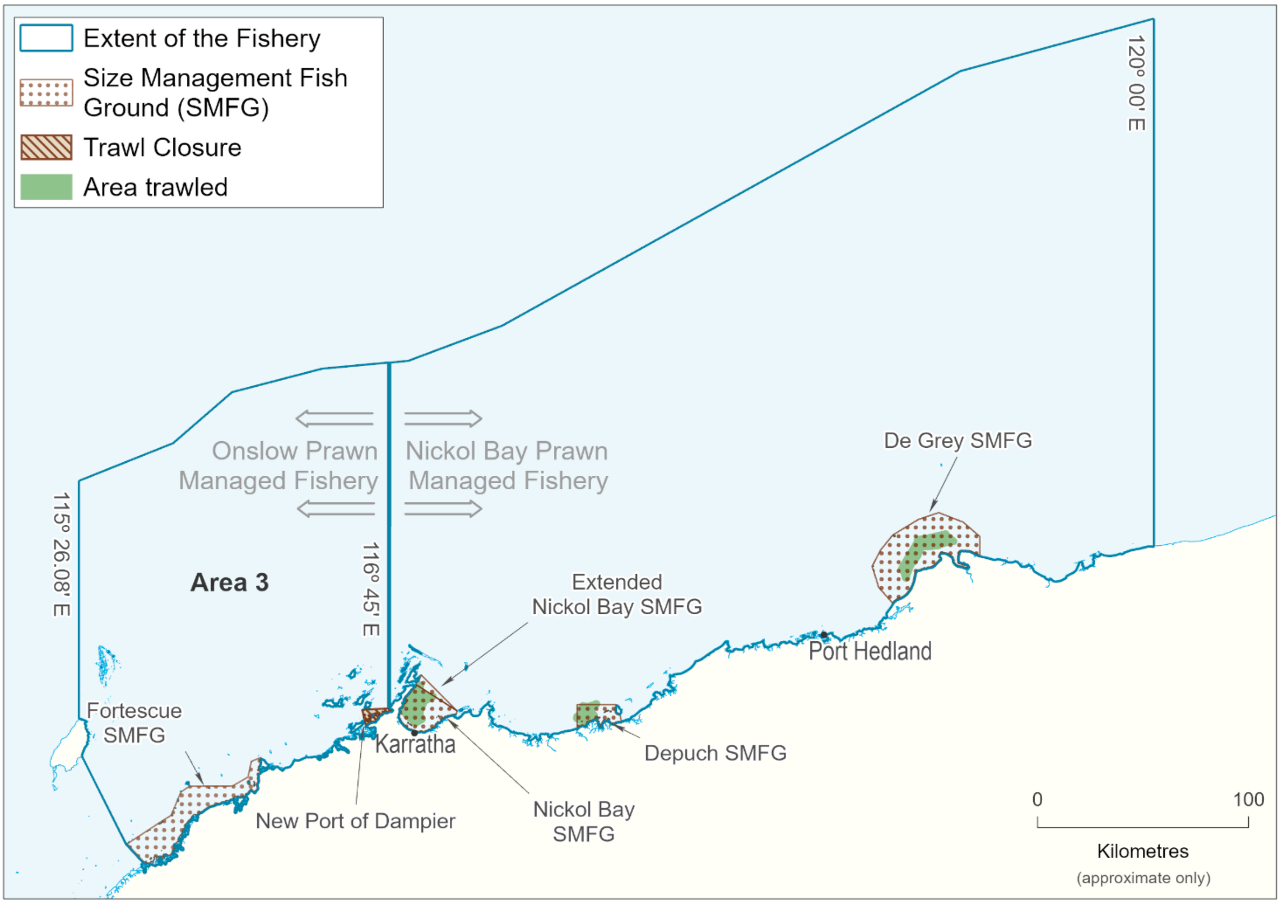
Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (2021)	Total Catch: 346 t	Acceptable
Recreational fishery (N/A)		
EBFM		
Indicator species		
Banana prawns (KPMF and NBPMF)	Moderate risk: Catches within predicted ranges	Adequate
Western king prawns (BPMF)	Low risk: Very low effort and catch	Adequate
Brown tiger prawns (OPMF)	Low risk: Low effort and catch	Adequate
Ecological		
Bycatch	Low risk	Adequate
Listed Species	Low risk	Adequate
Habitat	Low risk	Adequate
Ecosystem	Low risk	Adequate
Economic (GVP $5.3m)	High risk	Acceptable
Social (low amenity)	Low risk	Acceptable
Governance	Moderate risk	Acceptable
External Drivers	Moderate risk (climate)	



NORTH COAST PRAWN FIGURE 1.
Map showing boundaries of the Kimberley Prawn Managed Fishery and areas fished in 2021.



NORTH COAST PRAWN FIGURE 2.
Map showing boundaries of the Broome Prawn Managed Fishery

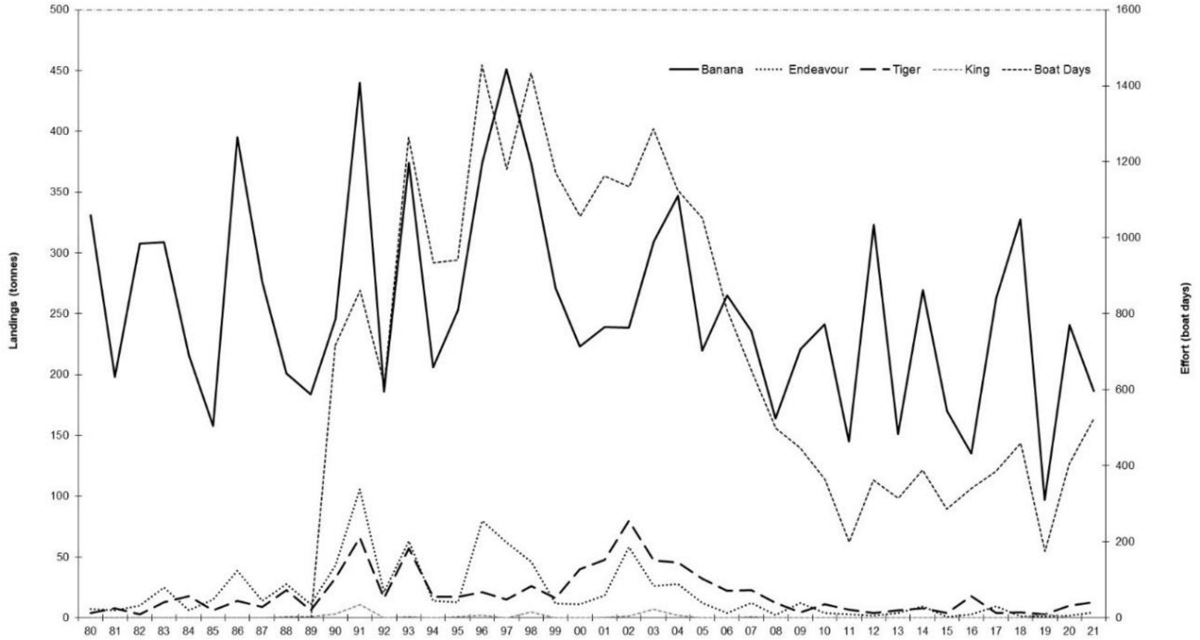


NORTH COAST PRAWN FIGURE 3.
Map showing boundaries of the Nickol Bay Prawn Managed Fishery and areas fished in 2021.

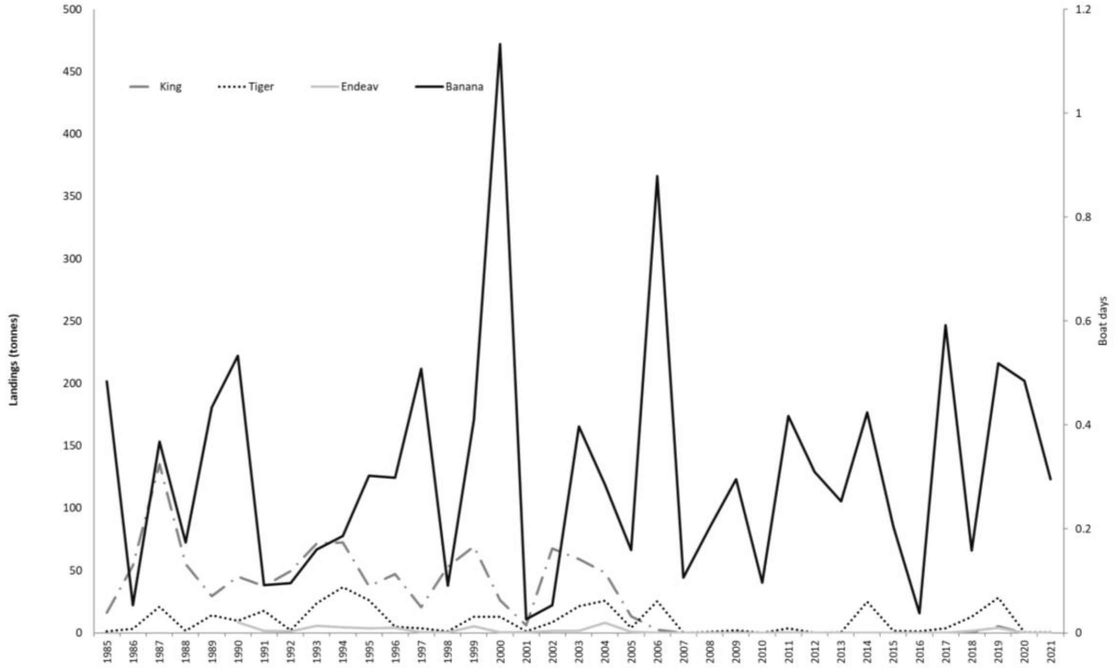
CATCH AND LANDINGS

Kimberley Prawn Managed Fishery (KPMF)

The total prawn landings in 2021 for the KPMF (North Coast Prawn Figure 1) were 203.9 t. The catch was primarily banana prawns (186.8 t), with 12.6 t of brown tiger prawns and 4.4 t of blue endeavour prawns also taken (North Coast Prawn Figure 4). The banana prawn landings were within the target catch range and the catch prediction. There are two fishing periods for the season (April to mid-June, then from August to the end of November) with around 74% of the total landings taken in the first fishing period. Negligible quantities of byproduct were reported.



NORTH COAST PRAWN FIGURE 4.
Annual prawn landings (t) and fishing effort (total adjusted hours) for the Kimberley Prawn Managed Fishery 1980-2021.



NORTH COAST PRAWN FIGURE 5.
Annual prawn landings (t) and fishing effort (total adjusted hours) for the Nickol Bay Prawn Managed Fishery 1985-2021.

Broome Prawn Managed Fishery (BPMF)

Extremely low fishing effort occurred as three boats undertook trial fishing activities to investigate whether catch rates were sufficient for commercial fishing. 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 2021 season in the NBPMF (North Coast Prawn Figure 3) were 123.4 t (North Coast Prawn Figure 5) with 99% being banana prawns, which were within the catch tolerance and predicted range (115–170 t). Minor landings of other prawn species were recorded. Fishing effort was 340 boat days compared to 261 in 2020.

Onslow Prawn Managed Fishery (OPMF)

The total landings in 2021 were less than the target catch (60 t) with 37 days of fishing taking place by one boat. Due to data confidentiality a spatial fishing map is not shown for 2021.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Kimberley 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 (DPIRD 2022a), it is considered that the stock is being fished at a sustainable level with the breeding stock considered **sustainable-adequate**.

Key evidence to support this is: (1) the lack of a marked declining trend in overall landings across the entire time series despite very marked reductions in effort in recent years (with catches typically fluctuating within the lower half of the catch target range); (2) although there has been some decline in catches in recent years, the level of reduction is consistent with that which would be expected given the level of effort reduction, according to the outputs of stock production models; (3) no decline in peak catch rates in recent years in the two main fishing grounds; (4) declining trends in fishing mortality due to low fishing levels, as estimated by a biomass dynamics model; and (5) high levels of spawning biomass relative to the estimated unfished level, in recent years, as determined from the biomass dynamics model.

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 very low level of fishing effort. Higher average water temperatures appear to be having a negative effect on western king prawn catches in the north coast prawn fisheries. There was only trial fishing at neglibigle levels and therefore, 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 (DPIRD 2022b), it is considered that the stock is being fished at a sustainable level with the breeding stock considered **sustainable-adequate**.

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

One boat fished in the OPMF in 2021 whilst the other operators chose to fish elsewhere where catches were likely to be more profitable. So overall this fishery recorded relatively low effort and catch. Therefore, the breeding stocks of banana, brown tiger and western king prawns were protected and are considered **sustainable-adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch

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.

Protected species

While protected species including dugongs, turtles, sawfish and sea snakes occur in the general area, only sea snakes and sawfish and occasionally turtles are encountered in the trawl catches. Most 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 2021 are as follows:

Kimberley: 57 sea snakes were recorded as being caught, with nine returned dead. Twenty sawfish were caught with six returned alive, eight returned dead and six with status unknown whilst one turtle was caught and returned alive.

Broome: No interations were reported. The fishery operates in relatively deep water, has a restricted trawl area and often has little to no trawl effort, which results in minimal interaction with protected species.

Nickol Bay/Onslow: Five sea snakes were caught with all reported as returned alive.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

The trawl gear has relatively little physical interaction with complex benthic environments. Given the predominantly mud and sand habitats of the trawl grounds, the nature of these fisheries and controls on effort, environmental impacts from operations is likely to be low. The total percetage of area fished in the approved boundary extent of the four northern prawn fisheries was 3 % in the KPMF, 1 % in the NBPMF and < 1% in the BPMF and OPMF. **Low** risk.

Ecosystem

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 and rainfall events. **Low** risk.

SOCIAL AND ECONOMIC OUTCOMES

Social

The estimated employment in 2021 was 50 - 65 people, including skippers and other crew, for all north coast prawn fisheries combined for the operational period.

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 GVP for the north coast prawn fisheries was 5.2 million.

GOVERNANCE SYSTEM

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 season, distributed in two parts. For the NBPMF, a conservative banana prawn resource harvest strategy allowing adequate spawning biomass to survive the key spawning period each year by opening key fishing grounds in May provides protection from recruitment overfishing. For the BPMF, trial fishing is undertaken to assess the stock level of western king prawns prior to commercial fishing commencing, thus retaining high levels of spawning biomass. Bycatch reduction devices, including grids and FEDs are mandatory under the EPBC Act.

Annual Catch Tolerance Levels

KPMF: 240 - 450 t (**Acceptable**). Banana prawns were within the catch tolerance range, whilst all other prawn species landings were below their allowable ranges.

BPMF: 55 -260 t (**Acceptable**). Minimal fishing occurred in 2021.

NBPMF: 90 - 300 t (**Acceptable**). Banana prawns were within the allowable and predicted range, all other prawn species were below.

OPMF: 60-180 t (**Acceptable**). Effort and catches were low in 2021.

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

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 for each season.

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

Management Initiatives/Outlook

A formal MSC Fisheries Improvement Projects is being developed by industry for the the KPMF. This will help guide future management direction for the fishrey.

A series of marine parks in the Kimberly are being implemented by the Department of Biodiversity Concervation and Attractions. These may limit the available fishing area in the KPMF.

The Department and industry were considering a management review of the KPMF and NBPMF. The review proposes to unitise effort days and introduce an individual transferable effort system. This would provide industry opportunity to consolidate entitlement, addressing latent effort and allow for improvements in the fishery's seasonal management arrangements. This review process has been put on hold for the time being.

Some members of industry commenced trialling different gear configurations for the Department to assess potential efficiency gains associated with their use.

EXTERNAL DRIVERS

A positive relationship has been observed with summer rainfall and banana prawn landings, particularly in the NBPMF.

High water temperatures have had a negative effect on western king prawn catches in recent years (Caputi *et al*. 2015a, 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.* 2015a, 2015b).

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NORTH COAST NEARSHORE AND ESTUARINE RESOURCE STATUS REPORT 2022

F. Trinnie, C. Skepper, S. Newman and S.Blazeski

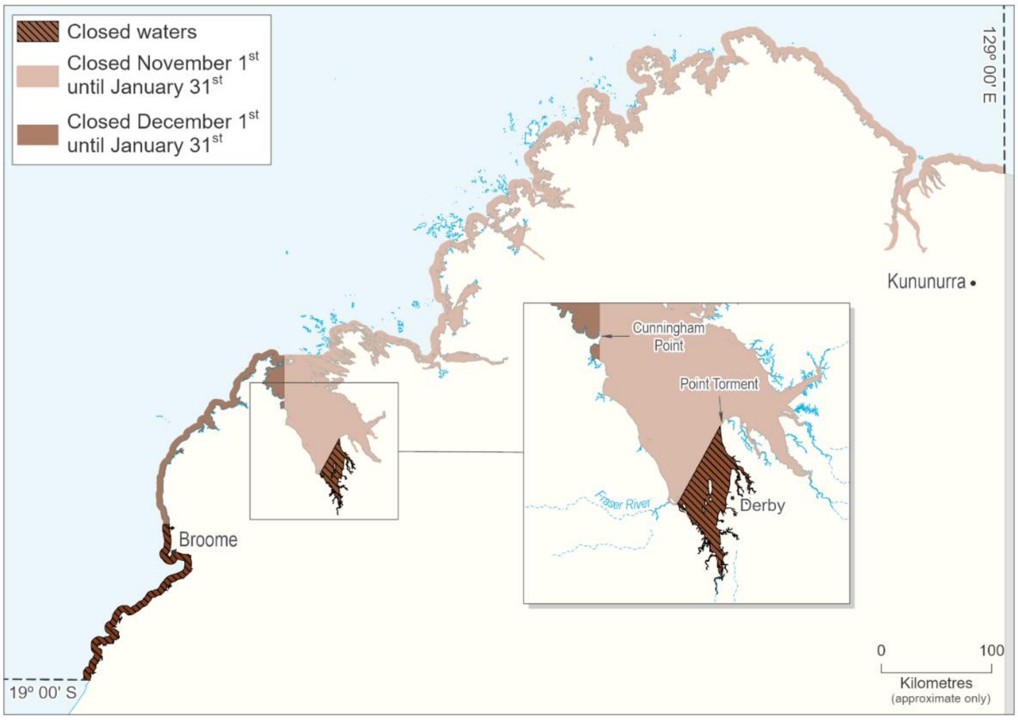
OVERVIEW

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; North Coast Nearshore and Estuarine Figure 1). 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. Commercial fishing is now prohibited between the southern boundary of the fishery (19º00′ S) to north of Willie Creek (17º44′ S) and in King Sound South (North Coast Nearshore and Estuarine Figure 1). 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, southern King Sound, encompassing Derby and the Fitzroy River, and all its creeks and tributaries south of 17º27′ S, and the lower Ord River upstream of Adolphus Island.

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (Barramundi 33-44 t)	Total Catch 2021: 100 t	Acceptable
Recreational fishery	Total Catch 2020/21: 12–23 t (boat-based only)	Acceptable
EBFM		
Indicator species		
KGBF	Medium Risk	
Barramundi	Above upper limit of reference range, catch rates remain high, effort is low	Adequate
King threadfin	Catches well below the average of 74.5 t for the 10-year period from 2004–2013	Adequate
Ecological		
Bycatch	Negligible Risk	Adequate
Listed Species	Low Risk	Adequate
Habitat	Negligible Risk	Adequate
Ecosystem	Negligible Risk	Adequate
Economic (GVP $ (<$1 m)	Low Risk	Acceptable
Social (low amenity)	Low Risk	Acceptable
Governance	Moderate Risk	Acceptable
External Drivers	Low Risk	Acceptable



NORTH COAST NEARSHORE AND ESTUARINE
Location and extent of the KGBF within the Kimberley region of Western Australia. Note: this map is indicative only.

CATCH AND LANDINGS

The total reported catch of all species in the KGBF in 2021 was 100 tonnes (t) (North Coast Nearshore and Estuarine Table 1). The total landings of barramundi in 2021 were 67.2 t (North Coast Nearshore and Estuarine Table 1, Figure 2), the highest recorded catch since 1990. The 2021 landings of threadfin from the KGBF were 25.4 t (North Coast Nearshore and Estuarine Table 1, Figure 2).

The top 10 nearshore and estuarine species (or species groupings) in the North Coast represented 80% of the boat-based recreational catch (kept by numbers) in 2020/21. The boat-based recreational harvest ranges for the top 10 nearshore and estuarine species in the North Coast were steady at 18 t (95% CI 12-23 t) in 2020/21 compared with 15 t (95% CI 9-20) in 2017/18, 21 t (95% CI 12-30) in 2015/16, 19 t (95% CI 12-26) in 2013/14 and 21 t (95% CI 11-32) in 2011/12 (Ryan *et al*. 2022). No recent estimates of shore-based recreational catches are available.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Barramundi (Sustainable-Adequate)

The barramundi catch in 2021 was 67.2 t, which is above the upper target and limit range. The catch rate remained high at 152.7 kg/block day (167.5 kg/block day in 2020, and 138.6 kg/block day in 2019; North Coast Nearshore and Estuarine Figure 3).

The above evidence indicates the biomass of these stocks is unlikely to be depleted and recruitment is unlikely to be impaired and that current levels of fishing mortality (catch) are unlikely to cause the stock to become recruitment impaired. Thus the breeding stock is classified as **sustainable-adequate**.

King threadfin (Sustainable-Adequate)

Threadfin catches are dominated by king threadfin. The catch of king threadfin in 2021 was 23.4 t, a substantial increase from the 6.9 t reported in 2020 and up from the 17.4 t reported in 2019, but 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 demonstrated in the fishery, following the removal of two fishing licenses from the Broome coast area, with the area closed to commercial fishing in late-2013. 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 these stocks is unlikely to be depleted and recruitment is unlikely to be impaired and that current levels of fishing mortality (catch) are unlikely to cause the stock to become recruitment impaired.

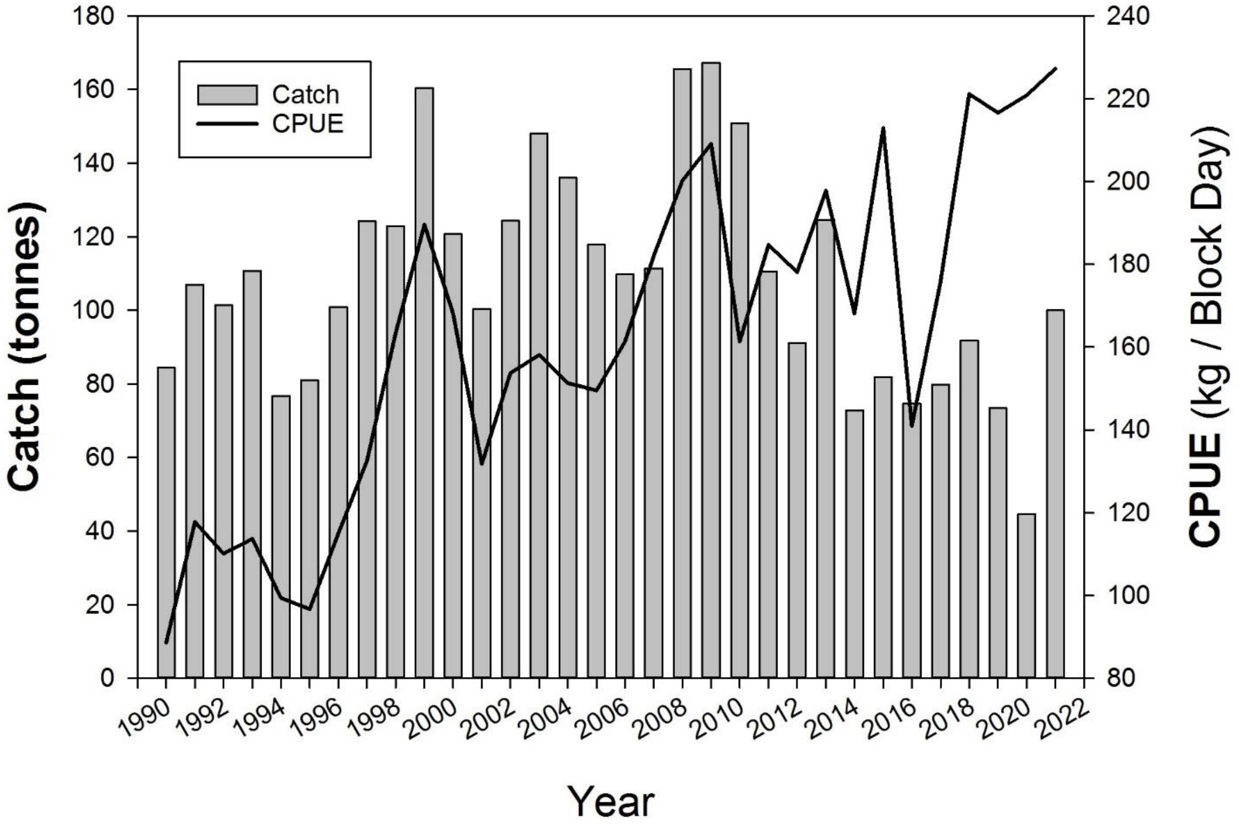
On the basis of the evidence provided above, the breeding stock of King Threadfin is classified as **sustainable-adequate**.

NORTH COAST NEARSHORE AND ESTUARINE TABLE 1

Summary of the reported catch (t) in the Kimberley Gillnet Barramundi Fishery in 2021 and the percentage composition of each of the major species retained.

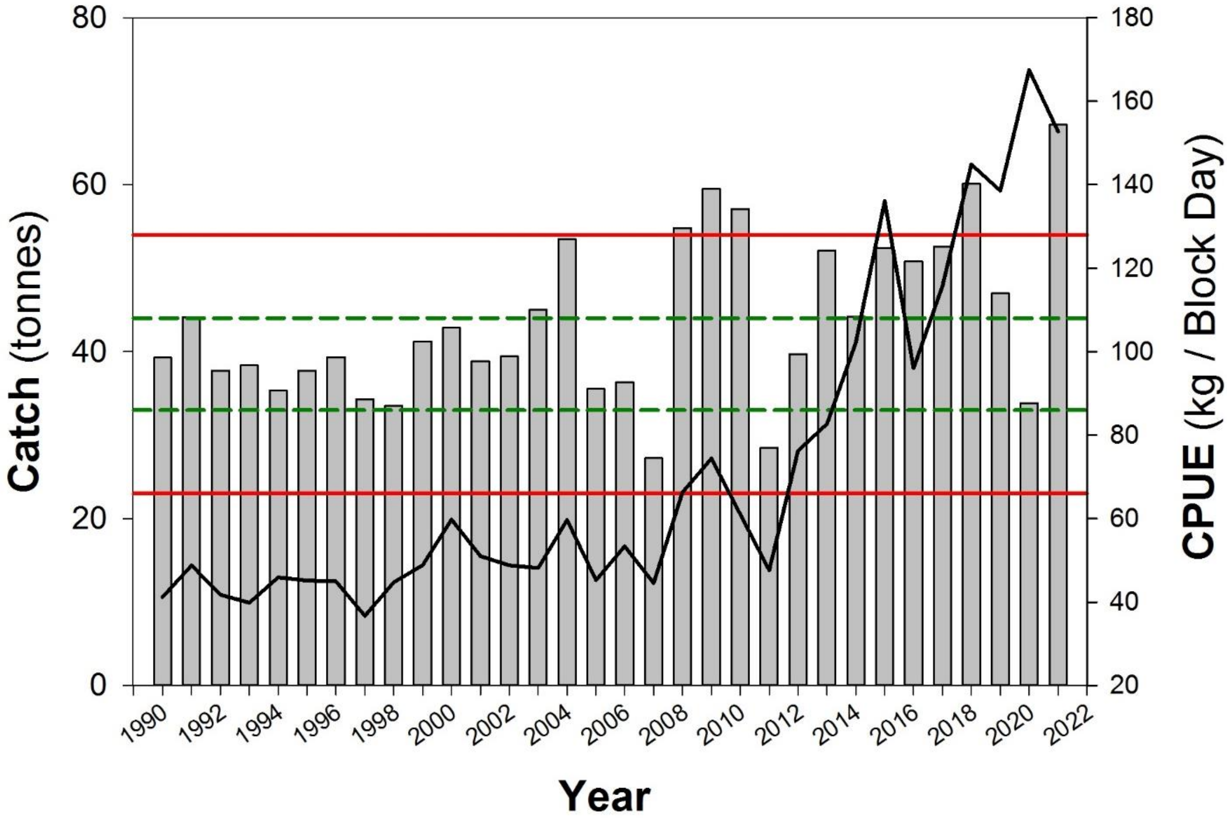
Species	Catch (tonnes)	Composition %
Threadfin	25.4	25.4
Barramundi	67.2	67.2
Tripletail	0.4	0.4
Black jewfish	4.5	4.5
Sharks*	0.2	0.2
Other fish*	2.3	2.3
Total	100.0	100.0

*Other fish includes general catfish, Giant queenfish, sea mullet and unspecified species. Shark species are not typically identified.



NORTH COAST NEARSHORE AND ESTUARINE FIGURE 2

The annual total catch and catch per unit effort (CPUE, kg block day^{-1}), from all areas of the KGBF including sharks and rays over the period 1990 to 2021.



NORTH COAST NEARSHORE AND ESTUARINE FIGURE 3
The annual catch and catch per unit effort (CPUE, kg block day^{-1}) for barramundi from the KGBF over the period 1990 to 2021. The lower and upper target commercial catch range bounds for barramundi are shown by the green lines at 33 and 44 tonnes and lower and upper limit bounds by the red lines at 23 and 54 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 2021, 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. **Low** 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 2021 season (February to November), four vessels fished in the KGBF with an average crew level of approximately 2 people, with an estimate of at least eight 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 2021 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.

Recreational fishers make a significant contribution to Western Australia's economy, and support economic activity in many regional towns on the coast and near inland fishing spots. These resources contribute in part to the $2.4 billion attributed to the value of recreational fishing to the State's economy each year.

GOVERNANCE SYSTEM

Harvest Strategy

The harvest strategy for barramundi in the KGBF is based on a *constant exploitation approach* where the annual commercial catches of barramundi may vary within the target catch range. The target catch range is based on an historical catch range during which the fishery was stable and levels of exploitation were considered to be sustainable.

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.

Prohibitions to commercial fishing in nearshore areas within the North Coast Bioregion such as the Pilbara Coast, Eighty Mile Beach, the Broome Coast, and the southern area of King Sound provide a significant reduction in commercial fishing effort and large areas of protection for the targeted species. Moreover, catches and catch rates are increasing overall in the remaining KGBF fishing areas. In addition, a barramundi stocking program is ongoing in the Kununurra region, which may contribute in some degree to the available fishable stock. All these factors indicate that there is a need to further review the harvest strategy and commercial catch ranges.

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

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

Management Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department. Consultation processes for the recreational fishing sector are 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 State marine parks are currently being developed for the Kimberley region. The establishment of these new marine parks may impact on the future economic viability of the KGBF. This represents a **moderate** risk, with the Department continuing to monitor the development of marine parks.

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).

The introduction of new marine parks 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.

In addition, inter-sectoral conflict between recreational and commercial fishing sectors in the Derby area surrounding access to the barramundi resource have resulted in the introduction of a commercial closure in the south of King Sound between Point Torment and Fraser River. This reallocation of the resource to the recreational fishing sector is reflective of the social value placed on barramundi, and is not due to any stock sustainability concerns.

Low risk.

NORTH COAST DEMERSAL RESOURCE STATUS REPORT 2022

C. Wakefield, F. Trinnie, C. Skepper, D. Boddington, S. Newman and A. Steele

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 (i.e. > 100 tonnes, in order of gross tonnage) are; goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*), saddletail snapper (*Lutjanus malabaricus*), rankin cod (*Epinephelus multinotatus*), crimson snapper (*Lutjanus erythropterus*), rosy threadfin bream (*Nemipterus furcosus*), and brownstripe snapper (*Lutjanus vitta*)..

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 (North Coast Demersal Figure 1). These fisheries are managed in accordance with the *North Coast Demersal Scalefish Resource Harvest Strategy 2017-2021* (NCDSR Harvest Strategy; DPIRD 2017).

The permitted methods in the NDSMF (Area 2 – offshore area) include handline, dropline and fish traps, but since 2002 it has essentially been a trap based fishery which uses gear time access and spatial zones as the primary management measures. The main species landed by this fishery 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.

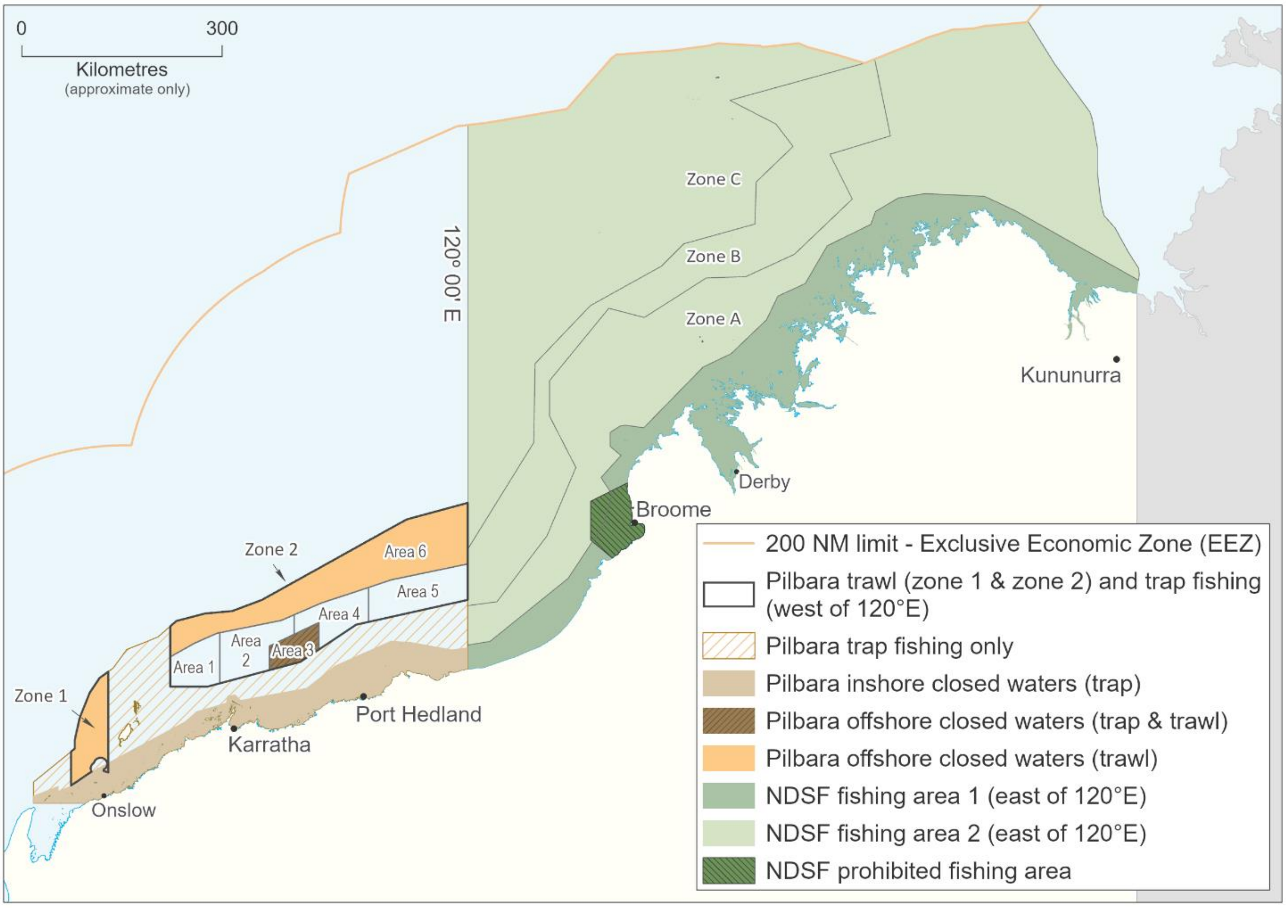
The PDSF includes the Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF), the Pilbara Trap Managed Fishery and the Pilbara Line Fishery. The PDSF collectively use a combination of limited entry, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures. The main species landed by the fisheries in the Pilbara subregion are bluespotted emperor, red emperor and rankin cod.

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 licences) and output controls (e.g. bag and/or boat limits, size limits). The recreational and charter sectors do not catch significant quantities of most demersal scalefish species targeted by the commercial fisheries.

Further details can be found in the RAR at https://www.fish.wa.gov.au/Documents/resource_assessment/resource_assessment_report_013.pdf

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery: NDSF PDSF	Total Catch 2021: 1,544 t Total Catch 2021: 2,714 t	Acceptable Acceptable
Recreational fishery	Total Catch 2020/21: 41–63 t (boat-based only)	Acceptable
EBFM		
Indicator species		
NDSMF Goldband snapper Red emperor	Medium Risk Biomass above threshold (B_{MSY}) Biomass around target (1.33 B_{MSY})	 Acceptable Acceptable
PDSF Red emperor Rankin cod Bluespotted emperor	Medium Risk Biomass equal to or above target (1.33 B_{MSY}) Biomass above target (1.33 B_{MSY}) Biomass above target (1.33 B_{MSY})	 Acceptable Acceptable Acceptable
Ecological		
Bycatch NDSMF PDSF	Negligible risk Low risk	Adequate
Listed Species NDSMF PDSF	Negligible-Low risk Low-Moderate risk	Adequate Adequate
Habitat NDSMF PDSF	Negligible risk Moderate risk	Adequate Adequate
Ecosystem NDSMF PDSF	Negligible risk Low risk	Adequate Adequate
Economic NDSMF (GVP $10-20 m) PDSF (GVP $10-20 m)	Medium risk Medium risk	Acceptable Acceptable
Social (low amenity) NDSMF PDSF	Low-Medium risk Low-Medium risk	Acceptable Acceptable
Governance NDSMF PDSF	Low risk Low risk	Acceptable Acceptable
External Drivers	Low risk	Acceptable



NORTH COAST DEMERSAL FIGURE 1.
Demersal scalefish fisheries of the North Coast Bioregion of Western Australia. In the Pilbara subregion: Areas 1 to 6 refer to the management regions in Zone 2 of the trawl fishery. Zone 1 has been closed to trawling since 1998. In the Kimberley subregion: Zones A, B and C lie in Area 2 of the NDSF.

CATCH AND LANDINGS

Kimberley

Since 2008, NDSMF annual catches have exceeded 1,000 t. The 2021 catch of 1,544 t is the largest reported catch across the whole fishery, following the previous highest of 1,507 t landed in 2019. The majority of the catch is landed from Zone B, with a catch of 1,406 t in 2021. The level of catch in Zone B is also the highest (previously 1,313 t in 2019) reported since zoning was implemented in 2006. The 2021 reported catch of the jobfish group (*Pristipomoides spp.*) was 627 t. Goldband snapper constitute ~91% of the jobfish catch. A breakdown of the landed weight by the major species in the NDSMF is reported in North Coast Demersal Table 1. The 2021 catch exceeded the acceptable catch range for total catch (i.e., 903-1,332 t), but this is acceptable as the median relative spawning biomass of both the indicator species (red emperor, goldband snapper) were assessed to be around the threshold level in 2018. A harvest strategy review is underway and acceptable catch ranges in the NDSF will be reviewed in line with the species catch ranges calculated in the Pilbara. A new assessment of the stock status of the indicator species is in progress.

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. Of the total commercial catches of demersal scalefish in the Pilbara in 2021 (2,714 t), 71% (1,928 t) were landed by the trawl sector, with 24% (662 t) taken by the trap sector and 5% (124 t) taken by the line sector. A breakdown of the landed weight by the major species in the PDSF is reported in North Coast Demersal Table 1.

A recent assessment (i.e., 2021) of the status of the indicator species with the highest risk in the Pilbara, red emperor (*Lutjanus sebae*), estimated the acceptable annual catch range was 136-244 t. In 2021, the combined commercial catch of red emperor was within the acceptable catch range (192 t).

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 2021, despite having the same annual effort allocations as those imposed since 2008, exceeded the acceptable catch range for total catch (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 509 t and 115 t per year, respectively. The total catch of the trap fishery exceeded the acceptable catch range in 2021 (i.e. 241-537 t), but was within the acceptable catch range for the line fishery (36-127 t).

The top 15 demersal species in the North Coast represented 86% of the boat-based recreational catch (kept by numbers) in 2020/21. The recreational harvest range for the top 15 demersal species (or groupings) in the North Coast was steady at 52 t (95% CI 41–63 t) in 2020/21 compared with 70 t (95% CI 54–86) in 2017/18, 50 t (95% CI 39–61) in 2013/14 and 76 t (95% CI 64–89) in 2011/12, but higher than 37 t (95% CI 29–45) in 2015/16 (Ryan *et al*. 2022).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Kimberley (Sustainable-Adequate)

Due to the resource comprising a large number of species, indicator species have been selected from the suite of demersal scalefish (based on their inherent vulnerability, management importance and overall risk to sustainability) for assessing the status of the overall resource. The demersal indicator species for the Kimberley region are red emperor (*Lutjanus sebae*) and goldband snapper (*Pristipomoides multidens*). The annual commercial catches of indicator species from the NDSMF are depicted in North Coast Demersal Figure 2.

A 2018 assessment of the two indicator species in the Kimberley estimated the median relative spawning biomass of both the red emperor stock and the goldband snapper stock to be **around** threshold level (which corresponds to B_{MSY}).

Representative age structure samples of each indicator species in the Kimberley region were collected in late 2021, and will be processed and used to update the stock assessments. The life history parameters for these species are also currently being reviewed and updated to better inform the assessment model.

The above evidence indicates that the current biomass of these stocks is unlikely to be depleted, recruitment is unlikely to be impaired, and current levels of fishing mortality (catch) are unlikely to cause the stock to become recruitment impaired.

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 annual commercial catches of these indicator species from the PDSF are depicted in North Coast Demersal Figure 2. 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 the indicator species is assessed periodically (~ every 5 years) using a weight-of-evidence approach that considers all available information as described above.

A 2021 assessment of the three indicator species in the Pilbara estimated the spawning biomass of red emperor stock to be currently equal to or **above** the target level (which corresponds to $1.33*B_{MSY}$). The stocks of rankin cod, bluespotted emperor and ruby snapper are **well above** the target spawning biomass levels.

Representative age structure samples of rankin cod collected in 2015 and 2019 will be processed and used to update the stock assessments in 2022/23. The life history parameters for these species are also currently being reviewed and updated to better inform the assessment model.

The above evidence indicates that the biomass of these stocks is unlikely to be depleted, recruitment is unlikely to be impaired, and current levels of fishing mortality (catch) are unlikely to cause the stock to become recruitment impaired.

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 2021.

Species	Pilbara (PDSF) catch		Kimberley (NDSMF) catch		Total catch
	tonnes	% total	tonnes	% total	tonnes
Goldband snapper (all *Pristipomoides* sp.)	204.6	25	627.3	75	831.9
Red emperor	193.1	54	167.2	46	360.3
Bluespotted emperor	286.5	87	44.2	13	330.7
Saddletail snapper	113.9	35	207.9	65	321.8
Rankin cod	171.1	64	95.4	36	266.5
Crimson snapper	212.3	80	51.5	20	263.8
Rosy threadfin bream	214.5	100	0.1	<0.1	214.6
Brownstripe snapper	156.5	90	17.4	10	173.9
Frypan snapper	94.0	100	<0.1	<0.1	94.0
Spangled emperor	45.9	61	29.3	39	75.2
Moses snapper	49.9	83	10.4	17	60.3
Longnose emperor	13.0	34	25.4	66	38.4
Barcheek coral trout	11.0	69	5.0	31	16.0
Ruby snapper	7.4	100	<0.1	<0.1	7.4
Other demersal scalefish	940.5	78	262.9	22	1,203.4
Total all demersal scalefish	2,714	64	1,544	36	4,258

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Kimberley Trap / Pilbara Trap

Bycatch

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.

Protected 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 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. In 2021, interactions with three potato cod were reported in the NDSF, and all were released alive.

The Kimberley and Pilbara trap fisheries regularly capture sea snakes. In 2021, the NDSF reported interactions with 30 sea snakes and the Pilbara trap fishery reported 253 sea snake interactions. All sea snakes were returned to the water alive.

Overall, the level of interactions with listed species is considered a **negligible** risk to their populations.

Pilbara Fish Trawl

Bycatch

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. While a number of species that are caught are not retained during demersal fishing activities (including inedible species and undersized marketable species) may not all survive, this still represents a minor impact to their stocks and therefore a **low** risk.

Protected 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

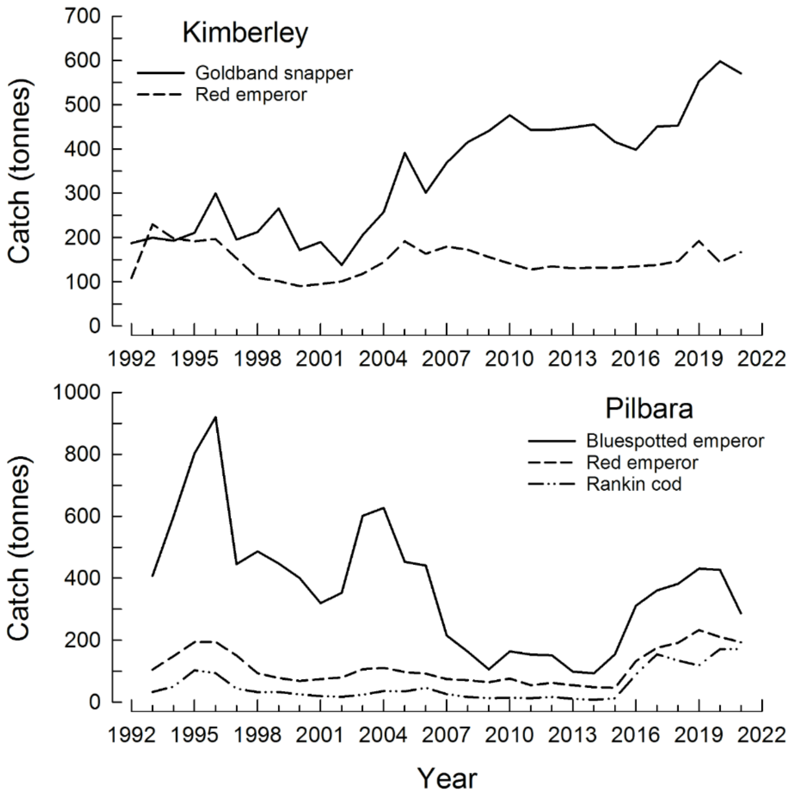
1,000 trawls) despite high levels of attendance and depredation during trawling. Loss of targeted teleosts through the BRD hatch is also rare (1.3% of fish during day trawls). Based on high levels of subsurface observer coverage in 2012 (60% of day trawls or 56% of day trawl hours), the subsurface expulsion of megafauna in poor condition was negligible (see Wakefield *et al*. 2014; Wakefield *et al*. 2016). Therefore, electronic monitoring of catches accurately reflects records of megafauna bycatch levels. The level of interactions with listed species is therefore considered **low-moderate** risk to their populations. The reported bycatch of listed species in the PFTIMF in 2021 is listed in North Coast Demersal Table 2.

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 the end of 2021. The accreditation included specific conditions around the observing, reporting and mitigation of endangered, threatened and protected species interactions.

NORTH COAST DEMERSAL TABLE 2.

Reported bycatch of listed species by skippers in the PFTIMF in 2021. [a]where the condition was not reported the status of the animal was considered to be unknown; [b]where the species of sawfish was not reported the animal was considered to be unknown sawfish.

Species	Number released Alive	Number deceased	Number unknown[a]	Total Reported
Bottlenose dolphins	2	15	0	17
Pipefish	8	33	0	41
Green sawfish	30	25	0	55
Narrow sawfish	6	0	0	6
Unknown sawfish[b]	2	2	0	4
Seahorses	7	2	0	9
Sea snakes	98	33	0	131
Turtles	0	0	0	0



NORTH COAST DEMERSAL FIGURE 2.

Annual commercial catches of indicator species from the Kimberley and Pilbara demersal scalefish fisheries from 1993 to 2021.

HABITAT AND ECOSYSTEM INTERACTIONS

Kimberley Trap / Pilbara Trap and Line

Habitat

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 these fisheries operate. Trap fishing is the main fishing method used in the NDSMF for demersal species, which has little physical impact on the benthic environment and hence **negligible** risk to benthic habitats.

Ecosystem

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. 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.

Pilbara Fish Trawl

Habitat

The PFTIMF is restricted to less than ~2% of the North West Shelf (NWS; Amoroso et al. 2018). 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 trawling 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.

Ecosystem

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 PFTIMF, 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 2021 fishing season, and at least 23 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. There is currently a **medium level of** risk to these values.

Pilbara: It is estimated that ~10 fishers on 2 vessels were directly employed during 2021 in the trawl sector, and 6 fishers on 2 vessels in the trap sector, and at least ~15 fishers on 7 vessels in the line sector. Overall, at least ~31 people (e.g. 2-4 crew per vessel) were directly employed in the PDSF. There is currently a **medium level of** risk to these values.

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 boat-based recreational fishing effort in the North Coast Bioregion was steady in 2020/21 (36,089 boat days,SE=4,085) compared with 2017/18 (32,279 boat days, SE=3,807), 2015/16 (29,889 boat days, SE=3,465), but lower than 2013/14 (41,629, SE=4,834) and 2011/12 (45986, SE=5,671) (Ryan *et al*. 2022).

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 $10-20 million (Level 4). The social amenity value is that this is an important asset locally. There is currently a **medium** risk to this level of return.

Pilbara: Overall, the estimated economic value of the PDSF is $10-20 million (Level 4). The fish trawl demersal scalefish catch is dominated by lower-valued species such as bluespotted emperor and threadfin bream. However, its value is estimated to be $5-10 million (Level 3). 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. The demersal scalefish catch from these sectors was estimated to have an economic value of $1-5 million (Level 2) and they also have social amenity value. There is currently a **medium** risk to this level of return.

Recreational fishers make a significant contribution to Western Australia's economy, and support economic activity in many regional towns on the coast and near inland fishing spots. These resources contribute in part to the $2.4 billion attributed to the value of recreational fishing to the State’s economy each year.

GOVERNANCE SYSTEM

Harvest Strategy

The NCDSR Harvest Strategy (DPIRD 2017) 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 (TAE) allocation system via individually transferable effort (ITE) 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.Allowable Catch Tolerance Levels (Acceptable)

Kimberley

For the 2021 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 the conclusion of the fishing year,13.1% of effort remained unitilized in Zone B, while 81.7% of Zone A effort and 100% of Zone C effort were not utilized. At these levels of total effort, the total catch of the fishery is expected to be in the range of 903–1,332 t (DPIRD 2017). The total 2021 catches were above the **acceptable** catch range and this has triggered a review of likely risks to sustainability. In addition, the ITE allocation has remained unchanged, and the fishery has landed more fish. Further, the nominal catch rates have not decreased. A stock status assessment of the two indicator species is in progress (sampling was undertaken in 2021), and this information will be used to improve and inform the individual species and total catch tolerance ranges.

Pilbara

The total catch of the trawl fishery exceeded the acceptable catch range in 2021 despite having the same (reduced) annual effort allocations as those imposed since 2008. This increased catch represents an increase in stock abundance following eleven years of reduced effort in the western trawl managed areas. The total catch in 2021 of the trap fishery also slightly exceeded the **acceptable** catch range, and that of the line fishery was within the acceptable catch range. The combined commercial catch of the indicator species with the highest risk, red emperor, was within the acceptable catch range in 2021.

Compliance

The primary management measures of gear time usage and spatial zone access for NCB 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 Department. Consultation processes for the recreational fishing sector are facilitated by Recfishwest under a Service Level Agreement, although the Department undertakes direct consultation with the community on specific issues.

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

Management Initiatives/Outlook Status

Kimberley

The Northern Demersal Scalefish Fishery Operators Guide to the Management Arrangements 2016 (DoF 2016) was published in July 2016, and is a plain English guide to the management arrangements, designed to assist licence holders.

Pilbara

In 2021/22, the Department will continue to collaborate with permit holders in the Pilbara Fish Trawl Interim Managed Fishery to address the conditions arising from the re-accredition process for Wildlife Trade Operation (WTO) approval.

In 2020, the Department collaborated with the Commonwealth Department of Agriculture, Water and the Environment and Pilbara Trap licence holders to complete an assessment of the Pilbara Trap Fishery under the EPBC for export approval, for which it was accreditated a new WTO.

EXTERNAL DRIVERS

The Commonwealth's North-west Marine Parks Network came into effect on 1 July 2018 and introduced marine reserves, including sanctuary zones which prohibit fishing. This will restrict access to fishing in parts of the NCB 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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PEARL OYSTER MANAGED FISHERY RESOURCE STATUS REPORT 2022

A. Hart, D. Murphy, S. Brown.

OVERVIEW

The Western Australian pearl oyster fishery (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, along with the seeding and grow-out of pearl oysters to produce pearls.

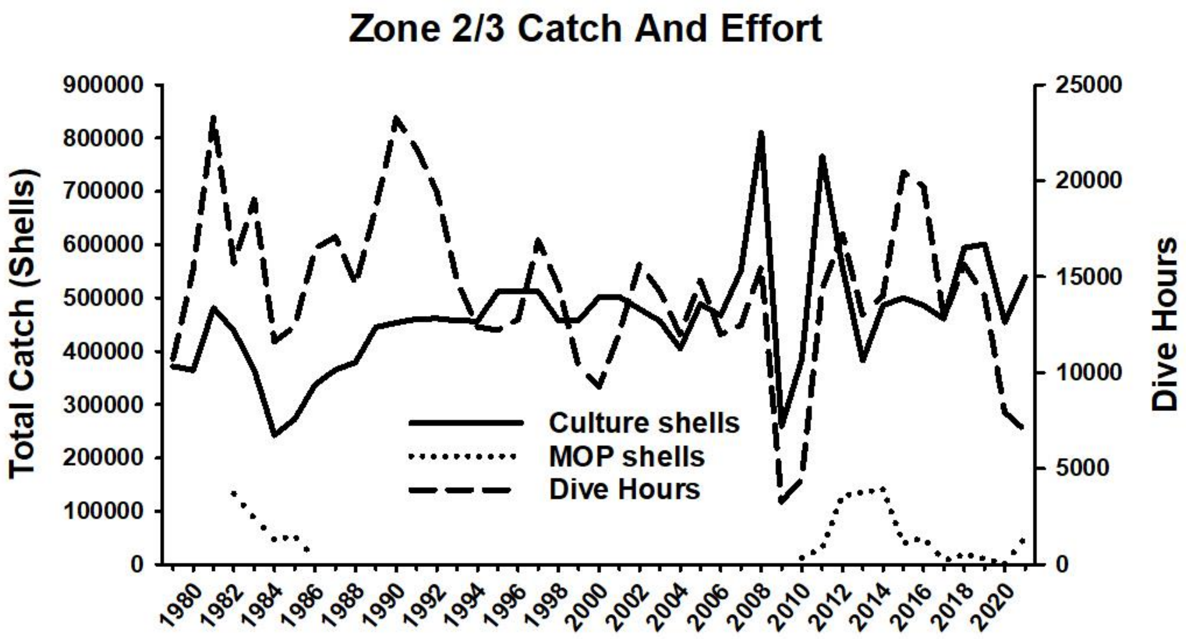
This fishery has been accredited for export under the EPBC Act for a period of ten years (re-assessment in 2025) and was certified under the MSC certification process in 2017. Further information can be sourced from Hart *et al*. (2016).

SUMMARY FEATURES 2022

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery	Total catch 2021: 590,064 shells	Acceptable
Recreational fishery	NA	NA
EBFM		
Assessment Indicator		
Silver lipped pearl oyster (*Pinctada maxima*)	Performance indicator above Target	Adequate
Ecological		
Bycatch	Negligible Risk	Adequate
Listed Species	Negligible Risk	Adequate
Habitat	Negligible Risk	Adequate
Ecosystem	Negligible Risk	Adequate
Economic (Level 4: GVP $64 M)	Moderate Risk	Acceptable
Social	Low Risk	Acceptable
Governance	MSC certification.	Acceptable
External Drivers	Moderate Risk	Acceptable

CATCH AND LANDINGS

In 2021, catch was taken in Zones 2 and 3 only with no fishing in Zone 1. The number of wild-caught pearl oysters was 590,064 comprising of 539,612 culture shells and 50,452 Mother of Pearl (MOP) shells (oysters ≥175 mm) (Pearl Figure 1). Total effort was 8,175 dive hours (Pearl Figure 1), a decrease of 3% from the 2020 effort of 8,389 hours. This value (8,389 hours) is an updated estimate from the 2020 report. No fishing has occurred in Zone 1 from 2017 to 2021 and only 4,594 culture shells were taken in 2016.



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, there is currently a **Low** risk to pearl oysters in Zone 1. 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, there is currently a **Medium** risk to pearl oysters in Zone 2. The medium risk reflects the controlled levels of fishing mortality. Current lines of evidence show an increasing abundance due to above average recruitment, catch rates above the threshold level, and the size-structure of harvested oysters having returned to the long-term average. 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 (medium) levels.

Zone 3 *Pinctada maxima* (Sustainable - Adequate)

Based on the information and analyses available, there is currently a **Low** risk to pearl oysters in Zone 3. 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 (Negligible Risk)

Divers have the ability to specifically target pearl oysters. 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 imposes a **negligible** risk.

There is no interaction between the pearl oyster fishing operation and protected species (Hart *et al*., 2016).

HABITAT and ECOSYSTEM INTERACTIONS (Negligible Risk)

The fishery removes only a small proportion of the biomass of pearl oysters on the fishing grounds and is considered to have negligible impact on the food chain in the fishing area. Pearl divers have minimal contact with the habitat during fishing operations. The main habitat contact is by pearl oysters held in mesh panels on holding sites following capture. However, these sites cover a very small proportion of the habitat and the activity concerned is unlikely to cause any lasting effect.

Similarly, the pearl farming operation, which uses longline systems in areas of high tidal flow to culture pearls, has limited impact on the environment. Physical effects are limited to static anchoring systems in typically sand/mud habitats. Environmental management research has demonstrated that pearl farming has **negligible** impacts on habitat and environment.

Based on the information available, there is currently a **negligible** risk to the ecosystems from pearling operations.

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 the peak of 16 in 1997 (overall), mostly due to increased fleet efficiency and increased reliance on hatchery-produced pearl oysters. The number of vessels fishing in 2021 was three. 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.

Personnel employed in the pearling industry (current full-time FTEs) is estimated to be around 300.

Economic (Moderate 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 2021 was considered to be approximately $63.5 million, which follows a similar trend to the value reported over the past five years.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels (Acceptable)

The overall TAC for the fishery for 2021 was 863,860 pearl oysters. This was comprised of a Zone 1 TAC of 54,970 pearl oysters and a Zone 2/3 TAC of 808,890 pearl oysters. The Zone 2/3 TAC is fished via a voluntary agreement that sets a maximum harvest level of no more than 776,900 pearl oysters between 100 – 175 mm and 31,990 MOP oysters.

Catch tolerance levels used in 2021 are for the Zone 2/3 "culture" fishery only.

TAC (776,900 "culture pearl oysters" in Zone 2/3 in 2019) to be caught in 14,071-20,551 dive hours.

Commercial catch (pearl oysters) for season 2021: 590,064 oysters at 8,175 dive hours.

Both the catch and effort levels were acceptable.

The voluntary maximum harvest level of 31,990 MOP was exceeded, with the MOP catch being 50,452. This occurred because of the very high total abundance of oysters, and predicted future increases to record levels.

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. This is 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.

Companies who produce hatchery-reared pearl oysters must hold the appropriate hatchery licence(s); if they intend on seeding these pearl oysters, they must also hold a pearling (seeding) licence with appropriate hatchery quota.

Seeded pearl oysters, whether from the wild or hatchery-reared, must be held on a pearl oyster farm lease. Applications for a pearl oyster farm lease are reviewed and approval determined by the Department. The total area a company can hold is linked to the pearl oyster quota and/or stock holding held by that company.

Health certification and transport approvals also apply for certain activities within the fishery.

Consultation

The Department undertakes consultation directly with the Pearl Producers Association (PPA) and licensees on operational issues. Formal licence 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

A new State Act of Parliament to ensure the sustainability and management of all WA's aquatic biological resources is currently being considered by Parliament. The *Aquatic Resource Management Act 2019* 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. A new harvest strategy is being prepared that takes into account the changes in piggyback spat settlement and its effect on both the 'culture' shell and 'MOP' shell components of the fishery.

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 at moderate-high risk to climate change effects due to environmental factors affecting the abundance of piggyback spat settlement.

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SEA CUCUMBER RESOURCE STATUS REPORT 2022


A. Hart, D. Murphy and A.Steele

OVERVIEW

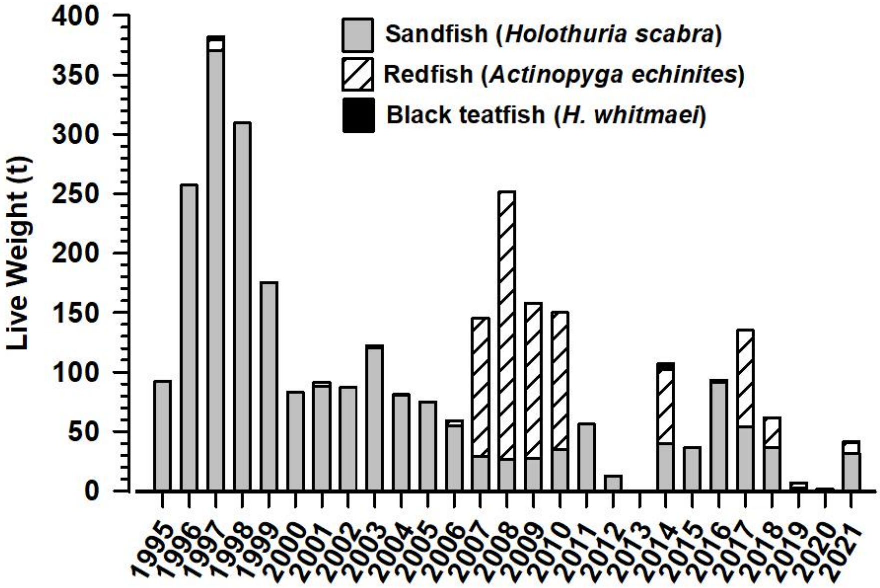
The Western Australian Sea Cucumber Fishery (WASCF) is a commercial only fishery, with animals caught principally by diving, and a smaller amount by wading. It targets two mainspecies: sandfish (*Holothuria scabra)* and redfish (*Actinopyga echinites)*. Fishing occurs mostly in the northern half of the State from Exmouth Gulf to the Northern Territory border, and Shark Bay was fished for the second time in 2021. Access is managed under Ministerial Exemptions. The WASCF is subject to input controls including limited entry, maximum number of divers, spatial closures, and gear restrictions. This fishery has achieved Marine Stewardship Council certification.

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery	Total Catch 2021: 41.1 t	Acceptable
Recreational fishery	Total Catch 2021: NA	
EBFM		
Assessment Indicator		
Sandfish Catch (Kimberley): 0-100 t Sandfish Catch (Pilbara): 0-80 t Redfish Catch (Pilbara and Gascoyne): 0-150 t	31.5 t 0 t 8.8 t	Adequate Adequate Adequate
Ecological		
Bycatch	Negligible Risk	Adequate
Listed Species	Negligible Risk	Adequate
Habitat	Negligible Risk	Adequate
Ecosystem	Negligible Risk	Adequate
Economic (Level 1 GVP <$1 million)	Low Risk	Acceptable
Social (low amenity)	Low Risk	Acceptable
Governance	Stable	Acceptable
External Drivers	Medium Risk	Acceptable

LANDINGS

In 2021, 41.3 tonnes of sea cucumber was harvested (Sea Cucumber Figure 1). This catch comprised 31.5 t of sandfish (*Holothuria scabra*), 8.8 t of deepwater redfish (*Actinopyga echinites*) and 0.8 t of black teatfish (*Holothuria whitmaei*). Sandfish was taken from the Kimberley only, which was last fished in 2017. Both deepwater redfish and black teatfish were taken from Shark Bay, under an exemption licence granted to Aboriginal native title holders, and it is the second time this stock has been fished. The commercial industry have adopted a rotational fishing strategy for the main species (sandfish – *H. scabra*), and redfish (*A. echinites*).



SEA CUCUMBER FIGURE 1:
Annual total retained catches (tonnes) in the Western Australian Sea Cucumber Fishery (WASCF) between 1995 and 2021.

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 LOW. This is an improvement over previous assessments of the fishery, which concluded a medium risk level. 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 (low) levels.

Pilbara Sandfish (Sustainable - Adequate)

Based on the information and analyses available, the current risk level for Pilbara sandfish was estimated to be MEDIUM. 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 acceptable levels.

Pilbara and Gascoyne Redfish (Sustainable - Adequate)

Based on the information and analyses available, the current risk level for Pilbara redfish was estimated to be LOW. 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 levels.

Shark Bay (Gascoyne) was fished for the second consecutive year in 2021. Independent stock surveys were undertaken in 2021, with preliminary results indicating a 50 t biomass of deepwater redfish over 11 sqkm.

Based on the information and analyses available, the current risk level for Shark Bay redfish was estimated to be LOW.

BYCATCH and PROTECTED SPECIES INTERACTIONS

Given the hand collection 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

Habitat

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.

Negligible risk.

Ecosystem

This fishery harvests only a small amount of sea cucumbers 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 effects

Generally, 4 to 6 crew are employed on a vessel, comprising a master, deckhand and 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.

Low risk.

Economic

The estimated annual value for 2021 was ~$230,000, based on a total live weight of 31.5 tonnes of sandfish at $5.50 per kg and 8.8 t of deepwater redfish at $6.00/kg. This is only a beach-price value and the processing sector adds significant value.

Low risk.

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.

Shark Bay sea cucumber populations are better understood due to the results of the 2021 biomass survey (see Hart et al. 2022).

Harvest Strategy

The Western Australian Sea Cucumber fishery is managed under a formal harvest strategy, with specified performance indicators, threshold levels, and control rules. Currently all stocks are above the target reference point.

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)

The WA Sea Cucumber Fishery has been formally assessed against Marine Stewardship Council (MSC) sustainability standards. Sea cucumber stocks in the Kimberley and Pilbara (Units of Certification) have passed the assessment,.

EXTERNAL DRIVERS

The remoteness of the currently fished stock and the large tidal ranges where it occurs are natural barriers to any 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 the 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. Sea cucumber were ranked as a **medium** risk to climate change effects.

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Hart, A.M., Murphy, D.M., Fabris, F.F (2022). Western Australian Sea Cucumber Resource. Resource Assessment Report (2022). Fisheries Research Report No. 324: Department of Primary Industries and Regional Development, Western Australia. 113 pp.

NORTH COAST CRAB RESOURCE STATUS REPORT 2022

D. Johnston, E. Myers, C. Maus and S. Blazeski

OVERVIEW

Blue swimmer crabs are targeted by the Pilbara Crab Managed Fishery (PCMF) using hourglass traps, primarily within inshore waters around Nickol Bay (North Coast Crab Figure 1). Recreational fishers for this species use drop nets or scoop nets, with diving for crabs becoming increasingly popular.

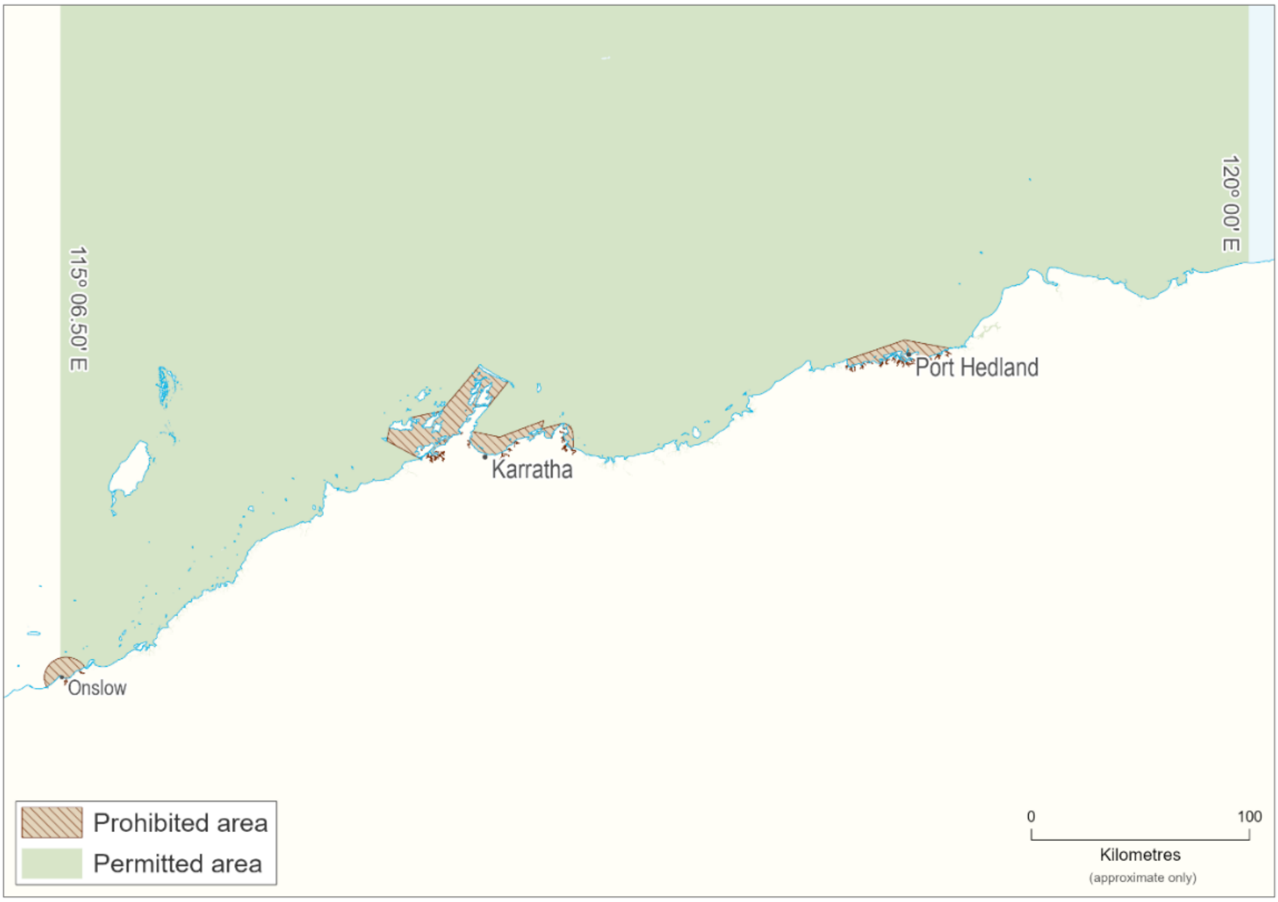
Mud crabs are harvested by the Kimberley Crab Managed Fishery (KCMF) using crab traps between Broome and Cambridge Gulf (North Coast Crab Figure 2). There is an allocation of 1200 units (currently equivalent to 600 traps) to holders of a Managed Fishery Licence under the *Kimberley Crab Managed Fishery Management Plan 2018*. The Minister for Fisheries has also provided an equivalent allocation of 600 traps for commercial purposes to allow for Aboriginal economic development. This is provided through the granting of non-transferable Instruments of Exemption under the *Fish Resources Management Act 1994* to Aboriginal groups. These Exemption holders use crab traps and drop nets in waters adjacent to their native title lands. There is also a small, but socially important, recreational fishery for mud crabs in the North Coast Bioregion where fishers use drop nets, wire hooks or scoop nets.

Management arrangements for commercial and recreational crab fisheries in the North Coast include minimum size limits and protection of breeding females, along with effort controls and spatial and temporal closures for the commercial fishery.

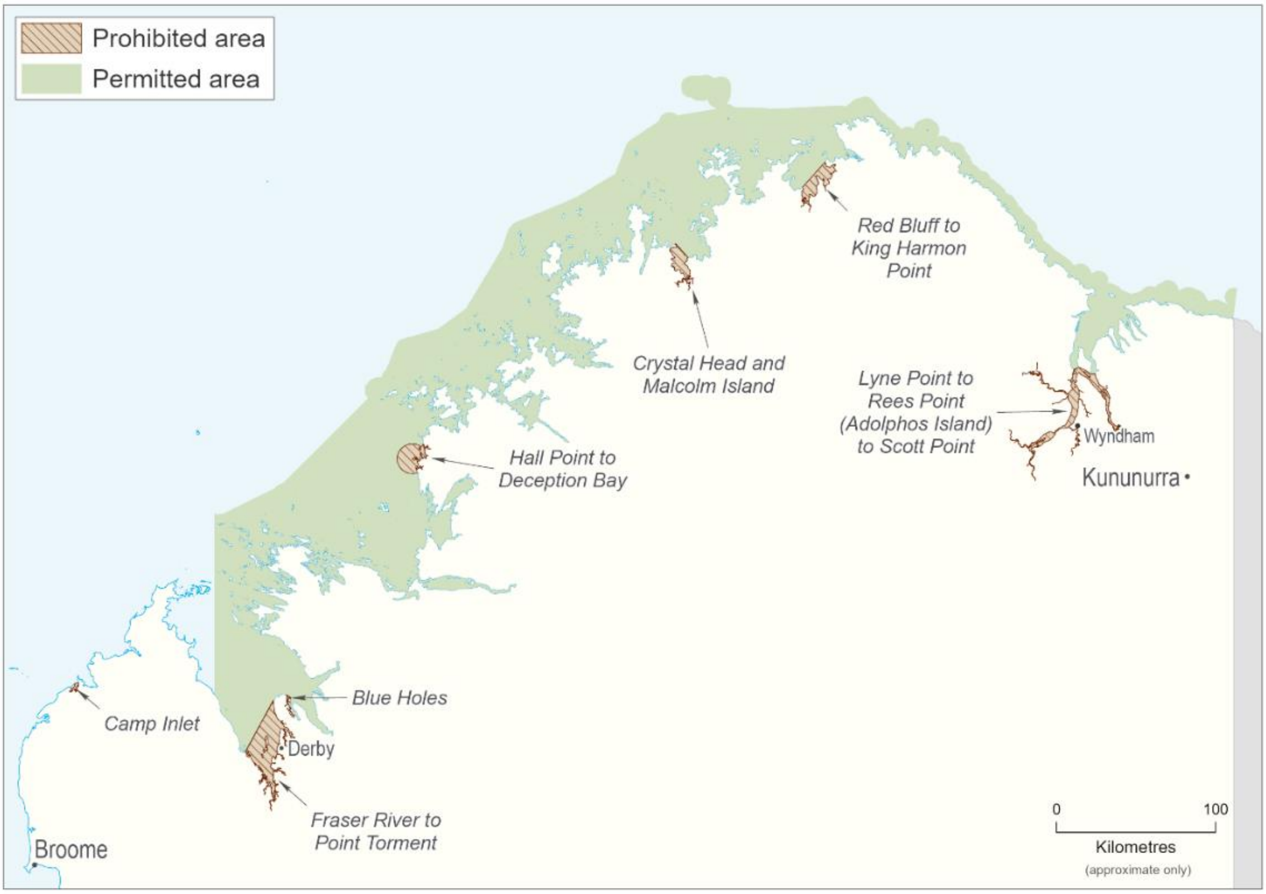
Further information regarding blue swimmer crab and mud crab biology and the North Coast crab fisheries can be sourced from Johnston et al. (2020; http://www.fish.wa.gov.au/Documents/research_reports/frr306.pdf).

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery	Total Catch 2021 Blue swimmer crab: 8.9 t Mud crab: 0.8 t	Acceptable Acceptable
Recreational fishery	Total Catch 2020/21 (boat-based only) Blue swimmer crab: 0.1–1.5 t Mud crab: 1.0–4.9 t	Acceptable Acceptable
EBFM		
Indicator species		
Pilbara Blue Swimmer Crab	Catch rate: Below threshold	Adequate
Kimberley Mud Crab	Catch rate: Above threshold	Adequate
Ecological		
Bycatch	Negligible Risk	Adequate
Listed Species	Negligible Risk	Adequate
Habitat	Low Risk	Adequate
Ecosystem	Low Risk	Adequate
Economic (GVP <$1 m)	Low Risk	Acceptable
Social (high amenity)	Low Risk	Acceptable
Governance	Low Risk	Acceptable
External Drivers	High Risk	Acceptable



NORTH COAST CRAB FIGURE 1.
Map showing the boundaries of the Pilbara Managed Crab Fishery.



NORTH COAST CRAB FIGURE 2.
Map showing the boundaries of the Kimberley Crab Managed Fishery.

CATCH AND LANDINGS

Commercial Sector

The total commercial catch of blue swimmer crabs and mud crabs in the North Coast Bioregion for 2021 was 9.7 t, a substantial increase from the 2.1 t caught in 2020 which was the lowest landed catch in 20 years.

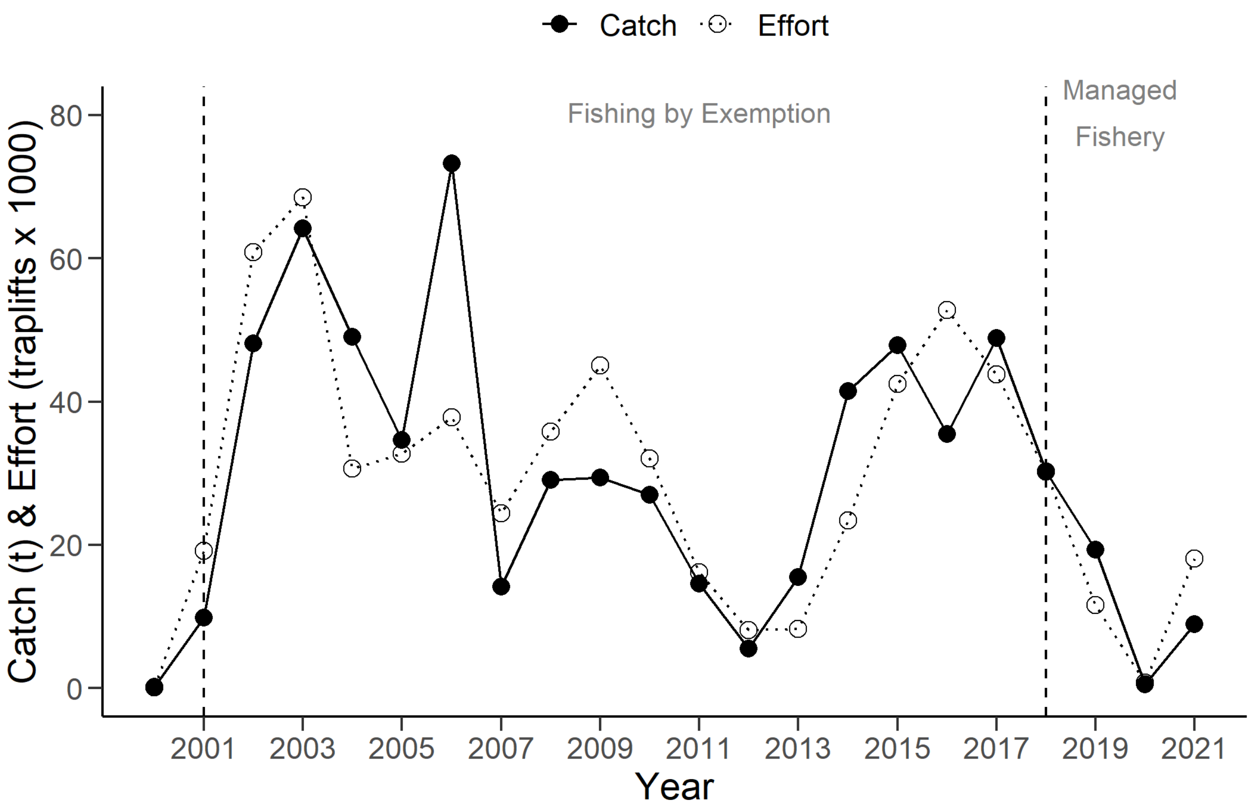
The 2021 North Coast blue swimmer crab catch of 8.9 t accounted for 1.4% of the State commercial catch of 642.5 t, with all catch taken from the PCMF (North Coast Crab Figure 3).

The KCMF catch of 0.8 t (North Coast Crab Figure 4) represented the entire commercial mud crab catch reported in WA in 2021. All catch was recorded as brown mud crab.

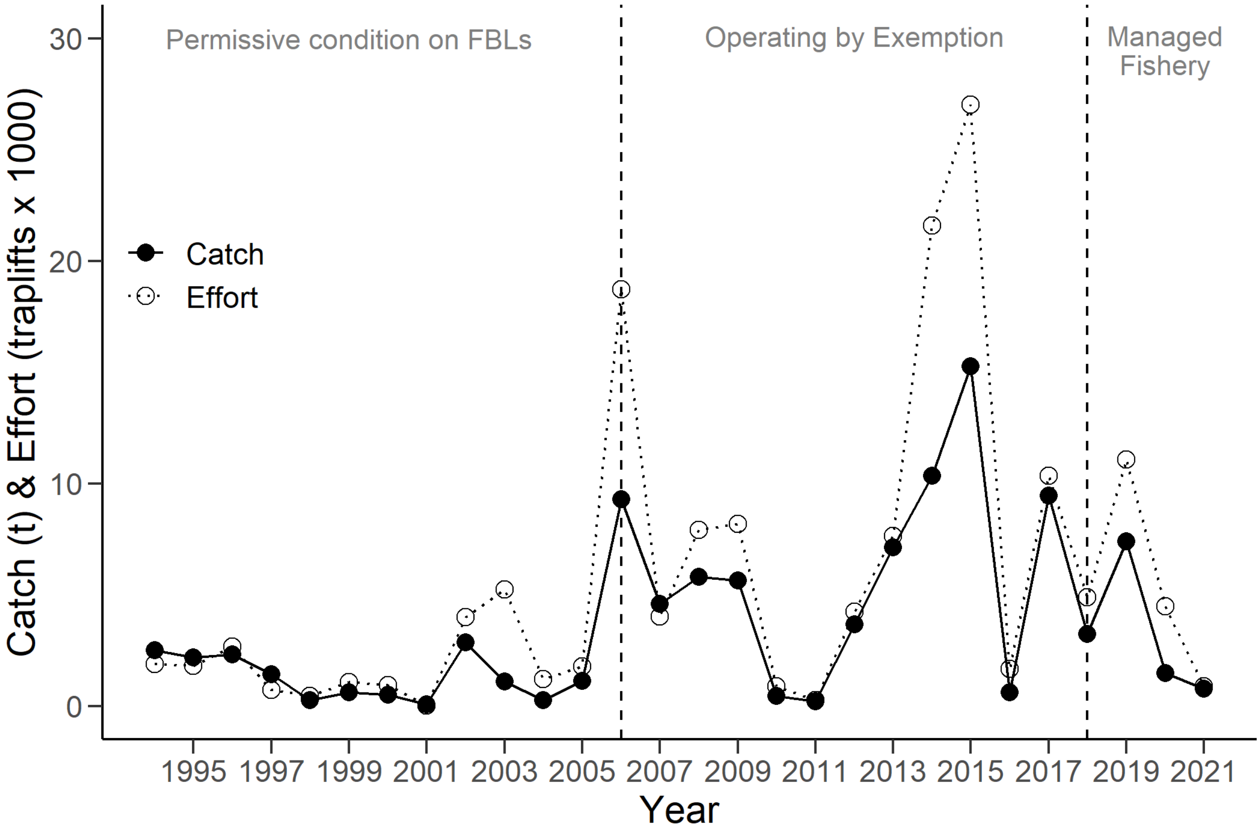
Recreational Sector

The boat-based recreational catch of blue swimmer crab in the North Coast represented approximately 2% of the statewide boat-based recreational catch (kept by number) in 2020/21. Harvest ranges for blue swimmer crab in the North Coast were steady at 0.8 t (95% CI 0.1–1.5) in 2020/21 compared with 1.7 t (95% CI 0.2–3.2) in 2017/18, 1.7 t (95% CI 0.4–2.9) in 2015/16, 3.9 t (95% CI 1.1–6.6) in 2013/14 and 3.7 t (95% CI 0.6–6.7) in 2011/12 (Ryan *et al*. 2022).

The boat-based recreational catch of mud crab in the North Coast represented 92% of the statewide boat-based recreational catch (kept by number) in 2020/21. Harvest ranges for mud crab in the North Coast were steady at 3.0 t (95% CI 1.0–4.9) in 2020/21 compared with 2.3 t (95% CI 1.1–3.6) in 2017/18, 2.4 t (95% CI 1.0–3.8) in 2015/16, 7.2 t (95% CI 4.0–10.4) in 2013/14 and 7.1 t (95% CI 4.1–10.2) in 2011/12 (Ryan *et al*. 2022).



NORTH COAST CRAB FIGURE 3.
Annual commercial blue swimmer crab catch (tonnes) and fishing effort (traplifts × 1000) for the Pilbara Crab Managed Fishery between 2000 and 2021, including the developing (2001-18) and managed (since 2018) phases of the fishery. Prior to 2001, fishing occurred via permissive condition on Fishing Boat Licences.



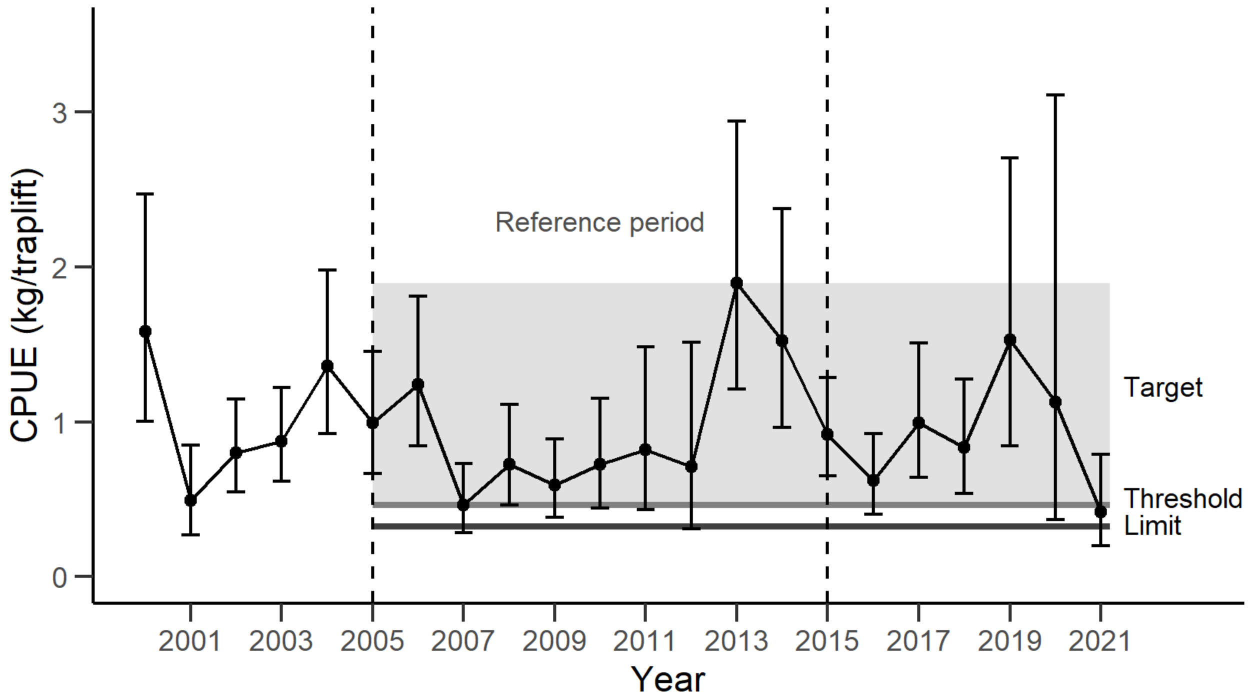
NORTH COAST CRAB FIGURE 4.
Historical annual commercial catch (tonnes) and fishing effort (traplifts × 1000) for trap fishers capturing mud crab in the Kimberley Crab Managed Fishery between 1994 and 2021, including the developing (2006–18) and managed (since 2018) phases of the fishery. Prior to 2006, fishing occurred via permissive condition on Fishing Boat Licences.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Blue Swimmer Crabs (Sustainable-Adequate)

The annual standardised catch rate from the PCMF provides an index of abundance that can be used to assess fishery performance. After significant increases in 2013 (1.9 kg/traplift), and 2014 (1.5 kg/traplift), the annual catch rate returned to historic levels (0.6–1.0 kg/traplift) during 2015–18 (North Coast Crab Figure 5).

Standardised catch rates increased to 1.5 kg/traplift in 2019, before declining to 1.1 kg/traplift in 2020 and 0.42 kg/traplift in 2021 (North Coast Figure 5). As the 2021 catch rate fell marginally below the preliminary harvest strategy threshold of 0.46 kg/traplift, a review of the fishery occrred. Unusually high water temperatures were experienced along the Pilbara coast in the winter months of 2021, which have been found to have a negative impact on blue swimmer crab stocks (e.g. Shark Bay in 2010/11). Declining catch rates in traditional fishing grounds resulted in exploratory fishing east towards Depuch Island with associated low catch rates. However, initial reports indicate that catch rates in the 2022 season have returned to above threshhold levels following a return to normal environmental conditions, with the fishery to be closely monitored as the season progresses. As such the status of the blue swimmer crab stock is considered adequate, with current management settings maintaining the level of risk at acceptable levels. Therefore, the blue swimmer crab stock in the PCMF is considered **sustainable-adequate**.



NORTH COAST CRAB FIGURE 5.
The primary performance indicator, annual standardised commercial catch rate (kg/traplift) of blue swimmer crabs, for the Pilbara Crab Managed Fishery between 2000 and 2021, relative to the associated reference points (target, threshold and limit) for a proposed harvest strategy. The reference period (2005-15) covers the years when the fishery was considered to be operating under relative stability following an initial exploratory period (2000-04).

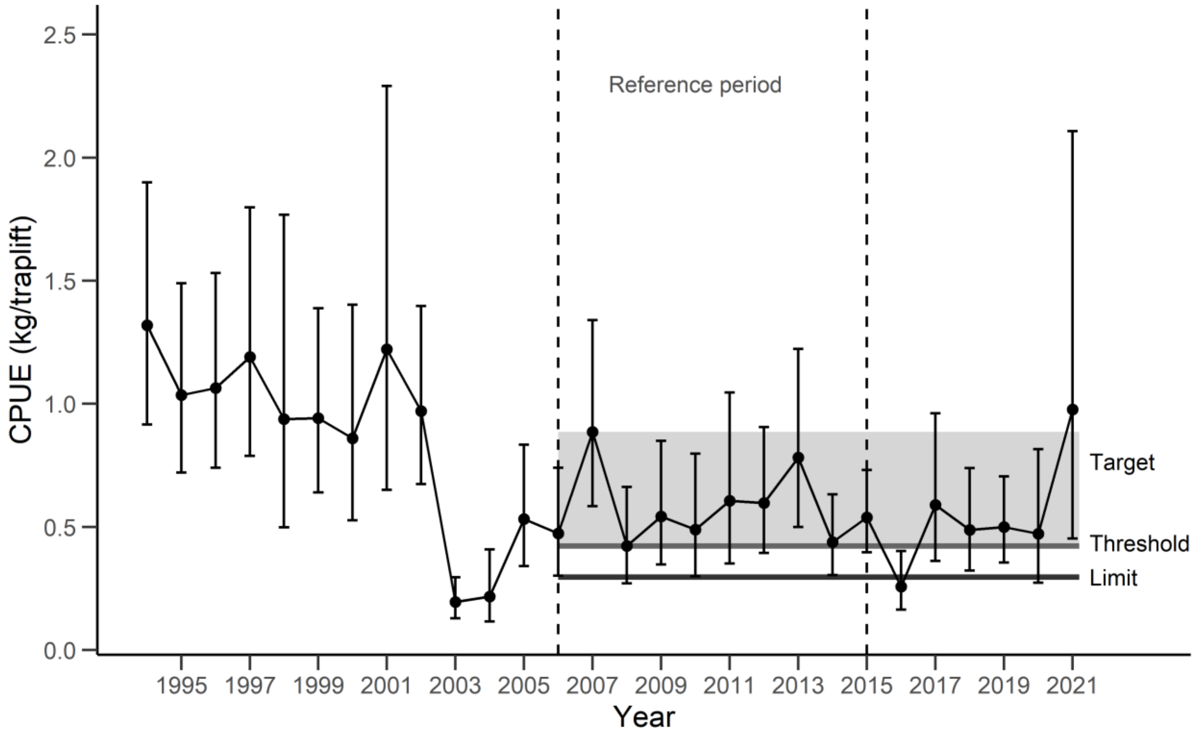
Mud Crab (Sustainable-Adequate)

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 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 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.

The annual standardised catch rate from the KCMF provides an index of abundance that can be used to assess this fishery's performance. Annual standardised catch rates fell below the limit of the harvest strategy during 2016 (0.3 kg/traplift), but increased and remained relatively constant at 0.5–0.6 kg/traplift from 2017 to 2020, within the harvest strategy target range (North Coast Crab Figure 6). In 2021 catch rates increased significantly to 0.98 kg/traplift, rising above the upper limit of the target level of the harvest strategy (0.9; North Coast Crab Figure 6). Minimal effort due to a lack of fishing in 2021, and high localised catch rates is most likely to be the cause of the steep rise in catch rate.

In addition, the relatively small catch by commercial and recreational fishers, the wide distribution of the species throughout the region, and the minimum legal size being set well above the size at first maturity, indicate that the status of the mud crab stock is adequate and that current management settings are maintaining the level of risk at acceptable (low) levels. The mud crab stock is considered **sustainable-adequate**.



NORTH COAST CRAB FIGURE 6.
The primary performance indicator, annual standardised commercial catch rate (kg/traplift), for the Kimberley Crab Managed Fishery since 1994 (when permissive conditions of fishing boat licenses were issued), relative to the associated reference points (target, threshold and limit) for a proposed harvest strategy. The reference period spans 2006–15 when the fishery was considered to have operated under relative stability following initial exploratory fishing (2000–05).

BYCATCH and PROTECTED SPECIES INTERACTIONS

Blue Swimmer Crab

Bycatch

The shift from using set nets to traps in most blue swimmer crab commercial 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.

Protected Species

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

Bycatch

Commercial mud crab traps are purpose built to effectively target larger (legal-sized) mud crabs. The overall trap design and mesh size allows sub-legal mud crabs and non-targeted bycatch species the 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 (hauled) regularly, and undersized and berried crabs must be returned to the water.

Protected Species

As commercial 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 is considered a **negligible** risk.

HABITAT and ECOSYSTEM INTERACTIONS

Habitat

Blue Swimmer Crab

Fishing with traps results in limited habitat disturbance, with only minor dragging of traps on the bottom occurring during trap retrieval. Sand and associated biota do not get brought to the surface in commercial blue swimmer crab traps, as the mesh used on traps is sufficiently large to allow the escape of any sand-dwelling macro-benthos. Although seagrasses are occasionally brought to the surface with the trap, the infrequent nature of this occurrence, and the small amount of living seagrass removed, results in minimal habitat damage, posing a **low** risk to benthic habitats.

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 the capture of benthic organisms and only minor dragging of traps on the sea floor occurs during trap retrieval. The sheltered shallow mangrove environment is protected from wind and waves where the majority of traps are deployed, resulting in minimal habitat damage, posing a **low** risk to benthic habitat.

Ecosystem

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. It is classified as a low risk. During 2021, two people were employed as skippers and crew on vessels fishing for blue swimmer crabs along the Pilbara coast, although minimal fishing effort occured. 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 North Coast mud crab fishery provides a high social amenity to recreational fishing and to consumers via commercial mud crab supply to markets and restaurants. It is classified as a low risk. Commercial fishers travel vast distances due to the remoteness of their operations and stay at sea for several weeks before returning to unload the catch. In this scenario crabs are frozen and generally sold to local and interstate markets, although live product may also be sold at premium prices. During 2021, seven people were employed as skippers and crew on vessels fishing for mud crab in the KCMF, with effort occuring between April and September.

Economic

The estimated gross value of product (GVP) for the crab fishery within the North Coast Bioregion for 2021 was approximately $114 k (**Level 1** <$1million). The value for blue swimmer crabs was approximately $90 k and mud crabs was approximately $24 k.

Blue Swimmer Crabs

The average beach price for trap-caught blue swimmer crabs across all Western Australian fisheries for the 2020/21 financial year was $10.09 per kg. Price data was generated by collecting monthly returns recording prices paid to fishers by fish processors. A weighted average price is then calculated for the financial year from the monthly data. The crab catch from the Pilbara region was sold through local and interstate markets.

Mud Crabs

The average beach price for green and brown mud crabs (uncooked) in the Kimberley during the 2020/21 financial year was approximatley $45 and $30/kg, respectivley. However, prices do fluctuate seasonally depending on product availability,Queensland, Northern Territory fisheries production and demand from the Sydney and Melbourne fish markets. Aboriginal corporations may also trade and barter product adding value to the local communities that cannot be estimated.

GOVERNANCE SYSTEM

Harvest Strategy

The breeding stock of crab fisheries are protected by effort controls, legal minimum sizes well above the size at maturity, and spatial and temporal closures.

Blue Swimmer Crab

A preliminary harvest strategy has been determined for the PCMF where the primary performance indicator is the standardised annual commercial catch rate, specifically within the Nickol Bay area as the majority of fishing historically occurred in this area. The reference period spans 2005 to 2015, defined by the period when the developing fishery status commenced following a period (2001–04) of exploratory fishing.

The primary performance indicator was below the threshold in 2021, but no changes to the management of the fishery were introduced for the 2022 season. However, given that the harvest strategy indicator (catch rate) fell just below reference levels, the performance of the fishery will be closely monitored during 2022 to determine if aditional management action is required (see explanation in stock status section above).

Mud Crab

A preliminary harvest strategy has been determined for the KCMF where the primary performance indicator is the standardised annual commercial catch rate. The reference period spans 2006-15 when the fishery was considered to have operated under relative stability following initial exploratory fishing (2000–05).

No changes to the management of the fishery were introduced for the 2022 season as the CPUE was well above the threshold and at the upper target level.

Annual Catch Tolerance Levels

Pilbara BSC:	20–73 t
Kimberley Mud Crab:	5–30 t

Blue Swimmer Crab

Annual catch tolerance levels have recently been developed for the PCMF (see DPIRD, 2020) based on historical catch information relative to estimates of MSY derived from a preliminary production model to indicate the reference period in which the fishery has been operating sustainably (2005–2015).

Although the 2021 catch for the PCMF of 8.9 t was below the lower Catch Tolerance level (20 t), this can be attributed to substantially reduced fishing effort. Due to the COVID-19 pandemic and associated changes in market demands, fishing only occurred for three months of the year. Consequently, changes to management were considered unnecessary for the 2022 season.

Mud Crab

The current catch tolerance ranges used to assess annual fishery performance in the KCMF are based on the current stock status, and control rules have been calculated from the fishery's maximum and minimum catches between 2006 and 2015 including an additional 10% (of minimum catch) to generate the tolerance range. If the status of the resource changes such that the control rules trigger additional management adjustments, the tolerance range for this fishery will be adjusted accordingly.

The 2021 mud crab catch for the KCMF (0.8 t) was substantially below the lower Catch Tolerance level (5 t). However, the COVID-19 pandemic substantially reduced demand during the peak mud crab season and effort was reduced. There were also difficulties with retaining crew at this time. Therfore, no further management action was considered necessary for the 2022 season.

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. 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 relating to recreational fishing 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 formal harvest strategy for the Portunidae crab resource (blue swimmer crab and mud crab) in the North Coast and Gascoyne bioregions of Western Australia is yet to be developed, however, it is noted as a future management initiative.

EXTERNAL DRIVERS

Levels of recruitment to many 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 evaluated as further data become available. Climate change implications associated with these environmental variables are also under consideration. Blue swimmer crabs were rated a **high** risk to climate change due to their sensitivity to water temperature changes.

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SOUTH COAST BIOREGION

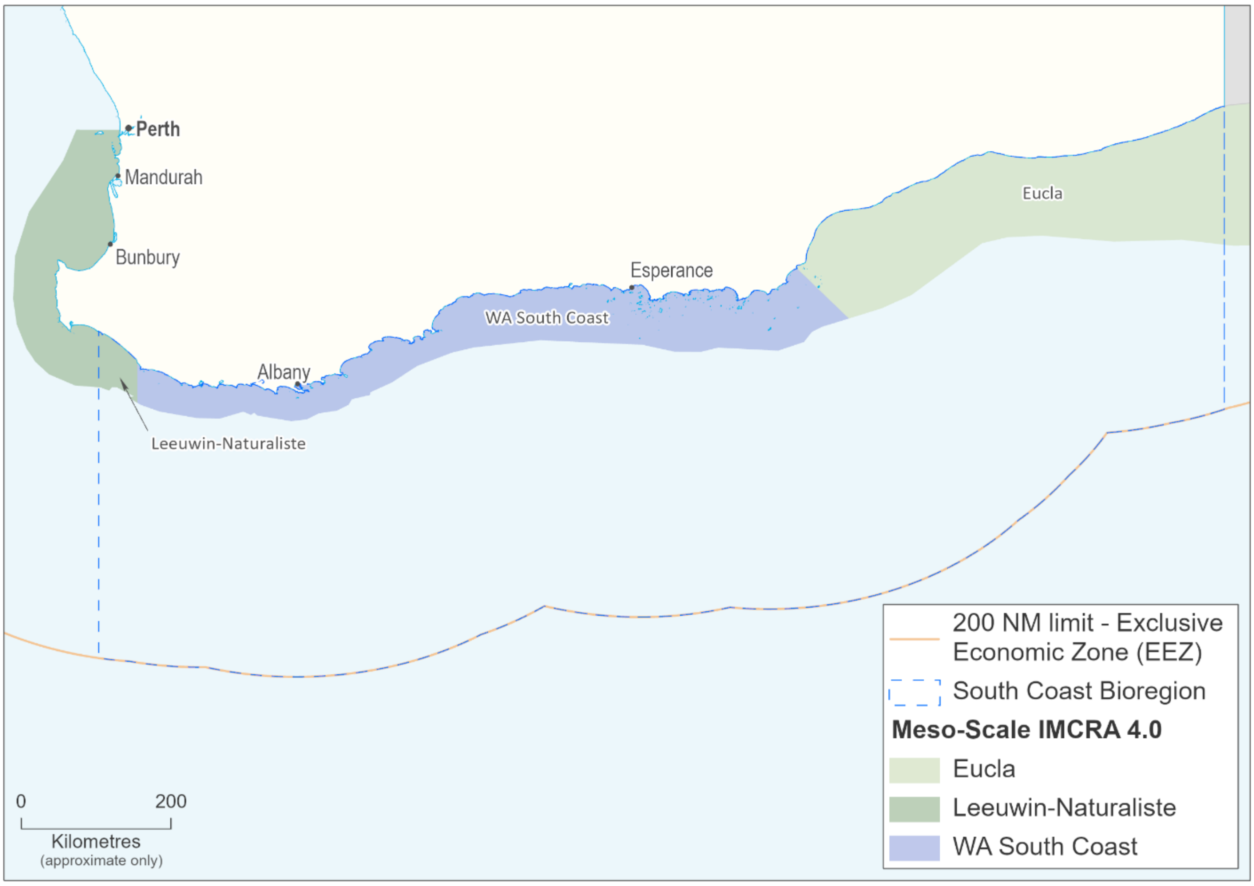
ABOUT THE BIOREGION

The continental shelf waters of the South Coast Bioregion (South Coast Bioregion 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 water temperatures (away from terrestrial effects along the beaches) to approximately 16°C to 17°C.

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 a 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 other estuaries are closed by sandbars and open 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 BIOREGION OVERVIEW FIGURE 1
Map showing the South Coast Bioregion and IMCRA (V 4.0) meso-scale regions: Leeuwin-Naturaliste, 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, 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 Bioregion's ecosystem boundaries as defined by IMCRA (V 4.0) are depicted in South Coast Bioregion 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 those 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:

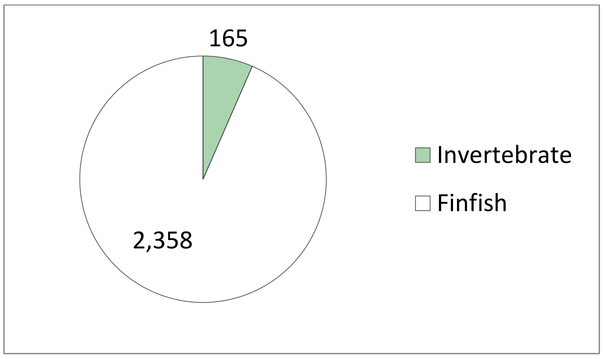
- increasing frequency of *El Niño*/Southern Oscillation (ENSO) events;
- more years with a weaker Leeuwin Current;
- increases in water temperature off the west coast of WA, particularly the lower west coast;
- increases in salinity, which includes some large annual fluctuations;
- change in the frequency and location of storms (and rainfall) affecting the lower west coast; and
- change in the frequency of cyclones (and summer rainfall) affecting the north-west coast which can influence rainfall along the south 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 of species, 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

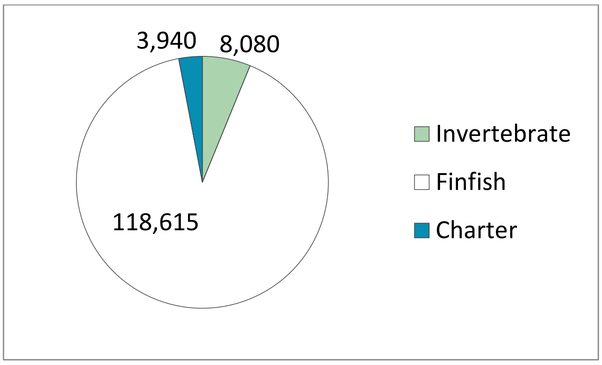
The major commercial fisheries of the South Coast Bioregion are the abalone fishery (which achieved Marine Stewardship Council certification in 2017), a trap fishery targeting southern rock lobsters and deep-water crabs, the purse seine fishery targeting pilchards and other small pelagics, and the demersal gillnet fishery for sharks and scalefishes. Other smaller commercial fisheries include the long-standing beach seine fishery for Western Australian salmon, and the intermittent scallop trawl fishery. There are commercial net fisheries for finfish operating in a number of South Coast estuaries and beaches. Commercial fishers also target demersal scalefish offshore with droplines and handlines. South Coast commercial fishing vessel operators often hold a number of licences to create a viable year-round fishing operation.



SOUTH COAST BIOREGION OVERVIEW FIGURE 2
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 Bioregion 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 dinghy and shoreline fishing in estuaries and rivers, focused in the western half of the bioregion where 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 BIOREGION OVERVIEW FIGURE 3

Recreational catches (by number) in the South Coast Bioregion. Finfish and invertebrate catches were assessed in the statewide survey of boat-based recreational fishing in 2020/21[1]. Charter boat catch is for the same period. Estimates of shore based recreational catch are unavailable.

Aquaculture

The predominant aquaculture activity undertaken on the south coast is the production of edible oysters and mussels from Oyster Harbour and Mistaken Island in King George Sound (both at Albany). Bivalve mollusc aquaculture has previously focused on these areas, due to the levels of nutrients related to terrestrial run-off to provide the planktonic food necessary to promote their growth. The Minister for Fisheries has declared the Albany Aquaculture Development Zone, which encompasses water areas in Oyster Harbour, Princess Royal Harbour and King George Sound. The first marine shellfish aquaculture development zone established in Western Australia, the Albany Zone, was declared in two stages: Stage 1: Oyster Harbour area – declared in August 2020; and Stage 2: areas in Shoal Bay (in Princess Royal Harbour) and Mistaken Island and Misery Beach (in King George Sound) – declared in December 2021. The combined areas of the zone now provide approximately 800 hectares of water for shellfish production.

Applications for aquaculture licences and leases in all the additional areas are being assessed and it is likely all available waters will be allocated. Growth of edible bivalve molluscs, including rock oysters and Akoya oysters, in the Albany Aquaculture Zone is being driven by significant private industry investment.

Aquaculture of shellfish in the Albany Zone and throughout the State is supported by a Government-funded shellfish hatchery located in Albany at the Albany Aquaculture Park. Other private hatcheries exist in the bioregion, including for abalone.

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, and offshore production in sheltered areas. The offshore abalone farms located near Augusta (Flinders Bay) and Esperance (Wylie Bay) are in less exposed areas in and are growing out abalone using purpose-built concrete structures located on the sea bed (see Aquaculture Regional Research and Development Overview section in this chapter). There is also growing interest in seaweed aquaculture in areas of the South Coast.

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 in 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

1 Ryan KL, Lai EKM, Smallwood CB. 2022. Boat-based recreational fishing in Western Australia 2020/21. Fisheries Research Report No. 327 Department of Primary Industries and Regional Development, Western Australia. 221pp.

community and surrounding regions during their visits. In addition, many international shipping routes to and from eastern Australia, traverse the South Coast Bioregion, often without docking in WA. Seismic surveys have been undertaken in the east of the bioregion to inform prospective oil and gas exploration in the western Great Australian Bight. However, exploratory drilling has yet to occur in this area.

Given that the impacts from vessels and ships tend to be concentrated around ports and anchorage areas, the Department has surveillance in place for marine pests in key port areas to aid in the early detection of any unwanted aquatic species from other locations.

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 Bioregion 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 and Nornalup Inlets Marine Park was declared on the 8th May 2009 and was the first marine protected area on the South Coast. The Department currently undertakes research and monitoring within the Walpole and Nornalup Inlets Marine Park. This is based on the Department's identified risks in conjunction with the Marine Park Management Plan priorities set by the Department along with the Department of Biodiversity, Conservation and Attractions (DBCA). This work includes the support and supervision of studies on the finfish community to assess current trends, movement ecology and the development of a long term monitoring program for the finfish community within the marine park.

In 2019, the State Government announced the 'Plan for Our Parks' initiative to create additional marine parks and terrestrial conservation reserves by February 2024. This initiative includes the establishment of a new marine park off the south coast of WA, which will extend from east of Bremer Bay to the SA border.

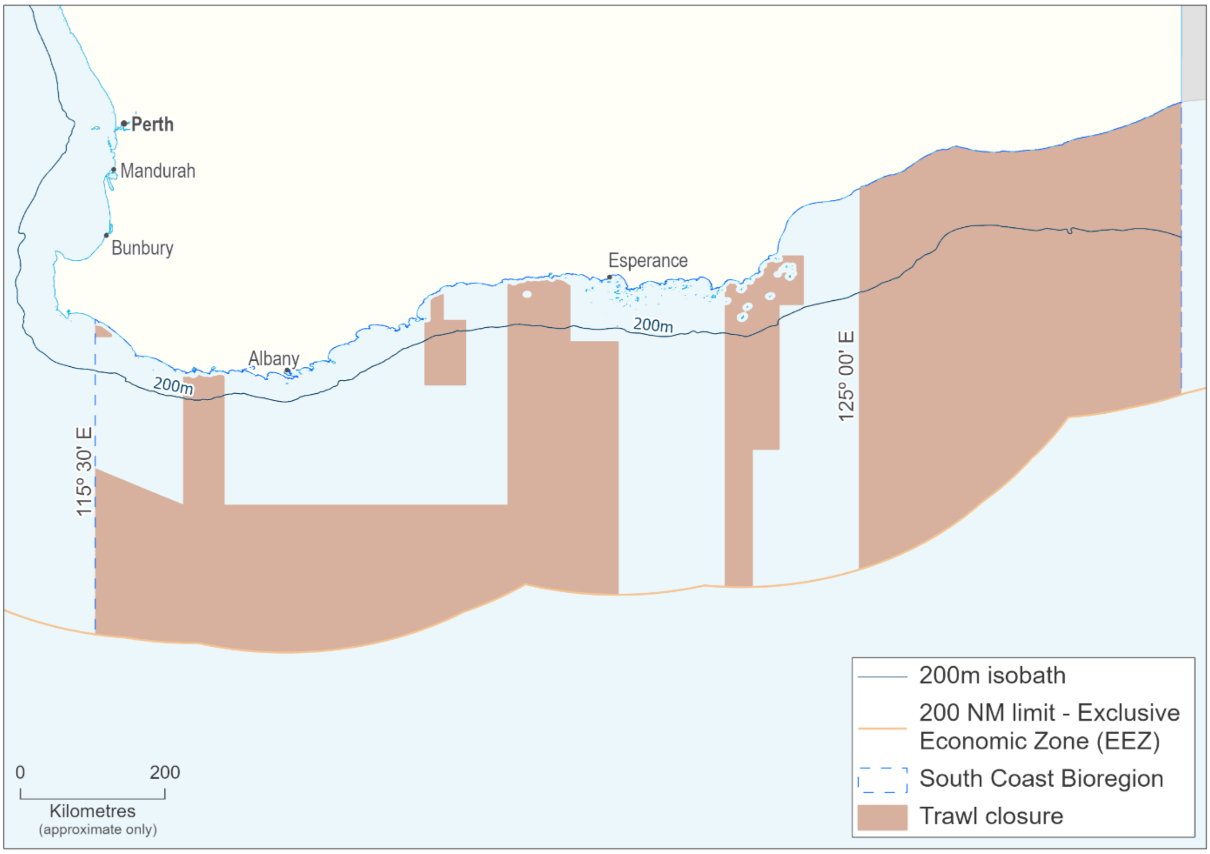
Additional access restrictions in the bioregion include closures under s.43 of the *Fish Resources Management Act 1994* at Greens Pool in William Bay, and in waters surrounding the wreck of the 'Perth' (Albany), the wreck of the 'Sanko Harvest' (east of Esperance) and Esperance Jetty.

The Commonwealth Government implemented an Australian Marine Park for the South-West Marine region (between Kangaroo Island in South Australia and Shark Bay in WA) in July 2018. This resulted in a network of marine parks off the South Coast of WA (South Coast Bioregion Overview Figure 5).

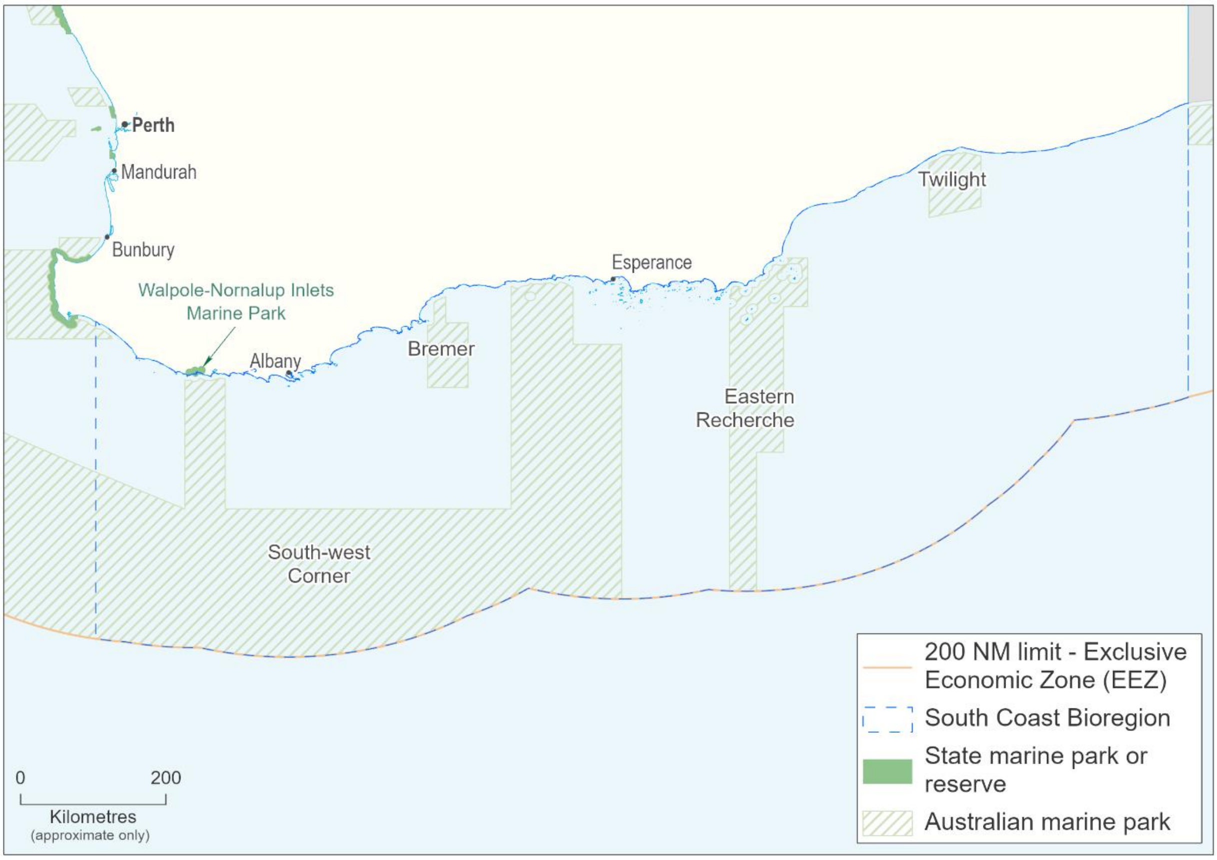
SOUTH COAST ECOSYSTEM MANAGEMENT TABLE 1

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 include State or Commonwealth closures that are currently in the process of implementation. These areas will be included in future volumes, when their respective implementation processes are concluded.

IUCN category or equivalent	State Waters only (17,116 km^2)				All Waters (534,016 km^2 (including State Waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km^2	%	km^2	%	km^2	%	km^2	%
I	0	0	0	0	0	0	0	0
II	1	< 1	0	0	1	< 1	6,700	1
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	96	11,200	2



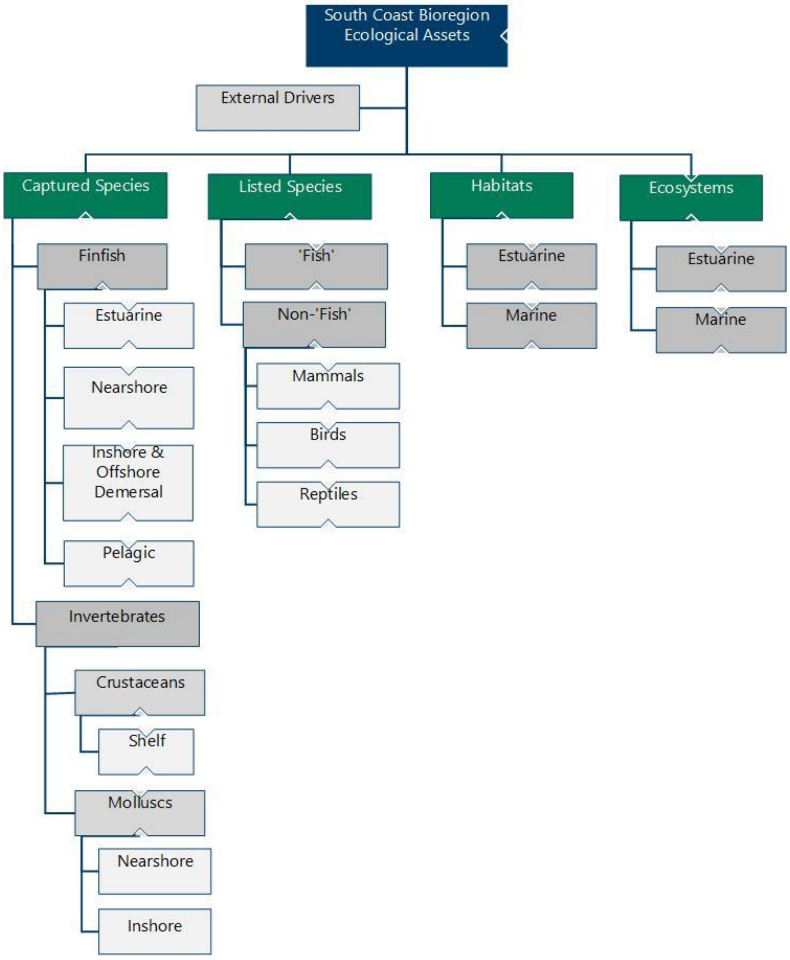
SOUTH COAST BIOREGION OVERVIEW FIGURE 4
Map showing the South Coast Bioregion and areas closed to trawling. The areas permanently closed to trawling are consistent with IUCN marine protected area category IV.



SOUTH COAST BIOREGION OVERVIEW FIGURE 5
Map showing the South Coast Bioregion and current 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 the 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 South Coast Bioregion are identified in South Coast Bioregion 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.

External Drivers

External factors that potentially impact marine and estuarine ecosystems at the bioregional level may not fall within the direct control of Fisheries 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 change and introduced pests and diseases[1].

Climate

External Drivers	Current Risk Status
Climate	LOW

While the current risk is Low, 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). Further information is required to examine potential impacts on this bioregion.

1 Biosecurity issues are now reported by the Biosecurity pillar of the Department of Primary Industries and Regional Development.

Captured Species

FINFISH

Estuarine

Captured Species	Aquatic zone	Ecological Risk
Finfish	Estuarine	MEDIUM

Stocks of estuarine cobbler and black bream are considered to be sustainable-adequate (refer to the South Coast Nearshore and Estuarine Chapter).

Nearshore (0-20 m depth)

Captured Species	Aquatic zone	Ecological Risk
Finfish	Nearshore	LOW

The most recent stock assessment on Australian salmon indicated that there is currently a low risk to sustainability. The stock of Australian herring is considered to have recovered to a level where there is a low risk to sustainabilty.

Inshore and Offshore Demersal

Captured Species	Aquatic zone	Ecological Risk
Finfish	Demersal	MEDIUM

Norriss et al. (2016[1]) assessed the risks to inshore demersal indicator species as being 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 acceptable pre-virus levels, their catches and those of other pelagic fish do not appear to have returned to pre-virus levels.

INVERTEBRATES

Crustaceans

Captured species	Aquatic zone	Ecological Risk
Crustaceans	Shelf	HIGH

There are some concerns for the stock biomass of the southern rock lobster in zone 3 of the fishery (refer to the South Coast Crustacean Chapter). A transition to quota management will assist in addressing the ecological risks for these crustaceans.

Molluscs

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

Management action has been taken to address concerns for stocks of abalone in some areas. The abundance of scallops varies inter-annually due to recruitment fluctuations and fishing only occurs when stocks are sufficiently robust.

Listed species

A variety of endangered, threatened and protected[2] (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 *Biodiversity Conservation Act 2016*, and the *Fish Resources Management Act 1994*.

Fish

Listed species	Risk
Fish (white shark, grey nurse shark)	MEDIUM
Fish (school shark)	SEVERE

In a recent ERA for the Temperate Demersal Elasmobranch Resource[3], the impacts of fishing on the grey nurse shark (*Carcharias taurus*) and the white shark (*Carcharodon carcharias*) were both considered to be a Medium risk. Effort in the Temperate Demersal Gillnet and Demersal Longline Fisheries has decreased since the 1980s and 1990s, which has likely reduced the level of bycatch. In the same ERA, the impacts of fishing on the school shark was considered to be a Severe risk. This was in recognition of their current stock status across southern Australia. While catches of school shark in the Temperate Demersal Gillnet and Demersal Longline Fisheries are unlikely to have significantly contributed to stock depletion, the assessment recognised that any catch may potentially impact the conservation dependent species.

Non-Fish

Listed species	Risk
Mammals	HIGH
Birds and Reptiles	HIGH

1 J.V. Norriss, E.A. Fisher, S.A. Hesp, G. Jackson, P.G. Coulson, T. Leary and A.W. Thomson. 2016. Status of inshore demersal scalefish stocks on the South Coast of Western Australia. Fisheries Research Report No. 276, Department of Fisheries, Western Australia. 116 pp.

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

3 Watt, M. et al., (2021), Ecological Risk Assessment for the Temperate Demersal Elasmobranch Resource. Fisheries Research Report 318. Department of Primary Industries and Regional Development, Perth.

Reported captures of Australian sea lions are rare and gillnet exclusion zones are in place around known colonies in Western Australia. However, a recent ecological risk assessment for the Western Australian Temperate Demersal Elasmobranch Resource identified Australian sea lions as being high risk[1]. This was attributed to the potential for interaction with commercial gillnets, a lack of population modelling and fishery-independent data validation.

Concerns about potential captures of juvenile Australian sea lions in South Coast Crustacean Managed Fishery pots have led to the requirements for Sea Lion Exclusion 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 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. In a recent ecological risk assessment for the Western Australian Statewide Small Pelagic Resource, a high risk was attributed to the Flesh Footed Shearwater (*Ardenna carneipes*)[1]. This score, rather than a Medium score, was based on the level of uncertainty associated with population modelling and fisheries dependent data.

Habitats and Ecosystems

The South Coast Bioregion, extends from Black Point (east of Augusta) to Israelite Bay (east of Esperance) (South Coast Bioregion Overview Figure 1).

South Coast Bioregion 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. For example, 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 Bioregion.

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 composition 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 provision of habitat.

Sponges: In southwestern Australia, sponges are found in areas where algae are less dominant, which includes areas deeper than 30 m and in caves.

The IMCRA ecosystem boundaries are illustrated in South Coast Bioregion 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	MEDIUM
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

1 Blazeski, S. et. Al., (2021). Ecological Risk Assessment for the State-Wide Small Pelagic Scalefish Resource. Fisheries Research Report No. 320 Department of Primary Industries and Regional Development, Western Australia. 115 pp.

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, eutrophication and other environmental factors.

Ecosystems

Ecosystems	Aquatic zone / category	Current Risk Status
South Coast	Estuarine	MEDIUM
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 in mean trophic level, mean length and a Fishery-In-Balance indicator had all stabilised in the South Coast Bioregion; and that there were 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 the opening and closing of sand-bars at river mouths.

1 Hall, N.G. and Wise, B.S. 2011. Development of an ecosystem approach to the monitoring and management of Western Australian fisheries. FRDC Report – Project 2005/063. Fisheries Research Report No. 215. Department of Fisheries, Western Australia. 112pp.

FISHERIES

SOUTH COAST CRUSTACEAN RESOURCE STATUS REPORT 2022

J. How and L. Wiberg

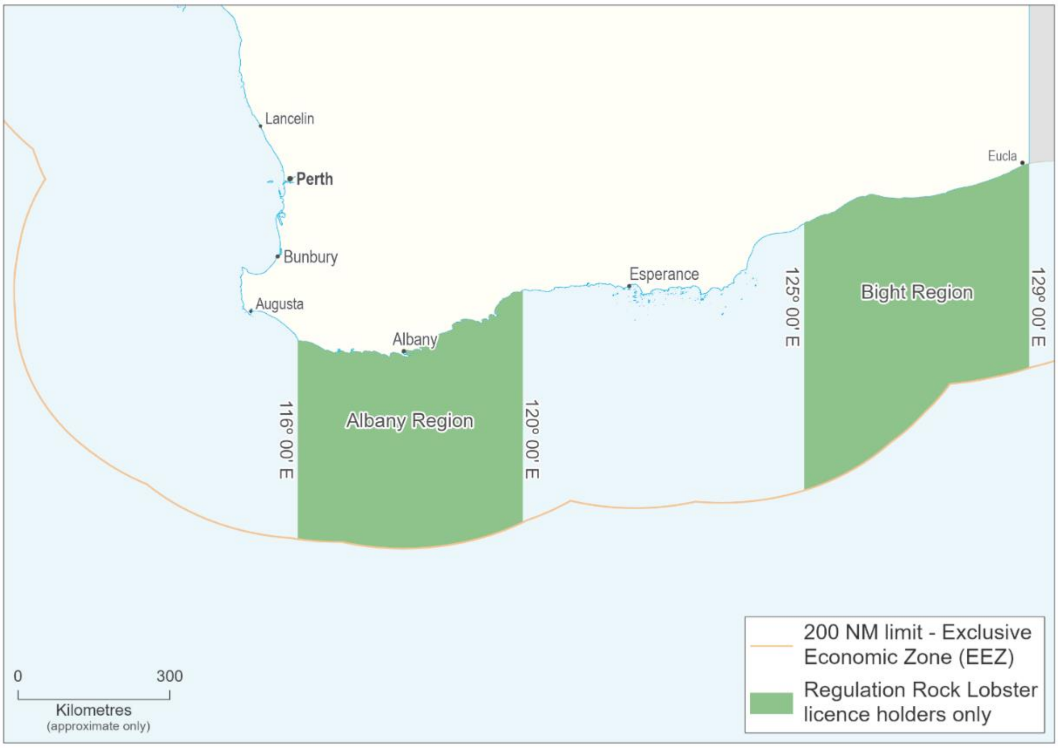
OVERVIEW

The South Coast Crustacean Managed Fishery (SCCMF) is a multi-species, effort-controlled pot based fishery, which includes catches of southern rock lobster (*Jasus edwardsii*) and western rock lobster (*Panulirus cygnus*), as well as deep-sea crab species, primarily, giant crab (*Pseudocarcinus gigas*), crystal crab (*Chaceon albus*) and champagne crab (*Hypothalassia acerba*). Planned management changes are underway to transition the fishery to output controls under quota, scheduled to commence on 1 July 2022.

Detailed information on the fisheries biology of the deepwater crab species can be found in How *et al*. (2015).

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (1977 pots)	Total Catch 2020-21: 27.4 t	Unacceptable: Management Action Required
Recreational fishery	Total Catch 2020-21: <5 t	N/A
EBFM		
Indicator species		
Western Rock Lobster (Zone 1)	Above threshold	Adequate
Crystal Crab (Zone 2)	Above threshold	Adequate
Southern Rock Lobster (Zone 3)	Below threshold, above limit	Adequate
Southern Rock Lobster (Zone 4)	Above threshold	Adequate
Ecological		
Bycatch	Low Risk	Adequate
Listed Species	Low Risk	Adequate
Habitat	Low Risk	Adequate
Ecosystem	Low Risk	Adequate
Economic (GVP $1 m; 2020/21)	Medium Risk	Acceptable
Social (Moderate amenity)	Medium Risk	Acceptable
Governance	Medium Risk	Unacceptable: Management Action Required
External Drivers	Medium Risk	Acceptable

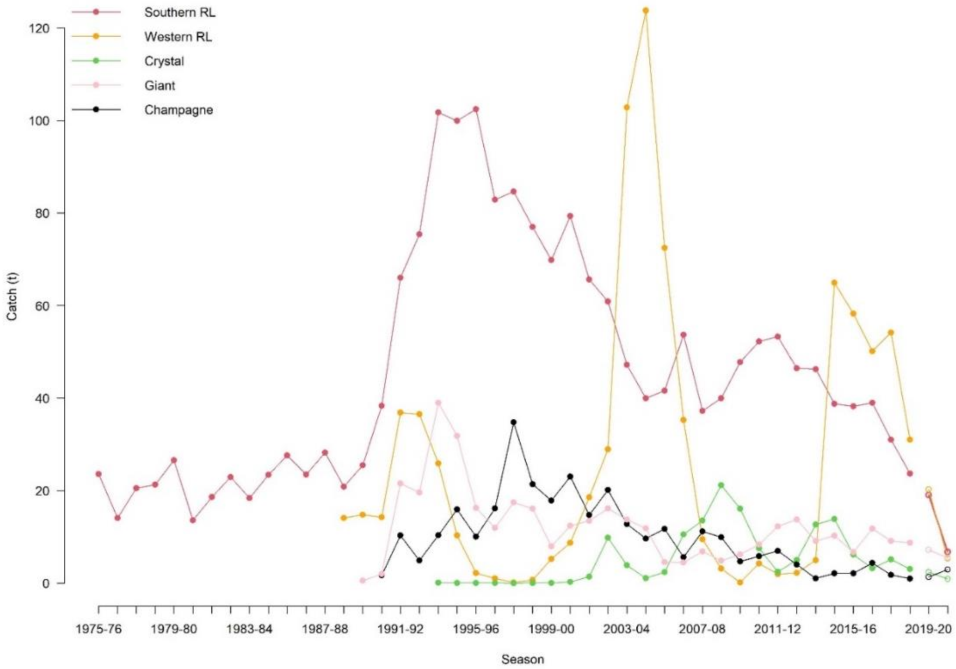


SOUTH COAST CRUSTACEAN FIGURE 1.
Map showing boundaries of the South Coast Crustacean Managed Fishery.

CATCH AND LANDINGS

The total crustacean landings accessed by the SCCMF in 2020/21 from this resource was 27.4 t, comprising 6.8 t of southern rock lobster, 5.3 t of western rock lobster, and 0.9 t of crystal crabs, 5.5 t giant crabs and 8.9 t of champagne crabs (South Coast Crustacean Figure 2). There was a voluntary catch limit in place for all species in Zone 3 which limited their catch.

The estimated recreational catch in 2020/21 was 44,954 lobsters (95% CI 13,019–76,889) (Smallwood et al. 2021).



SOUTH COAST CRUSTACEAN FIGURE 2.
Total landings in the South Coast Crustacean Fishery by species. Change in the statutory reporting from monthly (closed circles) to trip returns (open circles) is also presented

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

In each of Zones 1-4 an indicator species is used to assess sustainability. The indicator species are determined as those species that comprise the majority of the catch in that zone over the past ten years.

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 (South Coast Crustacean Figure 2) are highly cyclical and correspond well to puerulus settlement at Cape Mentelle lagged by four to five years. This provides evidence that the source of recruitment for western rock lobsters in the SCCMF is in the West Coast Bioregion. This component of the stock is accessed by the West Coast Rock Lobster Managed Fishery (WCRLMF), which was assessed as **adequate**. The total allowable catch (TAC) for western rock lobster in Zone 1 for the 2022/23 season is 35 t which is **sustainable** in the long-term.

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).

There were no landings of crystal crabs in Zone 2 during the 2020/21 season (South Coast Crustacean Figure 2). A voluntary memorandum of understanding limited the catch to approximately 2 t of crystal crab in Zone 2, and has been implimented since the 2019/20 season. No fishing occurred in the 2020/21 season due to market-related issues.

A Biomass dynamics model (BDM) has been developed for crystal crab in Zone 2. The assessment indicates that it is likely that the overall level of stock depletion is **adequate**, noting that the stock has improved due to sustained low catches of < 5 t over the last four seasons. Projected catches of crystal crab in Zone 2 of 6 t is considered **sustainable** in the long-term based on current model predictions (South Coast Crustacean Figure 3).

Zone 3 – Esperance & Zone 4 – Bight (Southern Rock Lobster)

The assessments for Zones 3 and 4 are 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 harvested (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 as being sustainable (Linnane *et al*. 2020), and that the catches of southern rock lobster from WA are very low relative to the other southern states. For more details see Linnane *et al*. (2020).

Zone 3 – Esperance (Sustainable-Adequate)

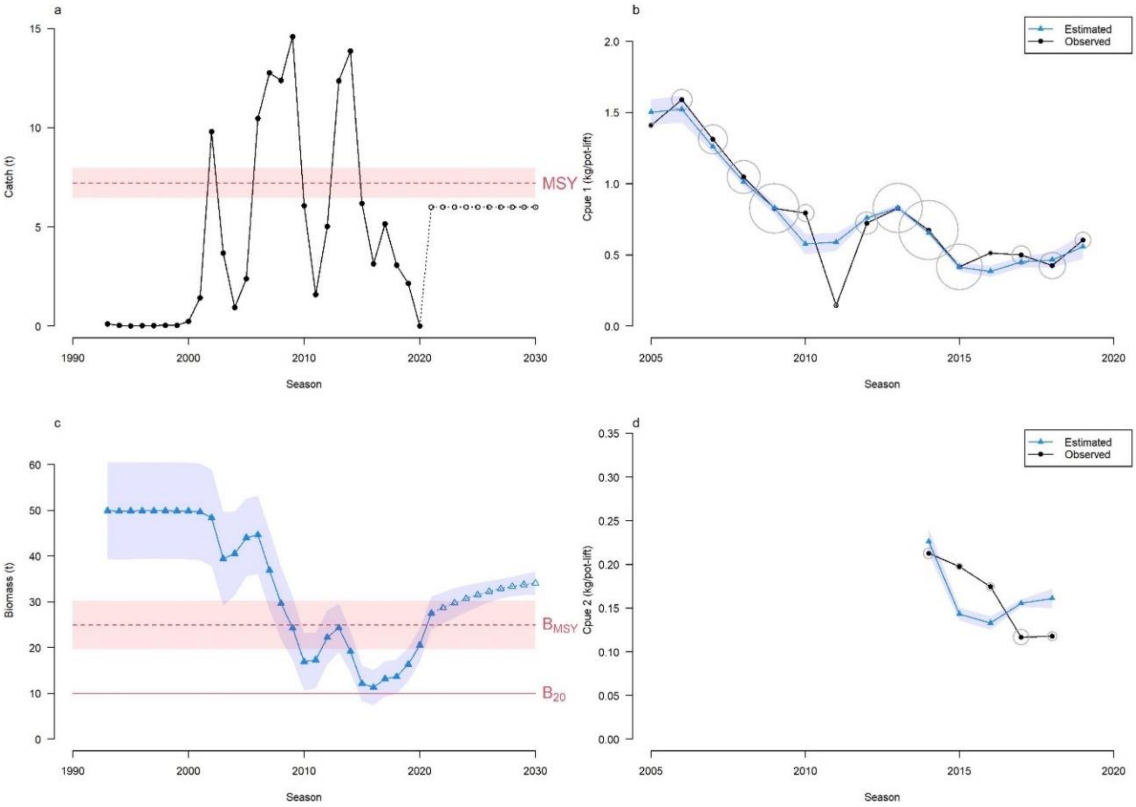
Catches of southern rock lobsters in Zone 3 have declined markedly in recent seasons due to export market related impacts, with a voluntary catch limit of 20 t also in effect since the 2019/20 season (South Coast Crustacean Figure 4a).

A Linked depletion model (LDM) has been developed for southern rock lobster in Zone 3. The assessment indicates that it is likely that the overall level of stock depletion is **adequate** (above limit) but below the threshold. The projected biomass based on average recruitment and catches of 16 t or less will result in an increase in the stock biomass in future seasons, therefore indicating that it is **sustainable** in the short to medium-term based on current model projections (South Coast Crustacean Figure 4).

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

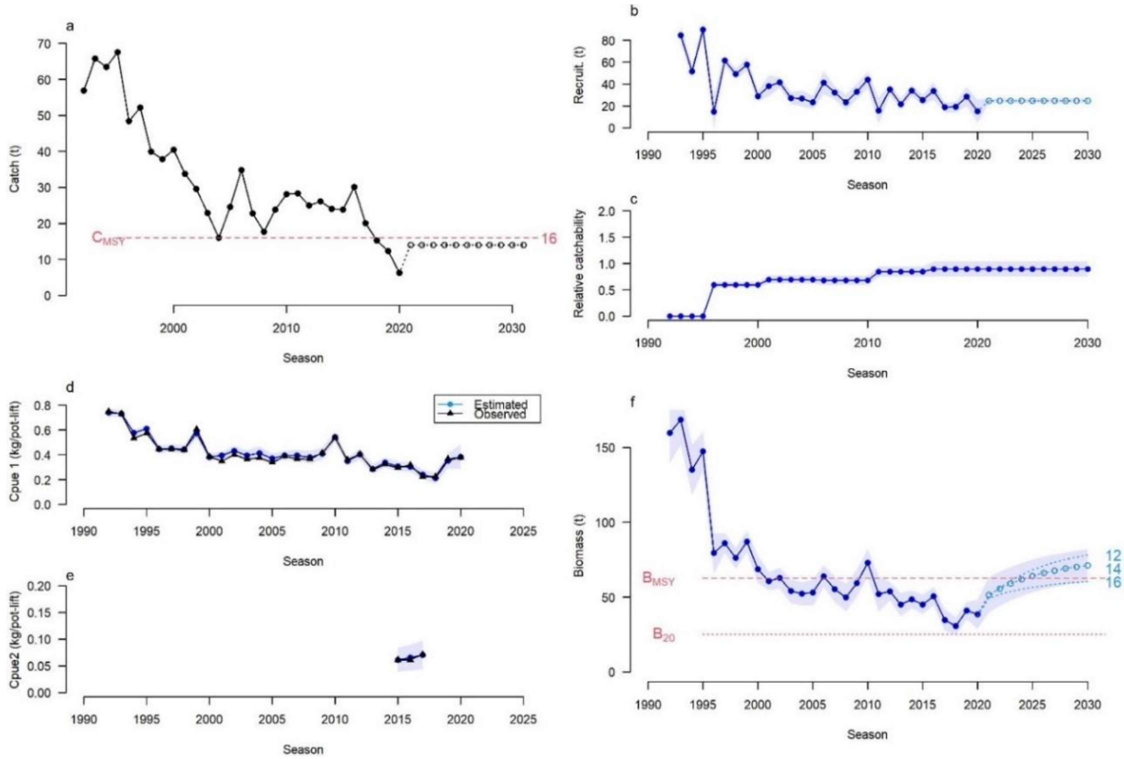
Catches of southern rock lobsters in Zone 4 have also declined markedly in recent seasons due to export market related impacts with no catch reported during the 2020/21 season (South Coast Crustacean Figure 5a).

A Linked depletion model (LDM) was also developed for southern rock lobster in Zone 4. The assessment indicates that it is likely that the overall level of stock depletion is **adequate**, noting that the stock has improved due to recent low catches. The projected biomass based on average recruitment and catches of up to 14 t will result in the biomass remaining above threshold levels indicating that it is **sustainable** in the short to medium-term based on current model projections (South Coast Crustacean Figure 5).



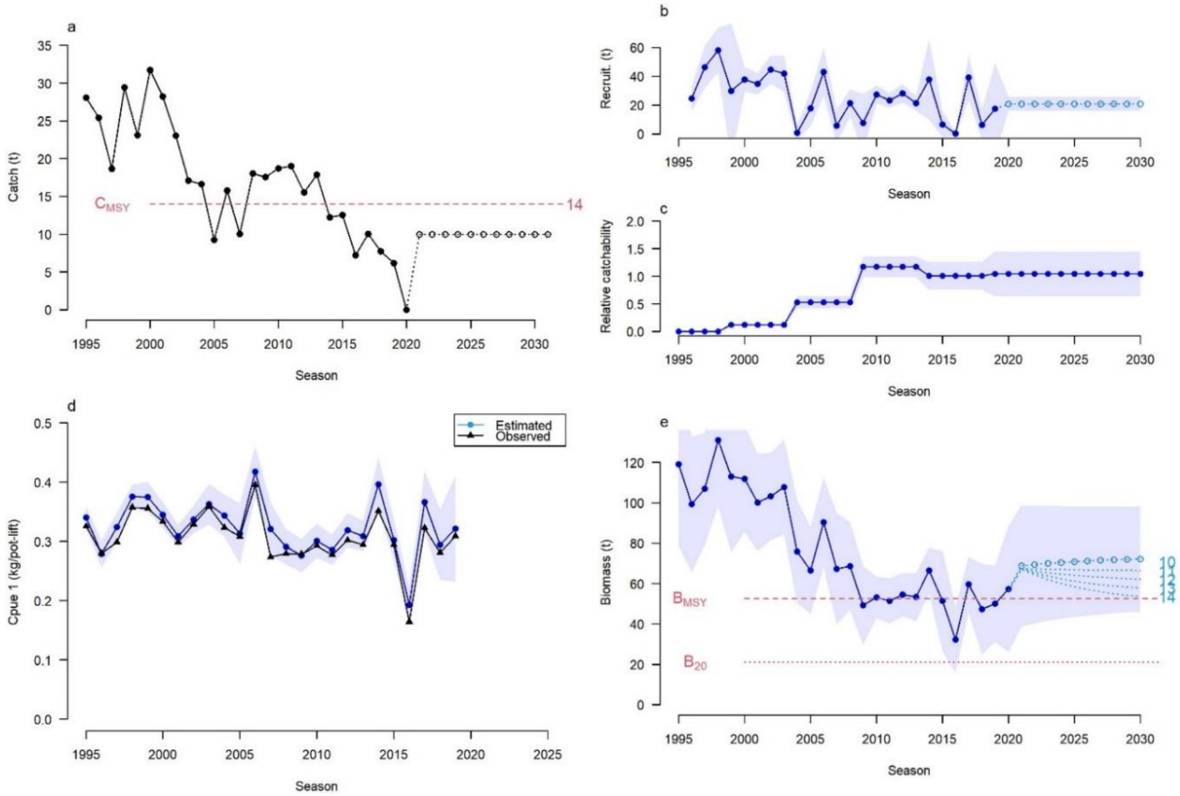
SOUTH COAST CRUSTACEAN FIGURE 3.

a) Commercial catch (black) of Crystal crab in Zone 2 with the Maximum Sustainable Yield (MSY) shown with 95 % CI (red). b) Observed (black) and model estimted (blue with 95% CI) CAES and trip return catch rates (grey circle depict relative weighting of each point with larger circles indicating a greater weighting). c) Model estimated (solid blue with 95% CI) biomass with projections out ten years (open triangles/dotted line). d) Observed (black) and model estimted (blue with 95% CI) logbook catch rates (grey circle depict relative weighting of each point with larger circles indicating a greater weighting).



SOUTH COAST CRUSTACEAN FIGURE 4.

a) Commercial catch (black) of Southern Rock Lobster in Zone 3 with potential catch of 14 t (red dotted line). b) Model estimated (solid blue line) recruitment with projections out ten years (open dotted blue line) and 95% CI (blue shading). c) Model estimated catchability. d) Observed (black) and model estimated (blue) catch rates from Catch and Effort Statistics (CAES) and trip returns. e) Observed (black) and model estimated (blue) catch rates from logbooks. f) Model estimated (solid blue line) stock biomass levels with projections out ten years (open dotted blue line) and 95% CI (blue shading). Three future catch scenarios are shown, 12, 14 and 16 t.



SOUTH COAST CRUSTACEAN FIGURE 5.
a) Commercial catch (black) of Southern Rock Lobster in Zone 4 with potential catch limits of 14 t (red dotted line). b) Model estimated (solid blue line) recruitment with projections out ten years (open dotted blue line) and 95% CI (blue shading). c) Model estimated catchability. d) Observed (black) and model estimated (blue) catch rates from Catch and Effort Statistics (CAES) and trip returns. e) Observed (black) and model estimated (blue) catch rates from logbooks. f) Model estimated (solid blue line) stock biomass levels with projections out ten years (open dotted blue line) and 95% CI (blue shading). Future catch scenarios are shown, 10 to 14t.

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 minimal.

Low risk.

Protected Species

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. The outcomes of this assessment showed that SLEDs have no impact on catch composition and catch rates. Statutory consultation was undertaken between the Department of Primary Industries and Regional Development and licence holders to establish suitable mitigation measures to reduce potential ASL interactions and minimise any impact on fisher catches. SLEDs were implented in the 2019/20 fishing season. In the 2020/21 season there were no ASL interactions attributed to the SCCMF.

In the 2020/21 season, there were no whale entanglements attributed to the SCCMF.

Turtles can also get caught in the float rigs of lobster pots. In 2020/21 no turtles were reported to have been entangled in fishing gear from the SCCMF.

Low risk.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

Potting is considered to have a low impact on the habitat over which the SCCMF operates. **Low** risk.

Ecosystem

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. The removal of crabs and lobsters by both of these fisheries have been assessed as having negligible effects on the food chain. Therefore, at current catch levels, it is unlikely that removal of lobster and crabs on the south coast are likely to result in any food chain effects. **Low** risk.

SOCIAL AND ECONOMIC OUTCOMES

Social

The SCCMF is based on mobile vessels that employ a skipper and one to 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 (Smallwood et al. 2021). **Medium** risk.

Economic

The beach value of the fishery was about $1 million in 2020/21 with the majority of the catch being sold live to Asian markets both locally and internationally. **Medium** risk.

GOVERNANCE SYSTEM

Annual Catch Tolerances

Southern Rock Lobster – 50-80 t (under revision)

Current fishing level –Unacceptable

The SCCMF planned for transitioning from an input to an output-controled management system with the implementation of TACs for five species in each of the four coastal zones. Anticipated to be implemented on 1 July 2022 (start of the 2022/23 season).

During the 2020/21 season however, the fishery remained 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 combined with COVID market impacts may have contributed to the lower 2020/21 southern rock lobster catch. In addition, voluntary catch limits have been in place for the five target species which are retained in Zone 3 as an interim measure to address sustainability concerns.

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 through Annual Management Meetings convened by WAFIC. 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 (Major)

Management initiatives are focusing on the transition of the fishery from input to output control. Quota working group meetings and broader consulation is currently underway to further refine quota management arrangements anticipated to commence at the start of the 2022/23 season.

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. The price obtained for rock lobsters has been affected by limitations in exporting live lobster into the Chinese market, as this was the main market. **Medium** risk.

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SOUTH COAST GREENLIP/BROWNLIP ABALONE RESOURCE STATUS REPORT 2022

L. Strain, F. Fabris and N. Blay

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 four management areas (Greenlip/Brownlip Abalone Figure 1), which are allocated annually as Individually Transferable Quotas (ITQs).

Recreational fishing only occurs in the Southern Zone (Greenlip/Brownlip Abalone Figure 1) with management arrangements that include a specific abalone recreational fishing licence, size limits, daily bag and possession limits, and temporal closures.

Further information on the fishery can be sourced from Hart *et al*. (2017) and Strain *et al.* (2021) at www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_8.pdf. and http://www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_8_addendum_4.pdf.

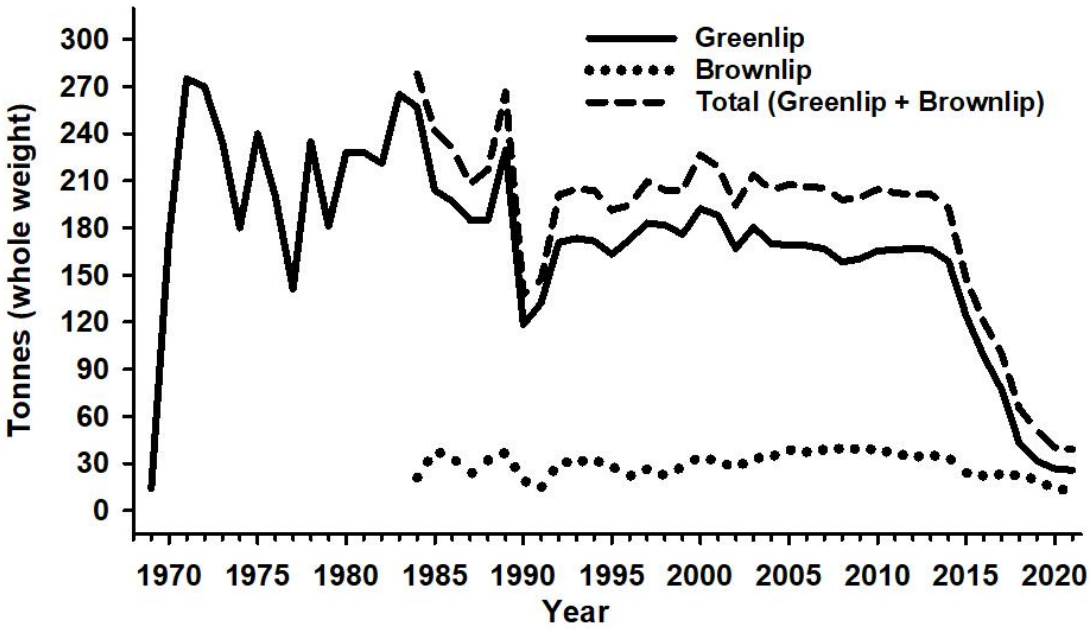
SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (48.8 t)	Total Catch 2021: 39 t	Management Action
Recreational fishery (not formal)	Total Catch 2021: 8 t	Acceptable
EBFM		
Indicator species		
Greenlip abalone (*Haliotis laevigata*)	Area 2 – PI below threshold but above limit Area 3 – PI below limit in open regions. Spatial closures enforced in 2021.	Inadequate
Brownlip abalone (*Haliotis conicopora*)	Area 2 – PI below limit Area 3 – PI above target	Adequate
Ecological		
Bycatch	Negligible risk	Adequate
Listed Species	Negligible risk	Adequate
Habitat	Negligible risk	Adequate
Ecosystem	Negligible risk	Adequate
Economic (GVP $2.3 m)	High risk	Management Action
Social (amenity)	Medium risk	Acceptable
Governance	High risk	Management Action
External Drivers	High risk	Management Action

GREENLIP/BROWNLIP ABALONE FIGURE 1.
Map showing the boundaries of the management areas for Greenlip/Brownlip Abalone in the commercial Abalone Managed Fishery in Western Australia. Also showing the boundaries of the three zones within the Western Australian Recreational Abalone Fishery; the Western Zone, the Northern Zone and the Southern Zone.

CATCH AND LANDINGS

In 2021 the total commercial Greenlip/Brownlip abalone catch was 39 t whole weight (Greenlip 25.9 t and Brownlip 13.1 t), which was 80% of the combined TACC (48.8 t whole weight). This was an increase in catch of 3 t from 2020 with the 2021 season recording the second lowest catch in 51 years (Greenlip/Brownlip Abalone Figure 2). The 2021 catch remained low given the historically low TACCs for both species, which included a reduction in the Area 2 Brownlip abalone TACC by 5 t whole weight, while a commercial industry decision restricted catch to less than 50% of the Brownlip abalone TACC in Area 2. The combined recreational catch of both species is estimated at 8 t, which was derived from a 2007 telephone diary survey, is still considered sufficiently accurate.



GREENLIP/BROWNLIP ABALONE FIGURE 2.
Commercial Greenlip and Brownlip abalone catch (t, whole weight) by season as recorded against the nearest calendar year.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Greenlip abalone (Inadequate)

Greenlip abalone are distributed from south-west WA across southern Australia to Victoria and Tasmania. A genomic study suggests the existence of one single Greenlip abalone population along the WA coast, but with five adaptive populations (Sandoval-Castillo *et al*. 2018). The fishery has a legal minimum length of 14.5 cm in Area 2 and 15 cm in Area 3, which allows 2–5 years of spawning to occur before recruitment to the fishery.

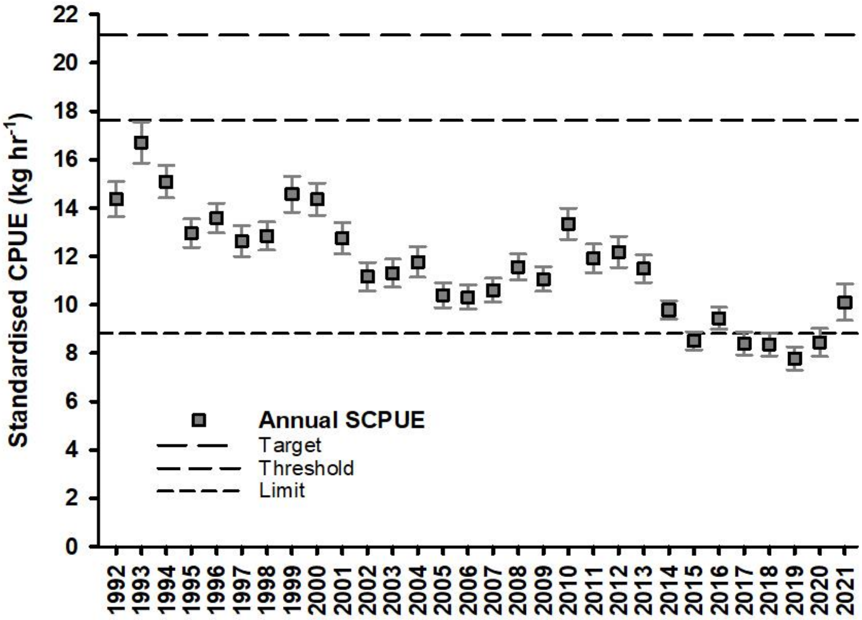
To determine the TACCs for each management area, the stock status is assessed by the performance indicator (PI) of standardised catch per unit effort (SCPUE), which uses commercial catch and effort statistics, and other measures such as fisheries-independent sampling. The reference levels for Greenlip abalone (Area 2 and 3) have recently been updated based on estimates of biomass relative to the levels associated with Maximum Sustainable Yield (MSY), i.e. B_{MSY}.

In Management Area 2 (Esperance) there was a declining trend in PI (annual SCPUE) from 2010 to below the limit reference level (2017-2020). However, in recent seasons this decline has arrested and the PI has increased to above the new limit reference level in 2021 (Greenlip/Brownlip Abalone Figure 3a).

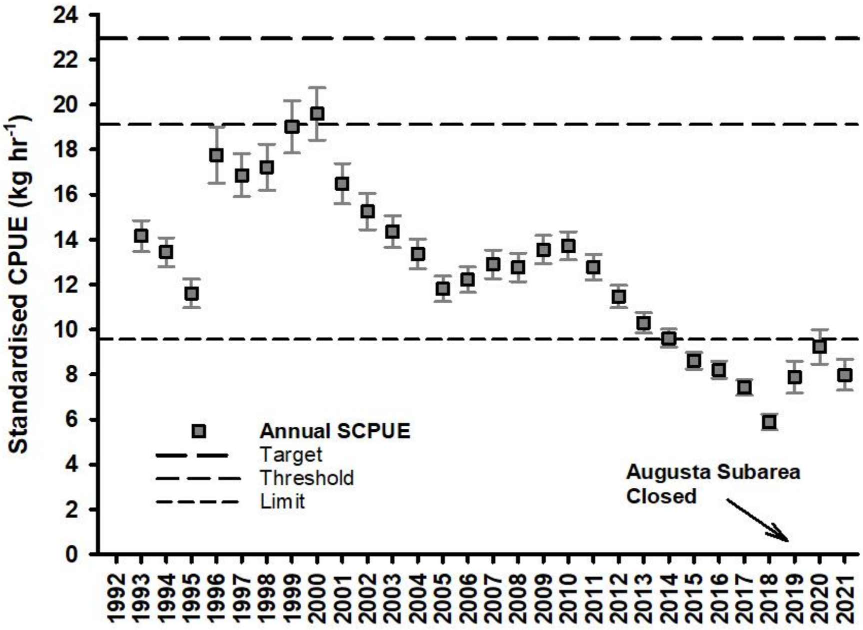
In Management Area 3 (Albany) the PI (annual SCPUE) declined between 2010 and 2018 but went below the limit reference level in 2015 (Greenlip/Brownlip Abalone Figure 3b). Note, the reference levels were updated in 2021 as part of the harvest strategy review. In 2019, the major component of Area 3 (Augusta) was closed to fishing and the TACC reduced to 4 t (whole weight). The PI increased over the next 2 seasons to the limit reference level but declined again in 2021, however this only represents the open regions of Area 3. Analysis of raw catch rate, average meat weight per individual and length-frequency trends also support evidence of the declining trend between 2010 and 2018. However, steady raw catch rates and increases in meat weight per individual have been present over the last 3 to 4 seasons. Fishery-independent surveys in the Augusta region indicate the total density of Greenlip abalone to be at low levels for the last seven years. The densities of juvenile animals (4 – 8 cm shell length) increased in 2018 after four years of record lows (2014 to 2017), but has since declined slightly post 2018.

Stock status of Greenlip abalone is considered **inadequate**.

a



b



GREENLIP/BROWNLIP ABALONE FIGURE 3.
The standardised CPUE (kg.hr^{-1}) for Greenlip abalone (performance indicator) and reference levels (target, threshold and limit) in Management Area 2 (a) and Area 3 (b).

Brownlip abalone (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 potentially considered conspecific with, Blacklip abalone (*Haliotis rubra*) (Brown and Murray 1992), which are distributed east from the 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 14.5 cm in Area 2 and 15 cm in Area 3, it allows 2–4 years of spawning to occur before recruitment to the fishery.

The stock status is assessed using commercial catch and effort statistics, and an integrated length-based model. Trends in the PI (annual SCPUE) were used for the assessment of the 2021 TACC for each management area. Reference levels for Brownlip abalone (Area 2 and 3) have recently been updated based on estimates of biomass relative to the levels associated with MSY.

In Management Area 2 (Esperance) the PI (annual SCPUE) for Brownlip abalone was relatively stable between 1999 and 2011 just under the threshold reference level. Over the next five seasons the PI declined markedly and was below the limit reference level. The PI then increased over the next two seasons to above the limit before declining again in 2019 and has been below the limit reference level for the last three seasons. In Management Area 3 (Albany) the PI (annual SCPUE) for Brownlip abalone fluctuated greatly during the 1999 to 2010 period. A relatively stable, increasing trend from below the threshold to above the target has been observed from 2011 to 2018. Over the last four seasons the PI has fluctated above the target reference level.

An integrated length-based assessment model has been 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 that the spawning biomass (relative to that for an unfished stock) has remained above the level equating to B_{MSY} in 2020. Consequently, the overall stock status of Brownlip abalone is considered to be **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 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 were 17 vessels registered to operate in the commercial Greenlip/Brownlip Abalone Fishery, but given the low catches in 2021 only a proportion of these were active. 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 17,255 recreational abalone licenses issued in 2021 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. **Medium** risk.

Economic

Estimated annual value (to commercial fishers) for 2021 was $2.3 million, based on the estimated average price received by commercial fishers of $165.73/kg meat weight ($62.14/kg whole weight) for Greenlip abalone and $133.55/kg meat weight ($53.42/kg whole weight) for Brownlip abalone. Greenlip and Brownlip abalone prices remained steady in 2021 and the price for Greenlip abalone is still well above the then high prices of 20 years ago (e.g. $146/kg meat weight in 2001). **High** risk.

GOVERNANCE SYSTEM

Harvest Strategy (Formal)

The harvest strategy 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. Reference levels for Greenlip and Brownlip abalone (Area 2 and 3) have recently been updated based on outputs from model-based assessments that have provided estimates of biomass relative to the levels associated with MSY (DPIRD 2022), which is consistent with MSC principles.

The TACCs (whole weight) have been set for the 2022/23 season using the revised harvest strategy, for Greenlip abalone they are 3.2 t in Area 1, 16 t in Area 2 and 10.7 t in Area 3, while for Brownlip abalone they are 150 kg in Area 1, 3.7 t in Area 2 and 11.2 t in Area 3.

Annual Catch Tolerance Levels Commercial – Not Acceptable Recreational – Acceptable

Commercial: 48.8 t (TACC for 2021/22) (3,440 – 5,270 fishing hours).

Recreational: Not formal.

Commercial catch was below the TACC due to commercial industry decisions. The commercial fishing effort (1412 hours) was also below the expected range. Greenlip abalone stock indicator is below the threshold reference level for Area 2 and below the limit for the open regions of Area 3.

The TACC was reduced to 45 t and spatial closures maintained in Area 3 for the 2022 season (Greenlip abalone TACC at 17% of long-term levels). Recreational catch levels are relatively small and not considered a risk to stocks.

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 the 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), the Southern Seafood Producers Association WA (SSPA) and licensees on operational issues. The Department convenes Annual Management Meetings through the Industry Consultation Unit at the West Australian Fishing Industry Council (WAFIC), who are also responsible for undertaking 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

A Recovery Strategy for Area 3 Greenlip abalone has been finalised, while a Recovery Strategy for Area 2 Brownlip abalone is currently being developed. The Department has reviewed the Harvest Strategy for the Western Australian Abalone Resource in consultation with the commercial and recreational sectors.

The commercial Greenlip/Brownlip abalone fishery has undergone full MSC assessment and achieved certification in 2017, with the 4th surveillance audit and re-certification completed during 2021/22 (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 varied substantially above the legal minimum lengths. Fishery management arrangements may need to be reviewed 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 including the marine heatwave period of 2011-2013, needs to be investigated further. Greenlip and Brownlip abalone have been assessed as a high risk to climate change effects. **High** risk.

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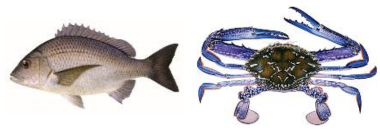
SOUTH COAST ESTUARINE AND NEARSHORE SCALEFISH AND INVERTEBRATE RESOURCE STATUS REPORT 2022



R. Duffy, D. Harris, B. Brooks, S. Blazeski and A. Quinn.

OVERVIEW

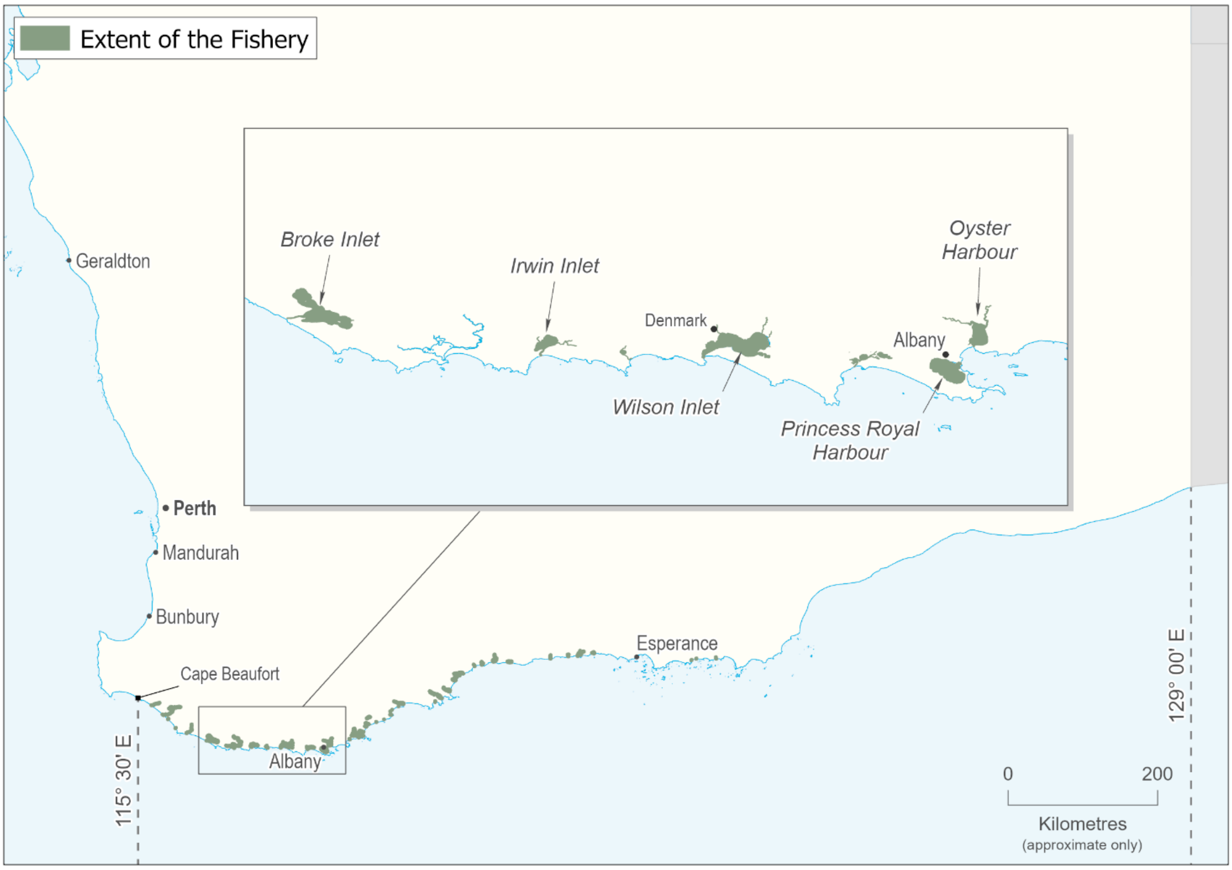
The South Coast Estuarine and Nearshore Scalefish and Invertebrates Resource (SCENSIR) covers a number of commercial fisheries (South Coast Estuarine Managed Fishery (SCEMF) [South Coast Nearshore and Estuarine Figure 1], South Coast Salmon Managed Fishery (SCSMF), and the South Coast Nearshore Net Managed Fishery, which in mid-2021 replaced the Open Access South Coast Fishery and a number of conditional fisheries), and two non-commercial fisheries (recreational fishing and customary fishing) operating in estuaries, and nearshore waters (defined as oceanic waters of less than 20 m depth).

The majority of the commercial catch in this resource is taken by gill net, purpose-designed crab traps, haul net and beach seine; 'G traps' caught large quantities of herring until the fishery was closed in 2015. Commercial catch is monitored via compulsory catch returns submitted as monthly records for most fisheries, but as daily records for the new nearshore net fishery. Although the resource is concerned only with species classified by the Department as nearshore/estuarine, other species are caught by the fisheries grouped within this resource. The creation of the nearshore net fishery, and closure of the open access fishery, now allows these species to be separated. Catch of nearshore/estuarine species in other fisheries on the south coast are not reported in this section.

Fish capture in non-commercial fisheries occurs mainly by line (finfish), drop and scoop nets (blue swimmer crabs), and there is also a small catch via recreational netting. Recreational catch is monitored through surveys of fishers, while customary catch has not been assessed but is considered minimal.

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery	Total Catch 2021: 275 t	Acceptable
Recreational fishery	Total Catch 2020/21: 17–31 t (boat-based only)	Acceptable
EBFM		
Indicator species		
Western Australian salmon	Above target	Adequate
Australian Herring	Above target	Adequate
Cobbler (Wilson Inlet)	Catch within target range	Adequate
Black bream	Increasing catch trends	Adequate
Blue swimmer crab	Not assessed	Adequate
Ecological		
Bycatch	Low risk	Adequate
Protected Species	Negligible risk	Adequate
Habitat	Negligible risk	Adequate
Ecosystem	Low risk	Adequate
Social (high amenity)	Moderate risk	Acceptable
Economic (GVP < $1m)	Moderate risk	Acceptable
Governance	Moderate risk	Acceptable
External Drivers	High risk	Acceptable



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 1.
Map showing the boundaries, and primary finfish and crab fishing areas, of the South Coast Estuarine Managed Fishery.

CATCH AND LANDINGS

In 2021, the total commercial catch of this resource was 275.1 t. The top 10 species (or species groupings), by weight, caught in this resource are shown in South Coast Estuarine and Nearshore Scalefish and Invertebrate Resource Table 1.

Since 1990 there has been a major decline in total catch in each of the main commercial finfish fisheries, resulting in a steady decline in commercial production in the SCB. This has been due to a complex suite of drivers, including effort reductions, changing environmental conditions, changing market demands, and declining abundance of some species.

The boat-based recreational harvest ranges for the top 10 nearshore and estuarine species in the South Coast (representing 97% of the resource kept catch by numbers) were steady at 24 t (95% CI 17–31) in 2020/21 compared with 13 t (95% CI 8–18) in 2017/18, 17 t (95% CI 11–22) in 2015/16 and 29 t (95% CI 20–39) in 2013/14, but lower than 46 t (95% CI 33–59) in 2011/12 (Ryan *et al*. 2022).

The boat-based recreational harvest range for blue swimmer crab in the SCB (representing <1% of state wide catch) was steady at 0.1 t (95% CI 0.0–0.3) in 2020/21 compared with 0.1 t (95% CI 0.0–0.2) in 2017/18 and 0.5 t (95% CI 0.0–1.0) in 2015/16, but lower than 2.3 t (95% CI 0.8–3.8) in 2013/14 and 2.9 t (95% CI 0.7–5.1) in 2011/12 (Ryan *et al*., 2022).

No recent estimates of shore-based recreational catches are available.

SOUTH COAST ESTUARINE AND NEARSHORE SCALEFISH AND INVERTEBRATE RESOURCE TABLE 1.
Catch (tonnes) of top 10 species (ordered by weight in 2021) from commercial fisheries in the South Coast Estuarine and Nearshore Scalefish and Invertebrates Resource in the previous five years.

Species	Scientific name	2017	2018	2019	2020	2021
Black Bream	*Acanthopagrus butcheri*	76.8	50.9	63.8	70.0	80.3
Australian Herring	*Arripis georgianus*	38.9	19.9	16.6	34.2	49.5
Western Australian Salmon	*Arripis truttaceus*	50.4	51.5	59.6	78.1	48.5
Estuary Cobbler	*Cnidoglanis macrocephalus*	60.6	37.2	35.0	41.2	32.1
Sea Mullet	*Mugil cephalus*	28.0	18.0	18.0	19.8	20.8
Tarwhine	*Rhabdosargus sarba*	8.2	8.0	9.8	9.7	12.9
Triggerfishes & Leatherjackets		10.4	11.0	8.9	12.9	7.0
King George Whiting	*Sillaginodes punctatus*	8.7	11.9	17.1	13.7	4.0
Southern Garfish	*Hyporhamphus melanochir*	4.5	4.5	4.6	5.3	3.5
Blue Swimmer Crab	*Portunus armatus*	10.5	7.3	19.0	10.7	3.5
Other species *						13.0
Total		328.9	249.9	289.2	334.1	275.1

*Other species data only presented for reporting year as changes in compostion of the top 10 species in the reporting year changes “other species” catch calculations in previous years.

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. The species reported below, Western Australian Salmon, Australian Herring, Estuarine Cobbler (Wilson Inlet) and Black Bream are those species currently identified as indicator species (Department of Fisheries 2011). Use of the indicator species approach for the SCENSIR is currently under review. Blue Swimmer Crab catch has been included in this report as increasing warmer temperatures (such as the 2011 extreme marine heatwave), which are influenced by the strength of the Leeuwin Current, have resulted in substantial periodic increases in crab catches on the south coast.

Western Australian Salmon (Sustainable-Adequate)

Western Australian Salmon in WA are managed as a single stock, consistent with its structure as a single biological stock across southern Australia. Higher level assessments are periodically undertaken (every 5 years). Stock status is assessed annually based on commercial and recreational catch in relation to recent trends and management action.

The most recent stock assessment (Wise & Molony 2018) found that low catches, low fishing mortality:natural mortality ratio and an SPR above 40% all indicated that there is a low risk to sustainabilty.

The commercial catch of salmon in the SCB for 2021 was 48.5 t, similar to previous years and substaintially lower than historic catches due to demand (Figure 2).

On this basis, the Western Australian Salmon stock is classified as **sustainable – adequate.**

Australian Herring (Sustainable-Adequate)

Australian herring in WA are managed as a single stock, consistent with its structure as a single biological stock across southern Australia, with the spawning biomass located in south-west WA. Higher level assessments are periodically undertaken (every 5 years). Stock status is assessed annually based on commercial and recreational catch in relation to recent trends and management action.

The most recent stock assessment (Duffy et al 2021) indicated that after a period of very high catches prior to 2000, catches have now been below the estimated MSY for more than a decade. The spawning biomass is estimated to be at or above the target level (40%). As a result, the stock is considered to have recovered to a level where there is a low risk to sustainabilty.

The catch of herring in the SCB in 2021 of 50 t was similar to previous years (Figure 3) as too was recreational catch.

On this basis, the Australian herring stock is classified as **sustainable – adequate.**

Estuarine Cobbler (Wilson Inlet: Sustainable-Adequate)

Estuarine cobbler in each estuary is a discreet biological stock (Avayzian et al. 1994). Historically, the majority of the cobbler catch has occurred in Wilson Inlet, as such stock status of cobbler is assessed in this estuary only. Higher level stock assessments are periodically undertaken (every 5 years). Stock status is assessed annually based on catch remaining below a 40 t tolerance level.

A Level 4 assessment completed in 2020 found a High Risk to the sustainability of the Wilson Inlet stock based on catches of over 50 t, that occured prior to 2018. Catches since 2018 have been approximately 40 t or less, and at this level the risk has been reduced to moderate. The catch of cobbler in Wilson Inlet in 2021 was 19.7 t, below the 40 t tolerance level (Figure 4). Catch has remained below 40 t for four consecutive years.On this basis, the Wilson Inlet estuarine cobbler stock is considered as **sustainable - adequate.**

Black bream (Sustainable-Adequate)

Black bream in each estuarine population represents a genetically discrete stock (Chaplin et al. 1997). Stock status is assessed annually for the SCB, and is based on comparison of current catch to annual trends for the four main estuaries, Beaufort Inlet, Oyster Harbour, Stokes Inlet and Wilson Inlet.

In 2021 catch of black bream in Beaufort Inlet was close to 0 t (Figure 5) due to fish kills related to reduced freshwater flows, algal blooms and very high salinity in 2020. Catch in Oyster Harbour, was 6.3 t, similar to previous years. Catch in Wilson Inlet was 17.0 t and 52.9 t in Stokes Inlet, both of which continue an increasing trend in catch. Total catch of black bream in the SCB continues to show an increasing trend, achieving the highest catch in nearly 30 years (Figure 5), despite the substantial reduction in catch from the the fish kill in Beaufort Inlet. Further work is required to determine whether the increase in catch reflects increased effort or increased abundance.

On this basis , the South Coast Bioregion black bream stock is considered as **sustainable - adequate**.

Blue swimmer crab (Sustainable-Adequate)

While there is the potential for some recruitment from more northern waters, blue swimmer crab populations in each estuary are considered to represent a discreet stock for management purposes. Stock status is assessed annually based on commercial and recreational catch in relation to recent trends and management action. Stock abundance of blue swimmer crabs in the SCB appears to be heavily influenced by the strength of the warm, southward-flowing Leeuwin Current. Crabs recruit to these waters during strong current years, which result in warmer water temperatures, with subsequent catch and effort highly variable in response to these pulses of abundance. The two peaks in abundance in the last 20 years have been as a result of the 1999 and 2011-2013 marine heatwaves. For more detailed descriptions of blue swimmer crab biology and South Coast crab fisheries see the Resource Assessment Report (Johnston et al., 2020).

The SCEMF reported a total annual blue swimmer crab catch for 2021 of 3.5 t, down from 10.5 t landed in 2020 (Figure 6). Most of this catch was taken in Oyster Harbour (dedicated traps – 1.5 t; gill nets – 0.9 t) and Princess Royal Harbour (dedicated traps – 0.5 t; gill nets – 0.7 t).

While the size of stock and relative exploitation level along the south coast is yet to be fully understood, the low commercial and recreational catch and effort and environmentally driven nature of the stock suggests the blue swimmer crab resource in the SCB is **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**.

Blue swimmer crab traps are purpose-designed to minimise the capture of non-target species and undersized crabs. The majority of fish and other bycatch species escape through the trap entrance gaps when the trap is soaking or hauled. The small quantity of bycatch that is caught and returned by commercial crab fishers is considered to pose a **negligible risk** to these stocks.

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 sea lion or seal in the net. Fishers are then able to release it from their seine net without injury to the animal. There have been no reports of incidental mortalities 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 arrangements 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, haul nets and crab traps over predominantly sand and mud bottoms is unlikely to have any impact on these habitats in estuaries and nearshore waters. Similarly, the risks from line fishing, and drop and scoop netting methods used by recreational fishers, to bottom substrates are **negligible**. 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 the risk to benthic habitats are considered **negligible** .

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 SCB provide a high social amenity for the WA community. There is currently a **moderate risk** to these values.

In 2021, catch was recorded against 25 licences in the South Coast Estuarine Managed Fishery, and eight in the South Coast Salmon Fishery. An additional commercial fisher is currently operating in the SCB targeting sand crabs by Exemption. 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 Managed Fishery is an important source of fresh local fish and crabs 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 (Gross Value of Production) to commercial fishers for 2021

Level 2: $1 million - $5 million

This reflects the commercial beach price of landed product only and does not include economic flow-on values such as employment within the fishery, additional employment/value in distribution networks, retail fish sales sectors and spending on fuel and equipment.

Recreational fishing in nearshore and estuarine waters generates economic activity in many regional towns in the SCB. Recreational fishing in the Great Southern area is estimated to be worth approximately $45.8 million, and $146.6 million in the Goldfields-Esperance area (McLeod and Lindner 2018).

Due to low catches in commercial salmon and estuarine fisheries as well as the long term decline in commercial production the economic risk is considered **Moderate.**

GOVERNANCE SYSTEM

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 commercial Western Australian salmon fisheries or the South Coast Estuarine Managed Fishery.

Annual Catch Tolerance Levels

A voluntary 40 t tolerance level for cobbler in Wilson Inlet has been arranged with commercial fishers. Maintenance of the catch below this level is considered indicative of a stock being above the target.

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 the Southern Seafood Producers Association, and licensees on operational issues. Industry Management Meetings are convened by the Department through the commerical peak representative body, Western Australian Fishing Industry Council (WAFIC), who are also responsible for undertaking statutory management plan consultation on behalf of the Department under a Service Level Agreement. 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 new stock assessment for Australian herring was completed in 2021.

A working group has been tasked with developing a future management strategy for the Australian herring resource. This strategy will be developed in collaboration with herring stakeholders to ensure that management of the herring stock is in line with the main objective for the resource set under the impending *Aquatic Resources Management Act 2016*, which is to support quality recreational fishing experiences and commercial fishing operations focussed on the supply of herring for human consumption.

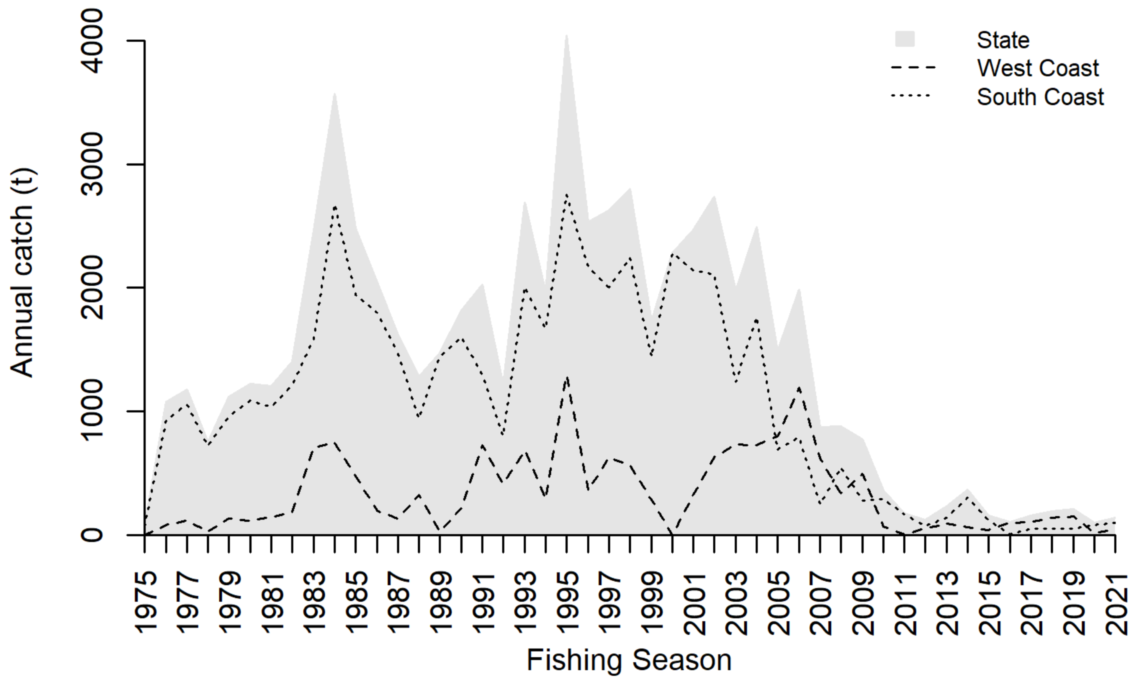
The Minister for Fisheries finalised the review of South Coast commercial line, fish trap and net fisheries in January 2019. The Department drafted two new management plans to give effect to the outcomes of the review, namely the South Coast Nearshore Net Managed Fishery Management Plan and the South Coast Line and Fish Trap Managed Fishery Management Plan. These new Management Plans will regulate previous open-access nearshore netting activities on the South Coast. The two new management plans commenced on 1 July 2021.

A five-year Instrument of Exemption was issued endorsing one commercial fisher to target the sand crab (*Ovalipes australiensis*) using purpose-designed hourglass traps in waters between Augusta and Hopetoun.

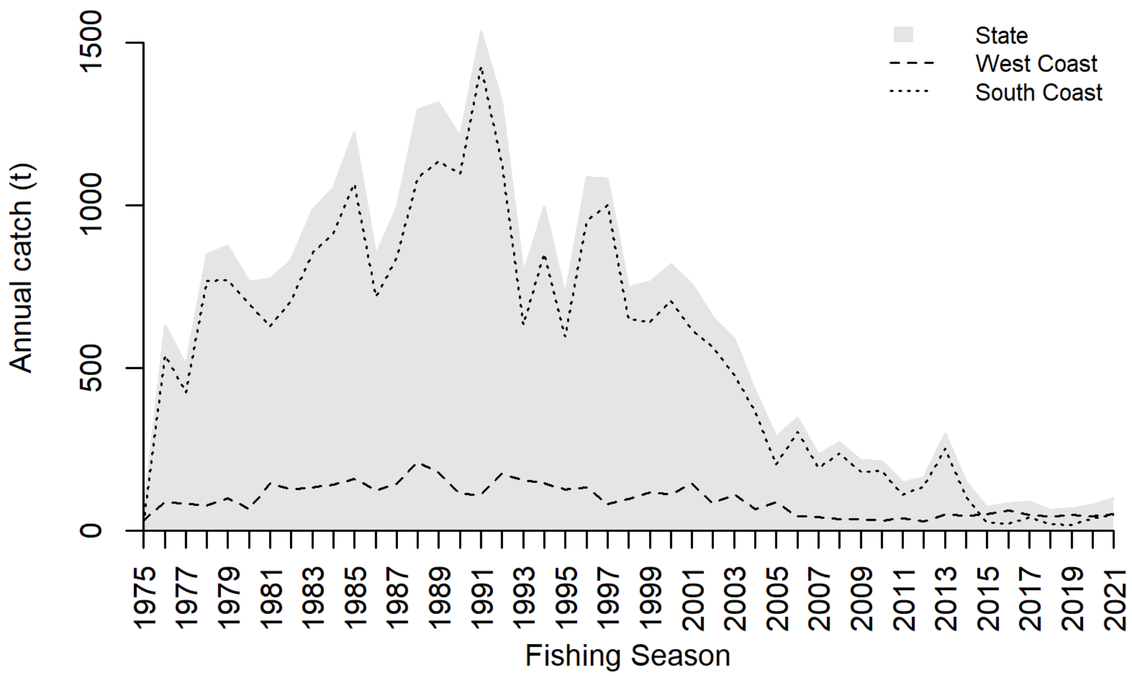
EXTERNAL DRIVERS

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, Western Australian salmon, and blue swimmer crab. Cool inshore temperatures due to a strong Capes Current provided a favourable 'corridor' for salmon to migrate northwards in 2016, with exceptionally high numbers of fish observed along the west coast during the autumn spawning period, and some travelling as far north as Exmouth.

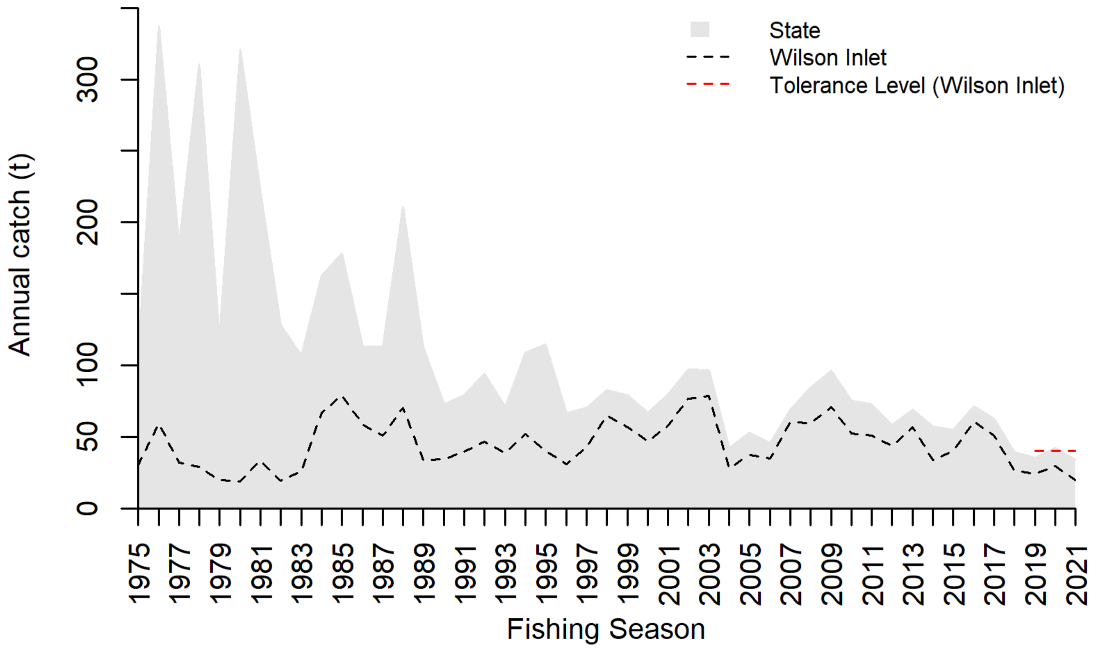
Fluctuating market demand is a significant factor affecting the annual commercial catch level of many species. On the basis of market demand and price commercial fishers sometimes elect not to capture a school of fish, or release part of their catch, when a market is not available. This is particularly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



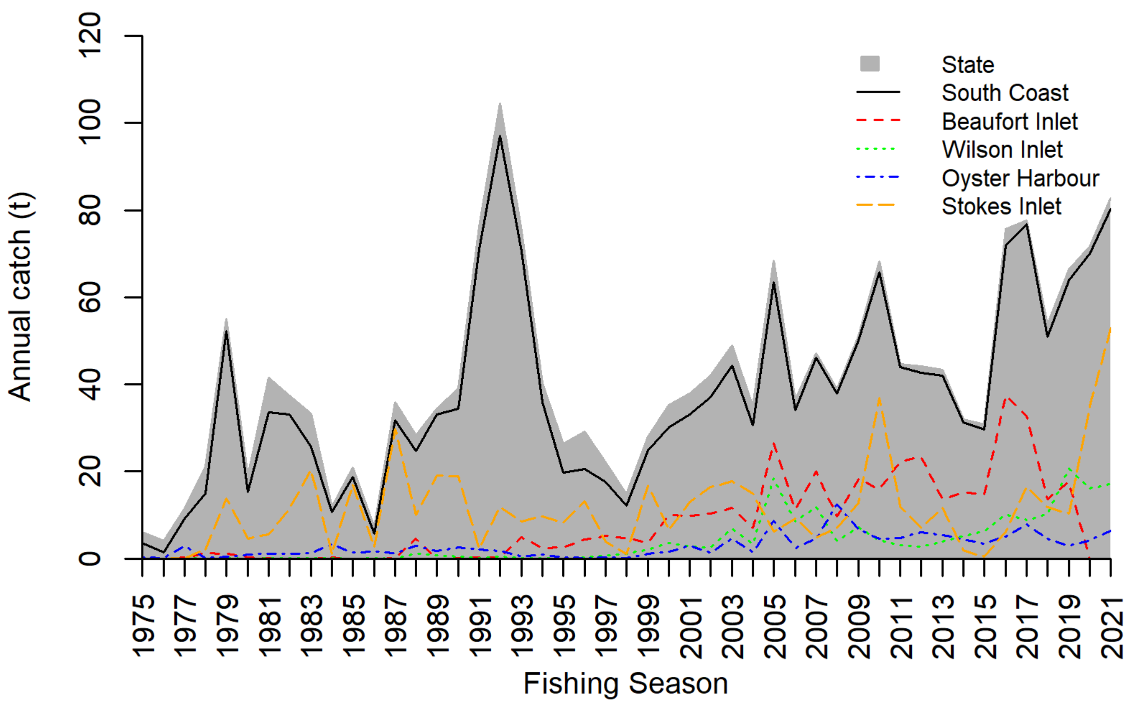
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 2.
Annual commercial catches of Western Australian salmon in the State and the South Coast Bioregion since 1975. Note data from 1975 is only for the second 6 months of the year when data collection began.



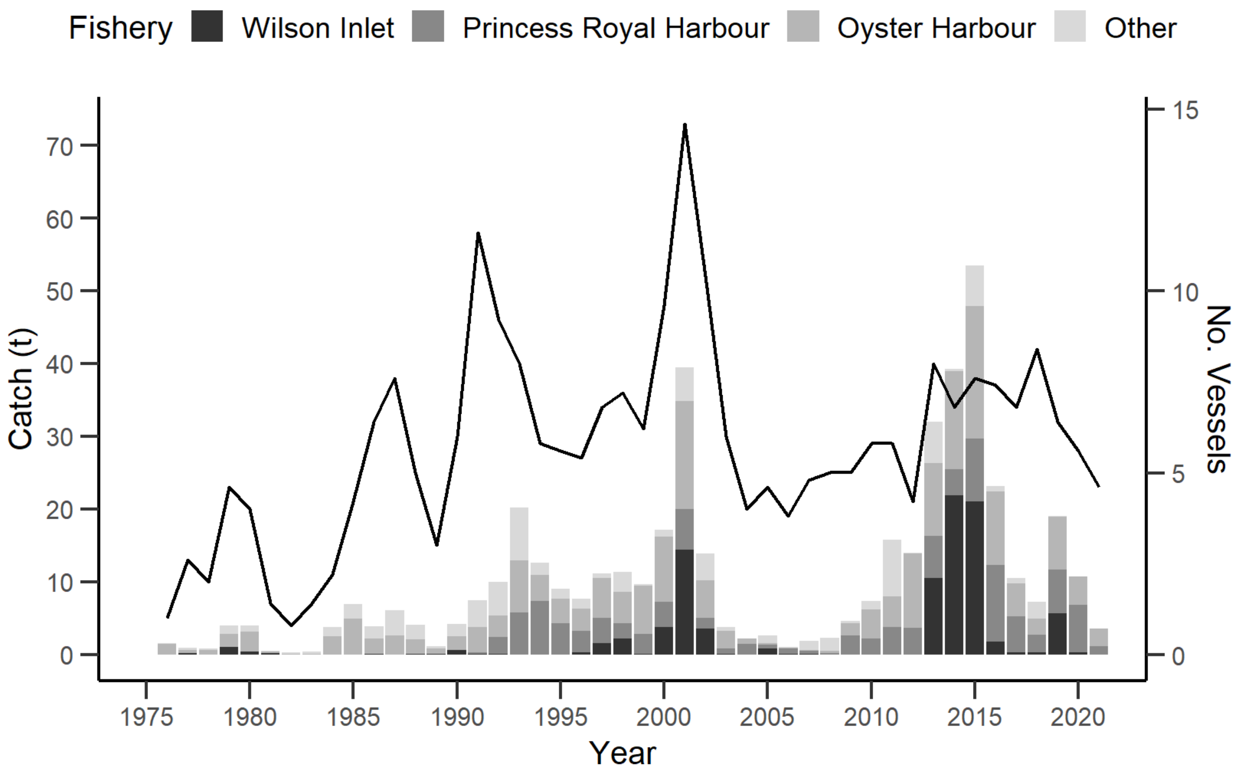
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 3.
Annual commercial catches of Australian herring in the State and the South Coast Bioregion since 1975. Note data from 1975 is only for the second 6 months of the year when data collection began.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 4.
Annual commercial catches of estuary cobbler in the State, South Coast Bioregion and Wilson Inlet, since 1975. Note data from 1975 is only for the second 6 months of the year when data collection began.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 5.
Annual commercial catches of black bream in the State, South Coast Bioregion, and two major estuaries, Wilson Inlet and Beaufort Inlet, since 1975. Note data from 1975 is only for the second 6 months of the year when data collection began.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 6.
Annual commercial blue swimmer crab catch for the resource across all fishing methods. The black line represents the historical change in the number of vessels reporting blue swimmer crab catches in the South Coast Bioregion. 'Other' fisheries include: Broke Inlet, Culham Inlet, Dempster Inlet, Gordon Inlet, Irwin Inlet, Stokes Inlet, Waychininup Inlet, Hamersley River, Oldfield River, King George Sound and Esperance.

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SOUTH COAST SMALL PELAGIC SCALEFISH RESOURCE STATUS REPORT 2022

J. Norriss and S. Blazeski

OVERVIEW

The five species comprising the south coast small pelagic scalefish resource are Australian sardine (pilchards, *Sardinops sagax*), yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*), scaly mackerel (*Sardinella lemuru*) and maray (*Etrumeus jacksoniensis*). Australian sardine is the indicator species and dominates the catch, taken predominantly by the quota managed, limited entry South Coast Purse Seine Managed Fishery (SCPSMF). These fishers use purse seine gear in waters between Cape Leeuwin and the South Australian border, although most effort is concentrated close to embayments at Albany, Bremer Bay and Esperance. 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 they have not reported catching sandy sprat since 1993/94, and have not reported catching blue sprat since 2010/11. The SCPSMF has five management zones (South Coast Small Pelagic Figure 1), centred on King George Sound (Zone 1), Albany (Zone 2), Bremer Bay (Zone 3), Esperance (Zone 4) and a developmental zone near Cape Leeuwin (Zone 5) where catches have been negligible. The SCPSMF was the largest tonnage fishery in WA during the late 1980s and early 1990s, until a virus devastated Australian sardine stocks in 1995 and 1998/99. While surveys demonstrated a strong recovery by the mid-2000s, low fishing effort has resulted in ensuing catches remain well below the total allowable commercial catch (TACC), which was conservatively set at 5,683 t.

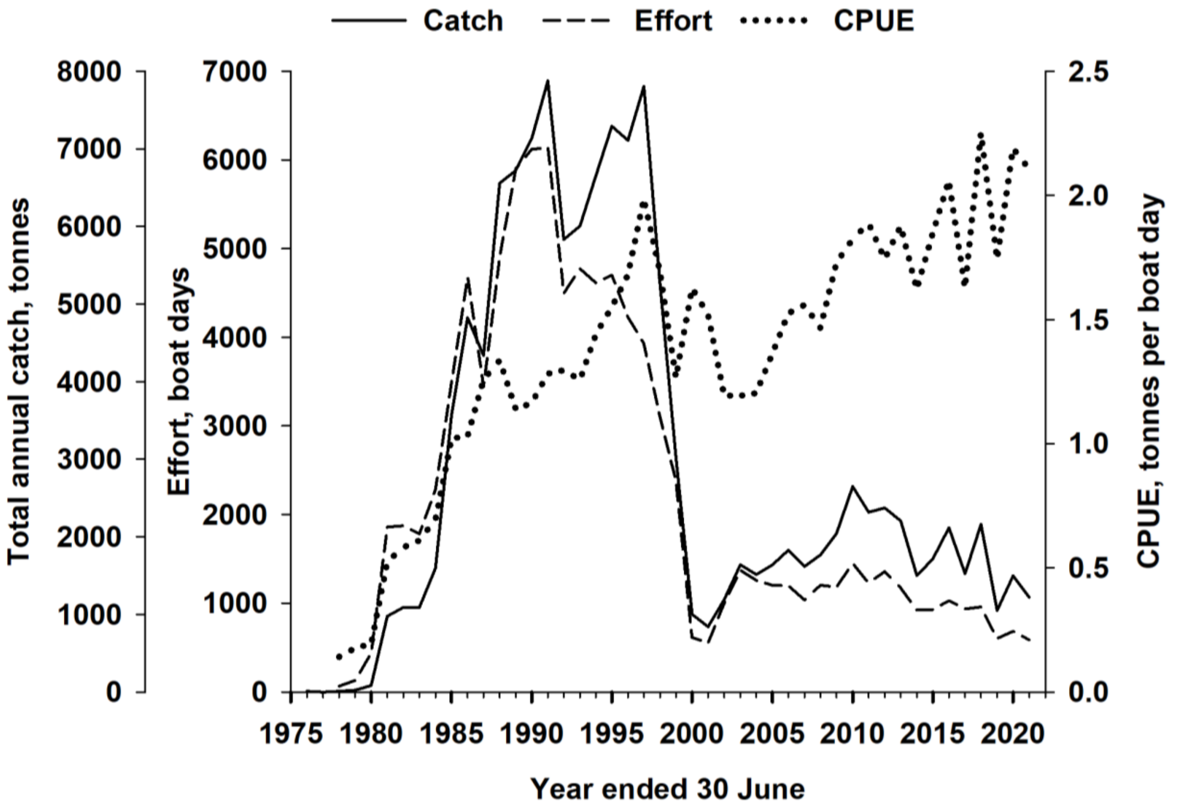
SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (5,683 t)	Total Catch 2020/21: 1,225 t	Acceptable
Recreational fishery (not applicable)	Total Catch 2020/21: <1 t (boat-based only)	Acceptable
EBFM		
Indicator species		
Australian sardine	Above target	Adequate
Ecological		
Bycatch	Negligible risk	Adequate
Listed Species	High risk	Voluntary monitoring and mitigation, industry consultation
Habitat	Negligible risk	Adequate
Ecosystem	Low risk	Adequate
Economic (GVP $1-5 m)	Moderate risk	Acceptable
Social (low amenity)	Low risk	Acceptable
Governance	Stable	Acceptable
External Drivers	Moderate risk	Acceptable

SOUTH COAST SMALL PELAGIC FIGURE 1.
Map showing the boundaries and management zones of the South Coast Purse Seine Managed Fishery. Fishing operations occur over a small area, almost exclusively in coastal embayments near Albany, Bremer Bay and Esperance.

CATCH AND LANDINGS

The SCPSMF total catch of 1,225 t in the 2020/21 quota year, was comprised of >99% Australian sardine, and represents a decrease of 18% from the previous year (South Coast Small Pelagic Figure 2). The total catch was comprised of 837 t from King George Sound (Zone 1) and 388 t from Bremer and Esperance (Zones 3 and 4) combined (South Coast Small Pelagic Table 1). Fishing effort in the 2020/21 quota year was 585 boat days, a 14% decrease from the previous year, involving 9 vessels.



SOUTH COAST SMALL PELAGIC FIGURE 2.
Total annual catch, effort and nominal catch per unit effort (CPUE) for Australian sardine in the SCPSMF from 1975/76 to 2020/21.

INDICATOR SPECIES ASSESSMENT AND STOCK STATUS

Australian sardine (Sustainable-Adequate)

The Australian sardine is a small, low trophic level pelagic species that feeds by filtering plankton. Longevity is reported up to 9 years of age, sexual maturity is achieved in the second year of life, and the maximum size is 200-250 mm SL.

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 annual exploitation rate in the mid-2000s 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 not exceeded 3,000 t since then. From 2008/09 the nominal catch rate has remained relatively high (South Coast Small Pelagic Figure 2). A risk based, weight of evidence assessment (Blazeski *et al.* 2021) found catches and the biological stock to be **sustainable-adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch

The SCPSMF is a species-restricted fishery prohibiting the landing of any species not listed in the management plan (listed above). Small quantities of fish bycatch species are sometimes captured incidentally, but this occurs infrequently and the majority are released from the net unharmed resulting in a **negligible** risk (Blazeski *et al.* 2021).

Protected species

SCPSMF operators must record all interactions with endangered, threatened and protected species on Catch and Disposal Records (CDRs) for each fishing trip and on statutory monthly Catch and Effort Statistics returns.

Interactions with protected species, particularly Flesh-footed shearwaters (FFS), are mitigated and managed through the implementation of a voluntary SCPSMF Code of Practice (Code) which is reviewed annually. A Special Management Period (SMP, March & April) has been designated under this Code, when the risk of FFS interactions is highest. During the SMP fishers avoid fishing at dawn when interaction risk is believed to be elevated. Analyses of fishery dependent and independent observer data confirm that the timing of the SMP is suitable as this is when FFS interactions are highest (Norriss *et al*. 2020). Based on observer data, total annual FFS mortalities for 2016/17 and 2017/18 were estimated (±95% confidence limits) to be 123 (52-251) and 172 (91-302) respectively (Norriss *et al*. 2020). Although these estimates are below the sustainable limits estimated for WA's FFS population, the extent of other anthropogenic mortalities is unknown. An Ecological Risk Assessment (Blazeski *et al.* 2021) found FFS to be at **high risk**. For dolphins there was a **low risk** and for other protected species there was a **negligible** risk.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

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 any impact is restricted to a small, localised area. Moreover, the likelihood of net damage motivates fishers to avoid contact with reef or coral. An Ecological Risk Assessment (Blazeski *et al.* 2021) found there was a **negligible** risk to habitats from the SCPSMF operations.

Ecosystem

Australian sardine are a relatively short lived, low trophic level species important for ecosystem structure and function. Their abundance is subject to large natural variation in response to environmental conditions, and catch quotas are likely to be <10% of the spawning biomass. An Ecological Risk Assessment (Blazeski *et al.* 2021) found there was a **low** ecosystem risk from the SCPSMF.

Broader environment

An Ecological Risk Assessment (Blazeski *et al.* 2021) found risks associated with air quality, water quality and noise pollution from SCPSMF operations was **negligible**.

SOCIAL AND ECONOMIC OUTCOMES

Social

Small pelagic fish are not a major target for recreational fishers and catches are low: the only species detected in the catch of boat-based recreational fishers during 2020/21 was <1 t of yellowtail scad (Ryan *et al*. 2022). Australian sardine are an important bait for recreational fishers. **Low** risk.

Economic

Nine active vessels as well as specialised small pelagic fish processing facilities in Albany, Bremer Bay and Esperance provided local employment during 2020/21. The majority of the catch is sold as bait for recreational and commercial fishers. Some is for human consumption, aquaculture feed and pet food. The estimated gross value of product (GVP) for the SCPSMF in 2020/21 was level 2 ($1-5 million). Considering possible management responses to seabird interactions, there is a **moderate** risk to this level of return.

GOVERNANCE SYSTEM

Harvest Strategy

The SCPSMF is managed under a constant catch harvest strategy approach, with catches limited to quotas (TACC) set for each management zone. Any proposed changes to the TACC are made with regard to total catches and nominal catch rates, in consultation with stakeholders.

Allowable Catch Tolerance Levels

The SCPSMF total annual catch for all species combined in the 2020/21 quota year was only 22% of the total allowable commercial catch (TACC, South Coast Small Pelagic Table 1). Catches are therefore at **acceptable** levels.

Compliance

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

Consultation

The Department undertakes consultation directly with the Southern Seafood Producers Association, and SCPSMF licensees on operational issues on an as needs basis, and more formally via industry Management Meetings convened by the Western Australian Fishing Industry Council (WAFIC) pursuant to 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

The South Coast Small Pelagic Scalefish Resource will continue to be monitored using catch and nominal catch rates.

In late 2022, the Department intends to apply to the Commonwealth Department of Climate Change, Energy, the Environment and Water, on behalf of the SCPSMF, to be assessed against the Commonwealth Guidelines for the Ecologically Sustainable Management of Fisheries, for the purpose of becoming an approved wildlife trade operation and gaining export approval. As a key part of this process, the Department convened an Ecological Risk Asessment (Blazeski *et al.* 2021) of the SCPSMF's impact on retained and bycatch species, endangered, threatened and protected species, habitats and the broader environment (results reported above). The ERA process involved a broad range of stakeholders including representatives of the commercial fishing sector, State and Australian Government agencies, Birdlife Australia, Conservation Council WA, the University of Western Australia, Murdoch University and the Marine Stewardship Council.

A formal harvest strategy for the Statewide Small Pelagic Scalefish Resource is yet to be developed, however, it is noted as a future management initiative.

EXTERNAL DRIVERS

Preparations and negotiations are underway for a proposed south coast marine park in state waters from Bremer Bay to the South Australian border. The impact on purse seine fishing is as yet unknown. Climate change is likely to be causing a gradual southward contraction in the natural distribution of Australian sardine. These external drivers represent a **moderate** risk.

SOUTH COAST SMALL PELAGIC TABLE 1.
2020/21 catches and total allowable commercial catches (TACC) for the major Management Zones of the South Coast Purse Seine Managed Fishery.

Management Zone	TACC (t)	2020/21 catch (t)	Active vessels	2020/21 catch as % of TACC
Albany (Zones 1 and 2)	2,683	837	6	31%
Bremer Bay and Esperance (Zones 2 and 3)[#]	3,000	388	3	13%
Total for Fishery	5,683	1,225	9	22%

Zones cannot be reported individually because insufficient vessels operated in 2020/21.

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TEMPERATE DEMERSAL GILLNET AND DEMERSAL LONGLINE FISHERIES RESOURCE STATUS REPORT 2022

M. Braccini & M. Watt

OVERVIEW

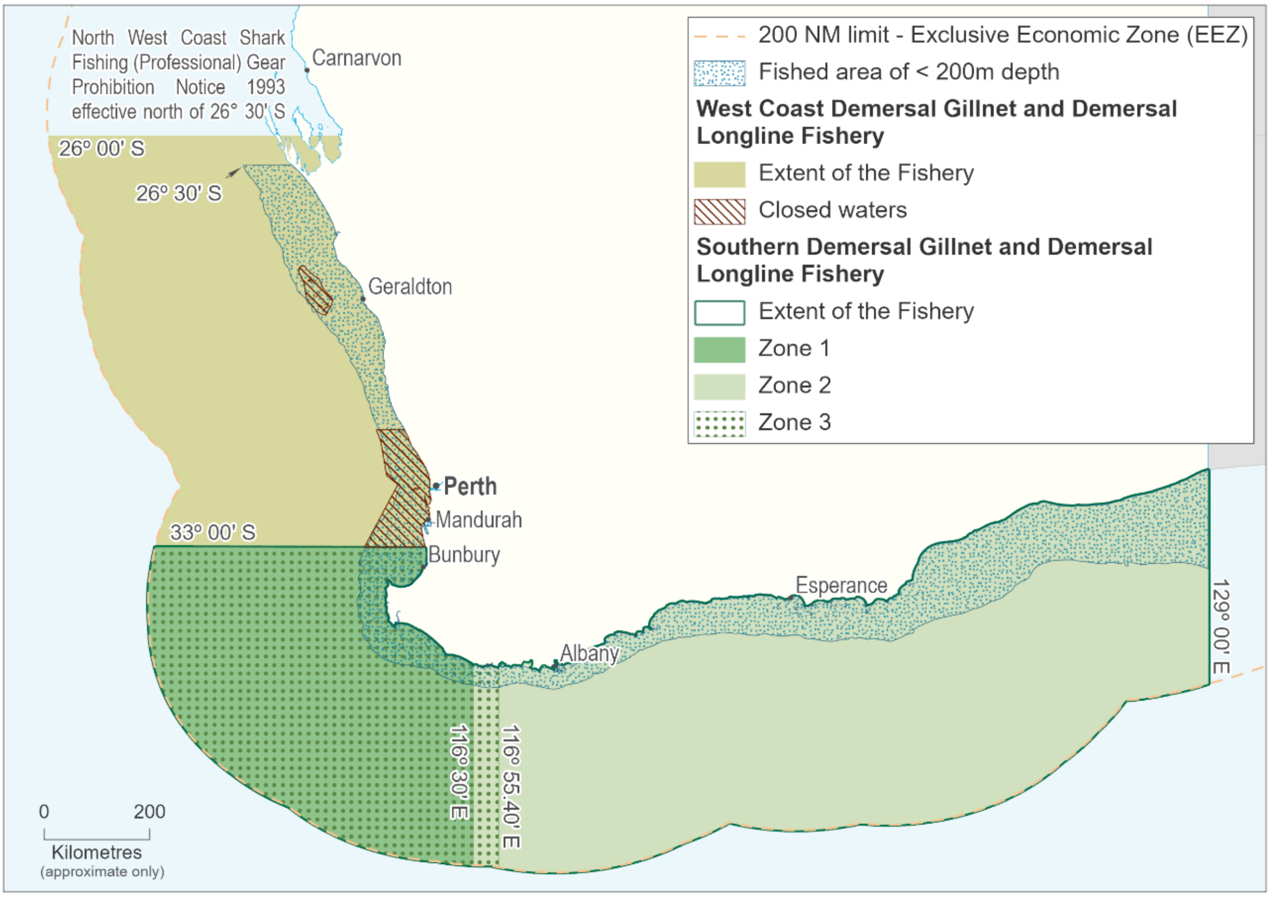
The Temperate Demersal Gillnet and Demersal Longline Fisheries (TDGDLF) comprises the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF), which operates between 26° and 33° S, and the Southern Demersal Gillnet and Demersal Longline Managed Fishery (SDGDLF)[1], which operates from 33° S to the Western Australian (WA)/South Australian 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*. (2018) and SAFS (2020).

SUMMARY FEATURES

Asset (Allowable catch for indicator species)	Outcome	Status
Commercial fishery (725−1,095 t)	Total Catch 2020-21 Sharks and rays*: 835 t Scalefish*: 119 t	Acceptable
Recreational fishery (not defined)	Total Catch 2019/20: ~ 10% of commercial catch	Acceptable
EBFM		
Indicator species		
Gummy shark	Above threshold	Adequate
Dusky shark	Above threshold	Recovering
Whiskery shark	Above threshold	Adequate
Sandbar shark	Above threshold	Recovering
Ecological		
Bycatch	Low Risk	Adequate
Listed Species	High Risk	Unacceptable
Habitat	Negligible Risk	Adequate
Ecosystem	Low Risk	Adequate
Economic (GVP $1-5 m)	Low Risk	Acceptable
Social (Moderate amenity)	Significant Risk	Unacceptable
Governance	Stable	Acceptable
External Drivers	Moderate Risk	Acceptable

*All reported weights are live weight

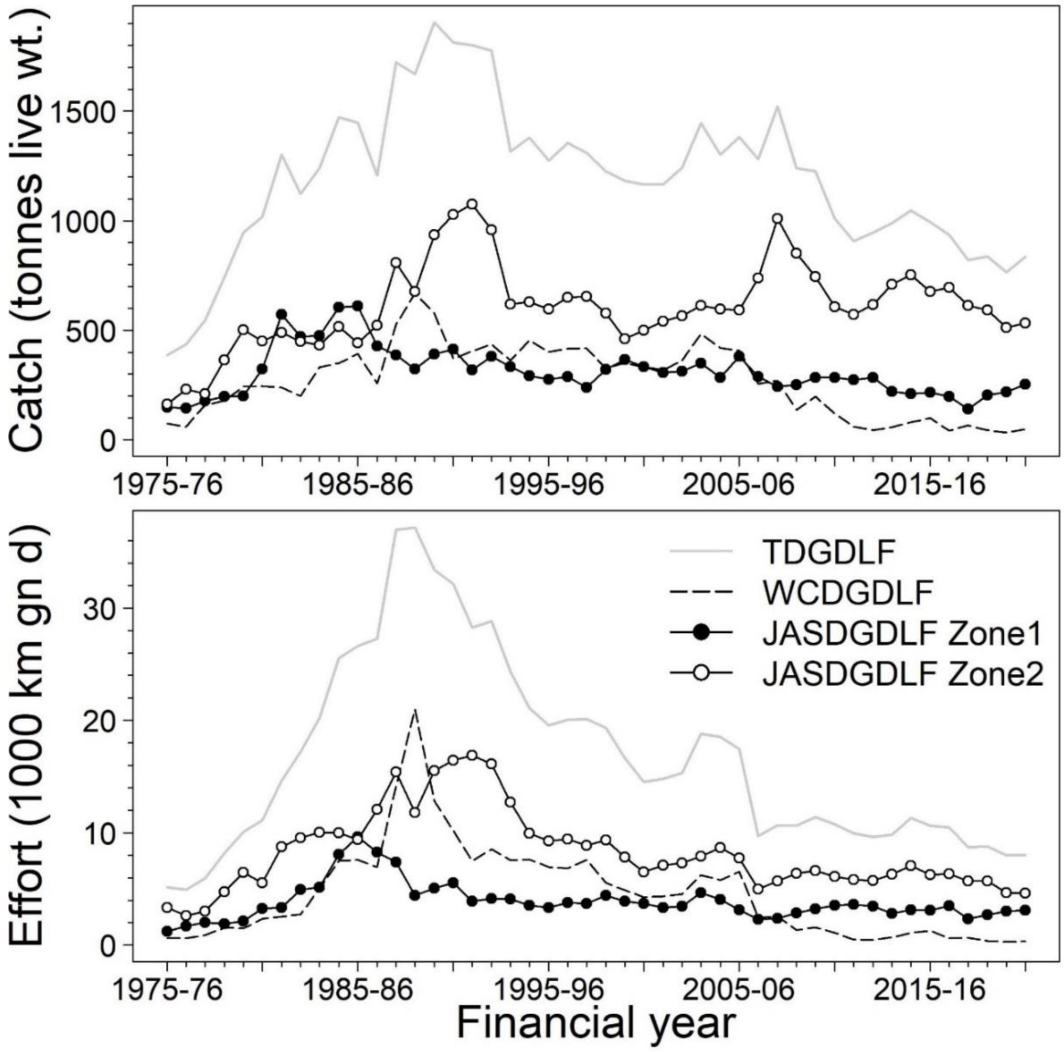
1 Previously the Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JASDGDLF). The JASDGDLF transitioned from joint Commonwealth/State management to State only management in December 2018



TEMPERATE DEMERSAL FIGURE 1.
Map showing the boundaries of the Temperate Demersal Gillnet and Demersal Longline Fisheries.

CATCH AND LANDINGS

For the TDGDLF, the reported catches of elasmobranchs and fishing effort peaked during the late 1980s and early 1990s and have stabilised at lower levels in recent years (Temperate Demersal Figure 2). The catch of sharks in other WA commercial fisheries is **negligible** (~ 5 t). Additionally, boat-based recreational fishers retain very small numbers of sharks in WA (Ryan *et al*. 2022). 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*. (2018).



TEMPERATE DEMERSAL FIGURE 2.
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)

Previous calculations of catch rates defined fishing effort as the product of the net length used per day and the number of days fished per month. This resulted in an historic peak in catch rates in the mid/late 2000s, which coincides with the historic peak in catches. Unfortunately, this catch rate series could not be used to fit population dynamics models. The peak in catch rates was partly due to a systematic increase in the number of hours fished per day in Zone 2 during that period of time. Hence, a new standardisation process was implemented where hours fished per day was included in the definition of fishing effort. Based on this, standardised catch rates have been stable since 2010 (Temperate Demersal Figure 3). The most recent weight of evidence assessment estimated a low current risk level for the gummy shark stock, with 87%, 100% and 100% of the simulated current (2015-16) relative total biomass trajectories being above the target, threshold and limit biomass reference points, respectively (Braccini *et al*. 2018). On the basis of the above, the current status of gummy sharks is **sustainable-adequate.**

Dusky shark (Sustainable - Recovering)

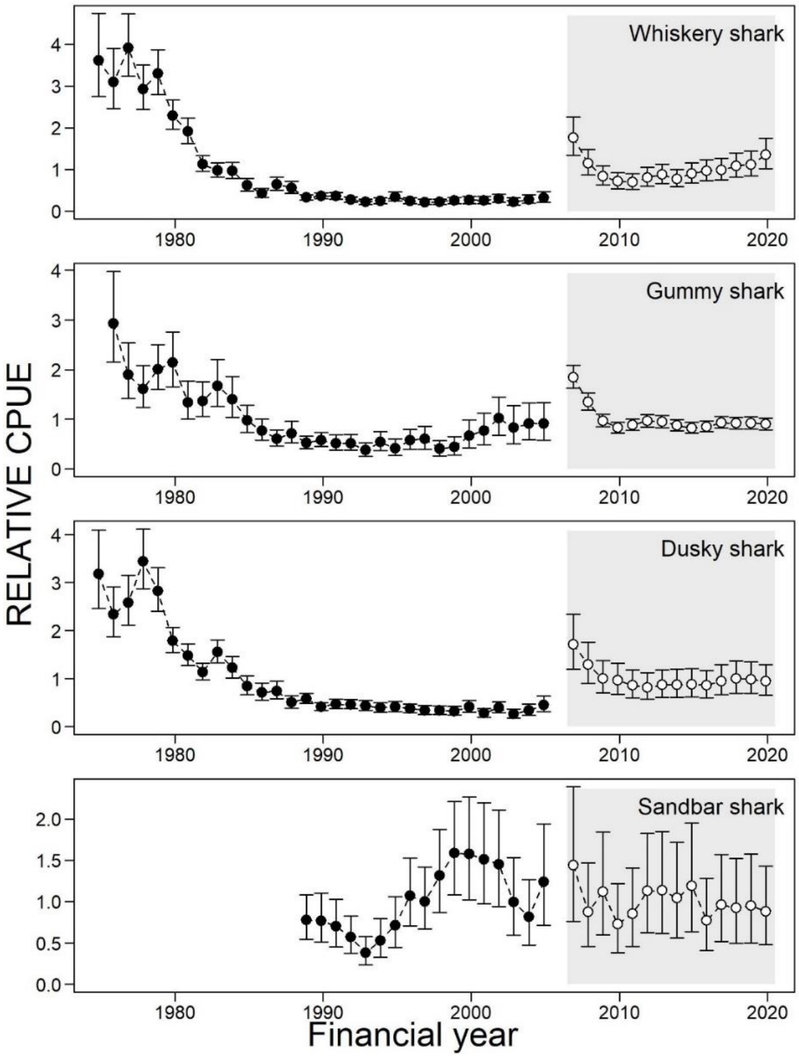
Standardised catch rates have been stable since 2009 (Temperate Demersal Figure 3). The most recent weight of evidence assessment estimated a Medium current risk level for the dusky shark stock, with 46%, 73% and 100% of the simulated current (2015-16) relative total biomass trajectories being above the target, threshold and limit biomass reference points, respectively (Braccini *et al*. 2018). Hence, current management arrangements are considered suitable to facilitate the gradual recovery of the breeding stock. On the basis of the above, the current status of dusky sharks is **sustainable-recovering.**

Whiskery shark (Sustainable - Adequate)

Significant declines in standardised catch rates in the early 1980s (Temperate Demersal Figure 3) was likely a result of changes in targeting practices (Simpfendorfer *et al*. 2000). Since 2010, standardised catch rates have steadily increased. The most recent weight of evidence assessment estimated a Medium current risk level for the whiskery shark stock, with 82%, 92% and 100% of the simulated current (2015-16) relative total biomass trajectories being above the target, threshold and limit biomass reference points, respectively (Braccini *et al.* 2018). On the basis of the above, the current status of whiskery sharks is **sustainable-adequate.**

Sandbar shark (Sustainable - Recovering)

Standardised catch rates have fluctuated since 2007 (Temperate Demersal Figure 3). The most recent weight of evidence assessment estimated a Medium current risk level for the sandbar shark stock, with 62%, 83% and 99% of the simulated current (2015-16) relative total biomass trajectories being above the target, threshold and limit biomass reference points, respectively (Braccini *et al*. 2018). In addition, recent annual catches have been well below allowable catch tolerance levels. On the basis of the above, the current status of sandbar sharks is **sustainable-recovering.**



TEMPERATE DEMERSAL FIGURE 3.
Relative annual standardised catch rates by species (mean and 95% confidence intervals). Each series has been normalised to a mean score of 1. The shaded area highlights the daily logbook time period.

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. Reconstructions of annual bycatch, found dusky morwong, buffalo bream and Port

Jackson shark to be the most commonly discarded species (Braccini & Murua 2022).

The impact of the TDGDLF activities on stocks of bycatch species was assessed in 2021 in an ecological risk assessment (ERA) for the Temperate Demersal Elasmboranch Resource (TDER). Risk to bycatch species were scored for Port jackson shark (negligible), dusky morwong (low), buffalo bream (low) and other bycatch species (negligible; Watt et al. 2021).

Protected Species

The TDGDLF has low reported interactions with listed species (McAuley & Simpfendorfer 2003). For 2020-21, fishers reported catching and releasing 0 Australian sea lions (ASL), 20 dead and 16 alive grey nurse sharks, 6 dead and 9 alive white sharks (Appendix 2).

The impact of TDGDLF activities on protected species was assessed in 2021 in an ERA for the TDER. Risk to protected species were scored for grey nurse shark (medium), white shark (medium), ASL (high), seabirds (negligible), dolphins (low) and other protected species (negligible; Watt et al. 2021).

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' area 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 and therefore represents a **negligible** risk to benthic habitats (Watt et al. 2021).

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 the 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*. (2018) and Watt *et al.* (2021).

SOCIAL AND ECONOMIC OUTCOMES

Social

Fishing returns reported that between 21 and 35 skippers and crew were employed in the SDGDLF and between 6 and 9 skippers and crew were employed in the WCDGDLF during 2020-21.

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 WA fish and chip shop market (WCDGDLF and Zone 1 of the SDGDLF) or sold to wholesalers in Adelaide and Melbourne (Zone 2 of the SDGDLF). However, anecdotal evidence suggests that recent tourism expansion in the southwest of the State may have resulted in a higher proportion of shark meat being sold to restaurants and fish retailers around landing ports.

The estimated annual value (to fisheries) for 2020-21 is $3.14 million and $0.17 million for SDGDLF and WCDGDLF, respectively (GVP level 2). There is currently a **low** risk to this return.

GOVERNANCE SYSTEM

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 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 gear restrictions. Maximum acceptable effort levels for each management zone have been based on their respective 2001/02 (daily) levels (Zones 1/3 of the SDGDLF: 84,075 km $gn.hr^{-1}$ or 3,503 km $gn.d^{-1}$; Zone 2 of the SDGDLF: 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 2020-21 effort levels were maintained within these ranges (49,300 km $gn.hr^{-1}$ or 3,081.7 km $gn.d^{-1}$ for Zones 1/3 of the SDGDLF; 85,200 km $gn.hr^{-1}$ or 4,613 km $gn.d^{-1}$ for Zone 2 of the SDGDLF; 9,700 km $gn.hr^{-1}$ or 343 km $gn.d^{-1}$ for WCDGDLF).

Allowable Catch Tolerance Levels

The 2020-21 total catch of sharks and rays was 835 t (315 t for gummy, 205 t for dusky, 36 t for sandbar, and 162 t for whiskery sharks), similar to previous years and within the acceptable catch ranges (725-1,095 t for the four key species and 350-450 t for gummy, 200-300 t for dusky, < 120 t for sandbar and 175-225 t for whiskery sharks). Whiskery catch was maintained below historical allowable levels due to reductions in targeted effort. Therefore, the recommended catch ranges should be revisited as part of the development of a new harvest strategy.

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

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 held annually between the Department and TDGDLF license holders, in conjunction with the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC).

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

Management Initiatives

In 2021, the TDGDLF was reaccredited under Parts 13 and 13A of the *Environment Protection and Biodiversity Conservation Act 1999*. The Wildlife Trade Operation export approval, includes conditions associated with landing sharks in a form that facilitates ready and reliable identification and the development of an independent data monitoring and validation program.

An ERA of the fisheries that access the TDER was undertaken in 2021. The ERA assessed the impact of current fishing activities, on retained, bycatch and protected species, and the broader ecosystem (Watt et al. 2021).

The development of a formal harvest strategy for the Statewide Elasmobranch Resource is expected to occur in 2023.

EXTERNAL DRIVERS

The TDGDLF key target species span multiple regional boundaries and sandbar and dusky sharks were historically targeted in the Northern Shark Fisheries. The risks to these stocks are currently negligible, with no fishing in the Northern Shark Fisheries since 2008/09 and low catches from fisheries other than the TDGDLF.

Environmental drivers pose a low risk to shark stocks. The main external risk to the viability of the TDGDLF is loss of access with the introduction of Commonwealth and State Marine Parks and ASL gillnet exclusion zones. The introduction of these spatial closures have resulted in the displacement of fishing effort which has implications for the interpretation of standardised catch rates. Another external risk to the TDGDLF is social licence and general public's understanding and acceptance of the fisheries operations.

These external drivers represent a **moderate** risk.

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SOUTH COAST DEMERSAL SCALEFISH RESOURCE STATUS REPORT 2022

J. Norriss and S. Walters

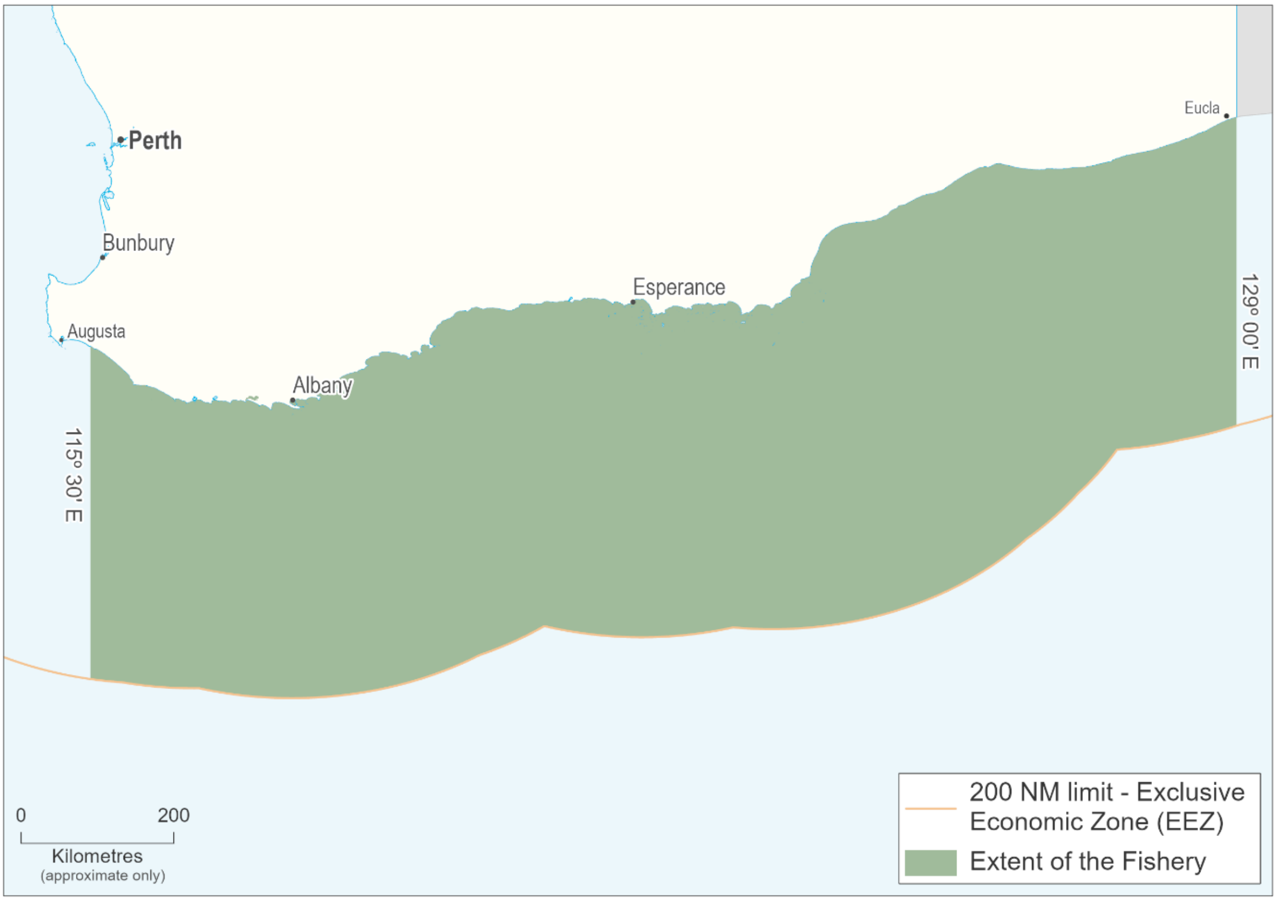
OVERVIEW

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 species (e.g., blue morwong and western blue groper) are landed by demersal gillnet as part of the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLMF; see the Temperate Demersal Gillnet and Demersal Longline Fisheries Resource Status Report). Snapper are also taken in estuaries by the South Coast Estuarine Managed Fishery using nets (see South Coast Nearshore and Estuarine Finfish Resource Status). Recreational and tour operator (charter) catches are almost exclusively boat-based using hook and line.

Details rearding the biology and assesment of the indicator species are reported in Norriss et al. (2016: www.fish.wa.gov.au/Documents/research_reports/frr276.pdf).

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (not defined)	Total Catch 2020/21: 202 t	Acceptable
Recreational fishery (not defined)	Total Catch 2020/21: 34–60 t (boat-based only)	Acceptable
EBFM		
Indicator species		
Snapper	Above threshold	Adequate
Bight redfish	Above threshold	Adequate
Blue morwong	Above threshold	Adequate
Western blue groper	Above target	Adequate
Hapuku	Above threshold	Adequate
Ecological		
Bycatch	Low Risk	Acceptable
Listed Species	Negligible Risk	Acceptable
Habitat	Negligible Risk	Acceptable
Ecosystem	Low risk	Acceptable
Economic (GVP $1-5 m)	Moderate Risk	Acceptable
Social (moderate amenity)	Moderate Risk	Acceptable
Governance	Under Review	Under Review
External Drivers	Moderate Risk	Acceptable



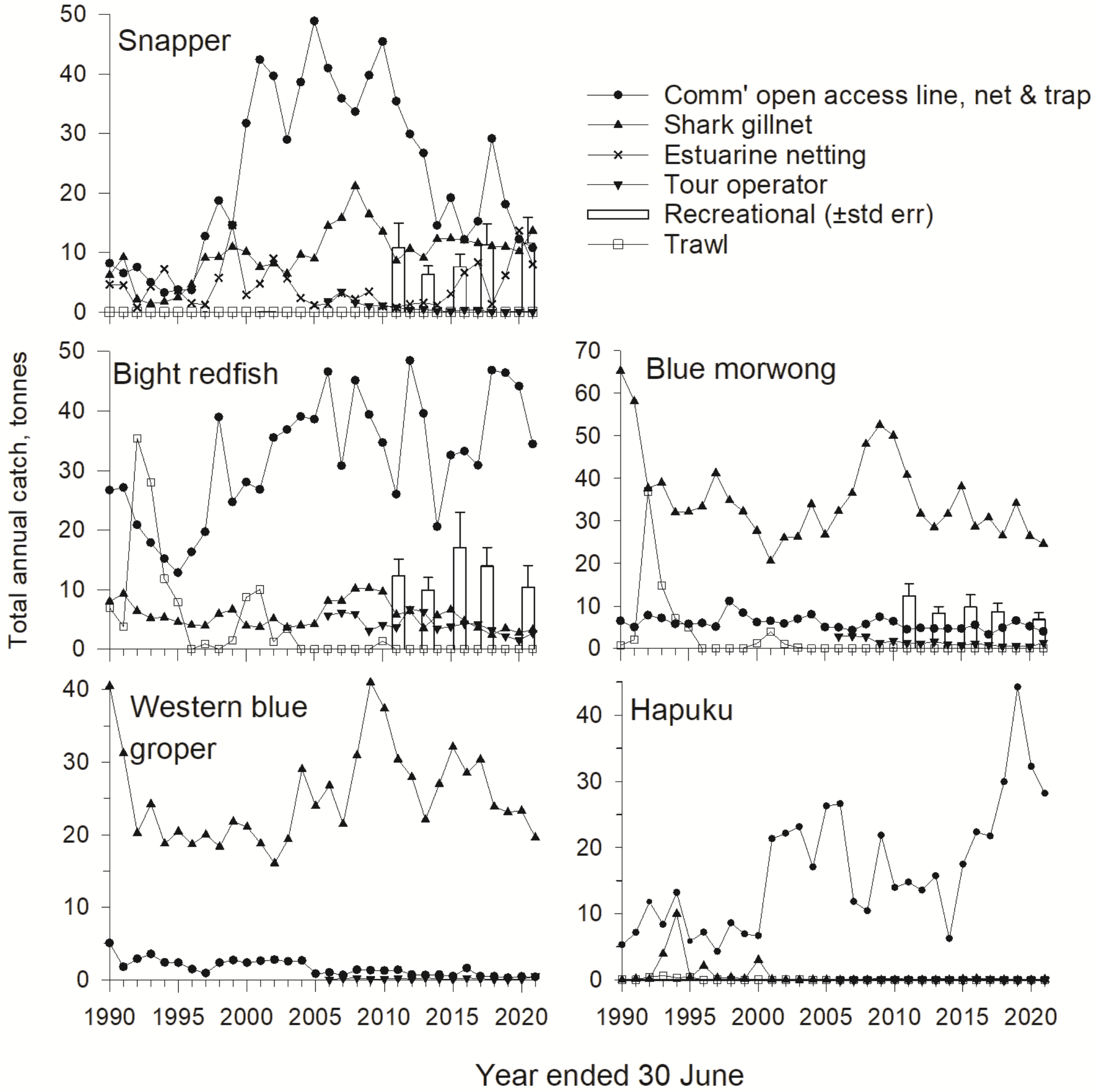
SOUTH COAST DEMERSAL FIGURE 1.
Map showing the boundaries of the south coast demersal scalefish resource.

CATCH AND LANDINGS

The SCDSR total commercial catch of 202 t in 2020/21 was an 10% decrease from the 223 t landed in 2019/20. Catches for all indicator species remain within recent historical levels (South Coast Demersal Figure 2).

The total tour operator catch for the five indicator species combined in 2020/21 was 5 t.

Recreational harvest estimates are presented in Figure 2 where sufficiently robust. The boat-based recreational harvest ranges for the top 10 demersal species in the South Coast (representing 96% of the resource kept catch by numbers) were steady at 47 t (95% CI 34–60) in 2020/21 compared with 62 t (95% CI 49–75) in 2017/18, 55 t (95% CI 40–69) in 2015/16, 37 t (95% CI 30–45) in 2013/14 and 58 t (95% CI 44–73) in 2011/12 (Ryan *et al*. 2022).



SOUTH COAST DEMERSAL FIGURE 2*:*
Annual catches by sector for each demersal indicator species in the South Coast Bioregion from 1989/90 to 2020/21. Recreational harvest weight estimates for western blue groper and hapuku were insufficiently robust to be presented.

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. Genetically, the SCB snapper population shows an isolation by distance structure with a temporal and spatial discontinuity discovered near Esperance (Bertram *et al.* 2022). Bight redfish 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. Fishing mortality and breeding stock levels 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 threshold reference levels (1.0 and 0.30, respectively), and had only a remote likelihood of breaching the limit reference levels (1.5 and 0.20, respectively). However, any significant increase in catches beyond the historical range would constitute an unacceptable risk.

Blue morwong (Sustainable-Adequate)

Age-based estimates of F and SPR for females show an almost zero likelihood of breaching threshold reference 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 levels (1.5 and 0.20, respectively).

There is only a very small capacity for increased catches beyond the historical range 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 threshold reference levels (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 level only a remote possibility. There is a small capacity for increased catches beyond recent historical levels.

Hapuku (Sustainable-Adequate)

An age-based assessment from sampling of the 2005 and 2006 catches estimated F to be within target and threshold levels (Wakefield *et al*. 2010). A recent, updated analysis of that data, which assumed variable recruitment and age-based selectivity, generated two spawning potential ratio estimates (±95% c.i.) using the per recruit and dynamic pool methods: 0.48 (0.43 - 0.54) and 0.44 (0.38 – 0.50) respectively, indicating a high likelihood that spawning biomass was above the threshold reference level of 0.30. Simultaneously generated estimates of fishing (F) and natural mortality (M) year^{-1} were 0.045 (0.04-0.05) and 0.09, respectively, giving an F/M estimate of 0.50 (0.42 – 0.60), well below the threshold reference level of 0.67. The new analysis shows the breeding stock was adequate, and level of fishing mortality sustainable, at the time the sample was collected. However, catches have increased to record highs in recent years. An updated age-based assessment is in progress.

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 species that are not retained (i.e. **low** risk). The risk to protected species from interactions with commercial line fishers is **negligible**.

HABITAT AND ECOSYSTEM INTERACTIONS

Line fishing using baited hooks has minimal 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), suggesting a **low** ecosystem risk.

SOCIAL AND ECONOMIC OUTCOMES

Social

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

The boat-based recreational fishing effort in the South Coast Bioregion was steady in 2020/21 (25,886 boat days, SE=3,329) compared with 2017/18 (21,631 boat days, SE=2,557), 2015/16 (24,658 boat days, SE=3,266), and lower than 2013/14 (27,837, SE=3,314), and 2011/12 (42,070, SE=5,440) (Ryan *et al*. 2022).

Economic

In 2020/21, a total of 64 commercial line/trap or estuarine net vessels reported taking demersal scalefish and it is estimated that ~190 fishers were directly employed (assuming ~3 crew per vessel). Employment is also generated by seafood processors in the SCB. The estimated gross value of product (GVP) for the SCDSR in 2020/21 was $1-5 million, which is subject to a **moderate** level of risk.

Seven tour operator licenses recorded catch during 2020/21, generating economic value and employment.

Recreational fishers make a significant contribution to Western Australia's economy, and support economic activity in many regional towns on the coast and near inland fishing spots. These resources contribute in part to the $2.4 billion attributed to the value of recreational fishing to the WA economy each year (McLeod and Lindner 2018).

GOVERNANCE SYSTEM

The South Coast commercial line fishery operated under open-access arrangements (as opposed to a Management Plan) until the commencement of the *South Coast Line and Fish Trap Managed Fishery Management Plan 2020* from 1 July 2021 (see below). The recreational sector is managed through a range of input and output controls such as a Recreational Fishing from Boat Licence, bag and size limits authorised under the *Fish Resources Management Act 1994* and *Fish Resources Management Regulations 1995*.

Harvest Strategy

A formal harvest strategy has not been developed for this resource.

Allowable Catch Tolerance Levels (Acceptable)

Not developed, but a recent stock assessment recommending that catches remain within the historical range (Norriss et al. 2016).

Compliance

Fisheries and Marine Officers conduct both at-sea and on-land inspections.

Consultation

A broad consultation process continues as part of the implementation of the *South Coast Line and Fish Trap Managed Fishery Management Plan 2020*, which commenced 1 July 2021. This includes consulation with commercial fishers regarding transitioning to new management arrangements and the use of a new formal daily/trip fishing log book (see Management Initiatives/Outlook Status below). Consultation also occurs with the West Australian Fishing Industry Council (WAFIC) 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

The *South Coast Line and Fish Trap Managed Fishery Management Plan 2020* formally commenced on 1 July 2021 following extensive consultation and a review of the previous open-access arrangements. The Plan introduces different classes of fishing license with varying entitlements with regard to fishing gear and access to spatial zones.

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. Bight redfish landings by that fishery in 2020/21 were 202 t, or 23% of the Commonwealth TAC of 893 t, predominantly from continental shelf waters (depths usually 120-200 m) off South Australia and the western Great Australian Bight (GAB) east of 125º E (Moore and Dylewski *et al.* 2021). Limited analysis indicates genetic homogeneity between Western Australia and the Great Australian Bight but there is some separation based on otolith chemistry between southwest WA and the GAB (Norriss *et al.* 2016).

Preparations and negotiations are underway for a proposed south coast marine park in state waters from Bremer Bay to the South Australian border. The impact on fishing for demersal scalefish is as yet unknown.

These external drivers represent a **moderate** risk.

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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 (e.g., silver cobbler).

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

Some of the key environmental trends that may be affecting ecosystems in WA (state-wide) include:

- increasing frequency of *El Niño*/Southern Oscillation (ENSO) events;
- more years with a weaker Leeuwin Current;
- increases 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 and intensity of cyclones (and summer rainfall) affecting the north-west coast.

The Northern Inland Bioregion is predicted to have relatively minor impacts from climate change, especially in the coming decade, compared to more southerly locations. The variables expected to drive climate change impacts include changes in rainfall and extreme weather conditions (e.g., cyclones and tropical storms).

Commercial Fishing

The main water body in the Northern Inland Bioregion, Lake Argyle, is a man-made 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, the population of 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 likely to be small but is currently unable to be estimated. 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 2020/21 statewide survey of boat-based recreational fishing in WA[1] 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 operated in Lake Argyle since 2001, with very few silver cobbler being retained.

Lake Argyle and its associated river system also support recreational fishing for cherabin (freshwater prawns). Limited surveys of recreational fishing in this region have been completed and shore-based and riverine recreational catches are unavailable at this time.

Aquaculture

Aquaculture development operations in the region have previously included the small-scale production of barramundi from cage operations in Lake Argyle, and the small pond production of redclaw crayfish in the Ord River irrigation system around Kununurra.

1 Ryan KL, Lai EKM, Smallwood CB. 2022. Boat-based recreational fishing in Western Australia 2020/21. Fisheries Research Report No. 327 Department of Primary Industries and Regional Development, Western Australia. 221pp.

Tourism

A small scale 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 water skiing and swimming. Since 2012 the State Government has funded a stock enhancement project at Lake Kununurra to create an impoundment based, recreational barramundi fishery in the region.

Other Factors

While Lake Argyle 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.

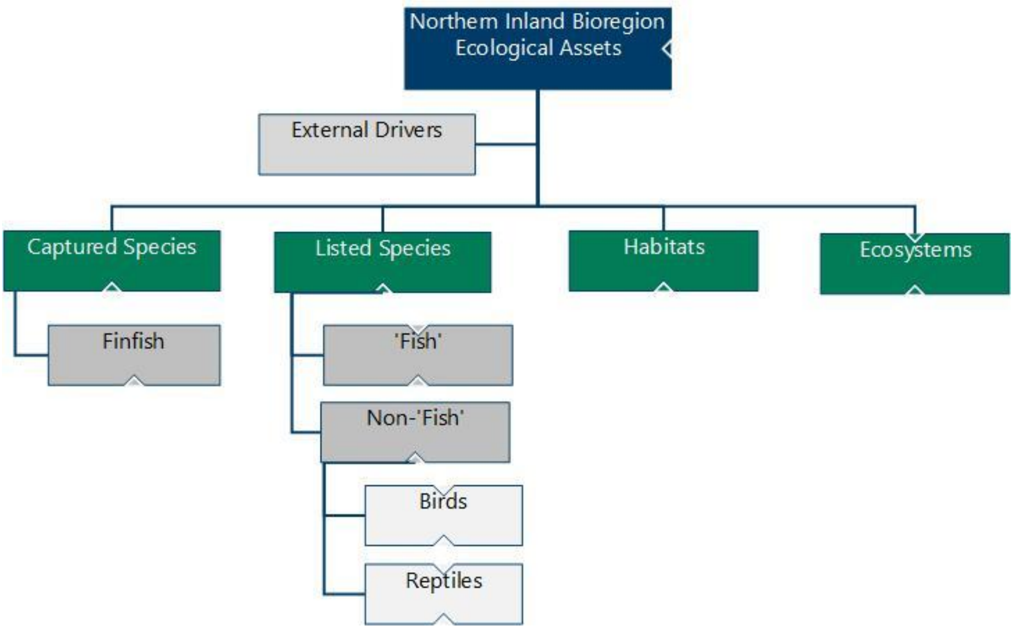
BIOREGIONAL SPECIFIC ECOSYSTEM MANAGEMENT

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 Australi., This minimises the environmental risks to freshwater ecosystems in the Northern Inland Bioregion associated with this activity. The introduced cane toad (*Rhinella marina*) has also been reported from around Kununurra and Lake Argyle, posing a major threat to the system.

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 the application of an Ecosystem Based Fisheries Management (EBFM) framework (see How to use this Volume for more information) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment. (*See How to Use section for more details*). The key ecological assets in 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 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., cyclones, 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 change and introduced pests and diseases[1].

Climate

External Drivers	Current Risk Status
Climate	MEDIUM

The Northern Inland Bioregion is predicted to have relatively minor impacts from climate change in the coming decade, compared to more southerly Bioregions.

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*). 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	NEGLIGABLE

The stocks of native 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. It should be noted that Lake Argyle is an impoundment and despite incidental capture, the population of crocodiles in that water body is considerably larger than it was in its pre-impoundment state.

Habitats and Ecosystems

Category	Aquatic zone	Current Risk Status
Habitats	Freshwater	LOW
Ecosystems	Freshwater	LOW

The Northern Inland Bioregion occurs north of Shark Bay (27˚S), from the coastline to the Northern Territory border. Within the Bioregion are a series of freshwater rivers and wetlands which have native fringing vegetation and aquatic plants, which 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.

Gillnets have relatively low habitat impacts and fishers actively avoid fishing in areas where the nets may become entangled on submerged vegetation.

1 Biosecurity issues are now reported by the Biosecurity pillar of the Department of Primary Industries and Regional Development.

FISHERIES

NORTHERN INLAND LAKE ARGYLE FINFISH RESOURCE STATUS REPORT 2022

F. Trinnie, C. Skepper, S. Newman and S.Blazeski

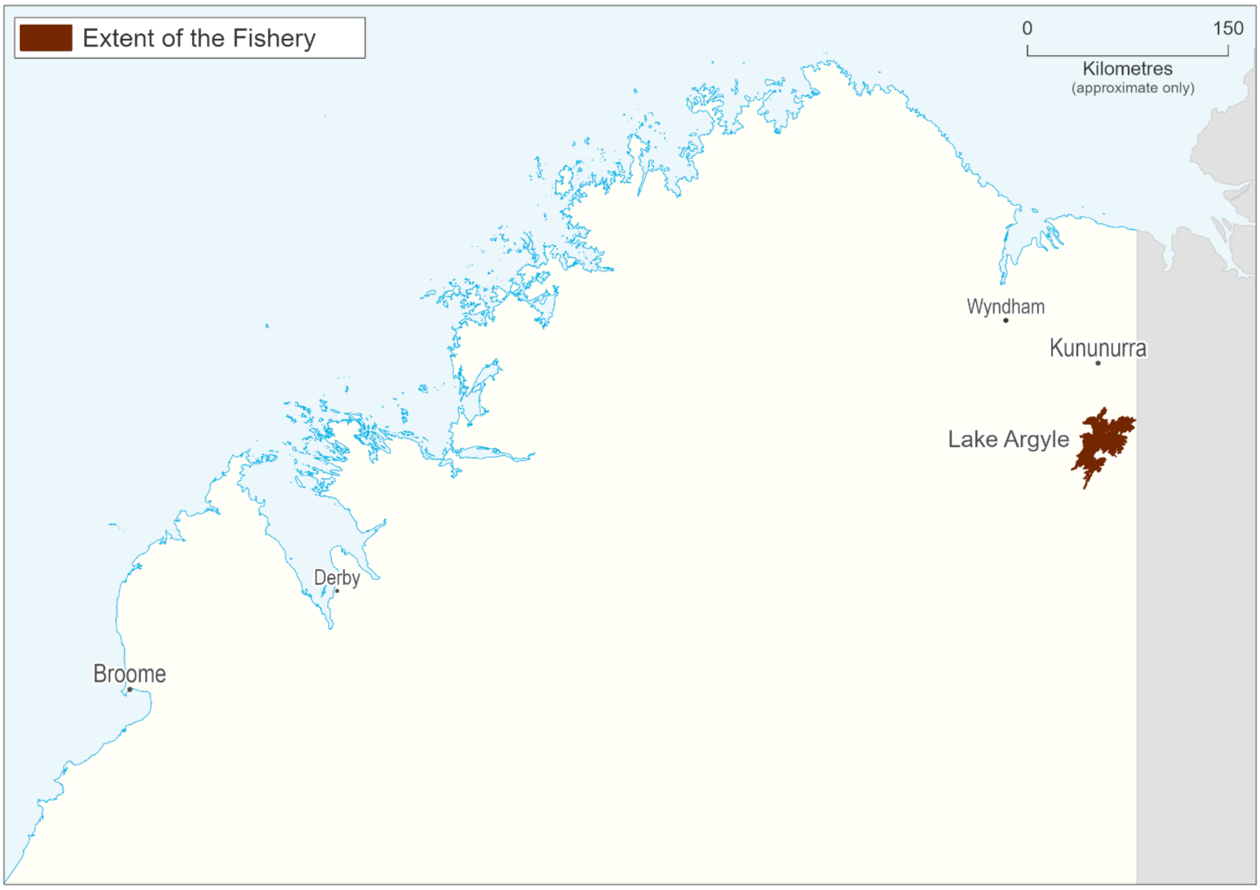
OVERVIEW

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 (Lake Argyle Silver Cobbler Figure 1) 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

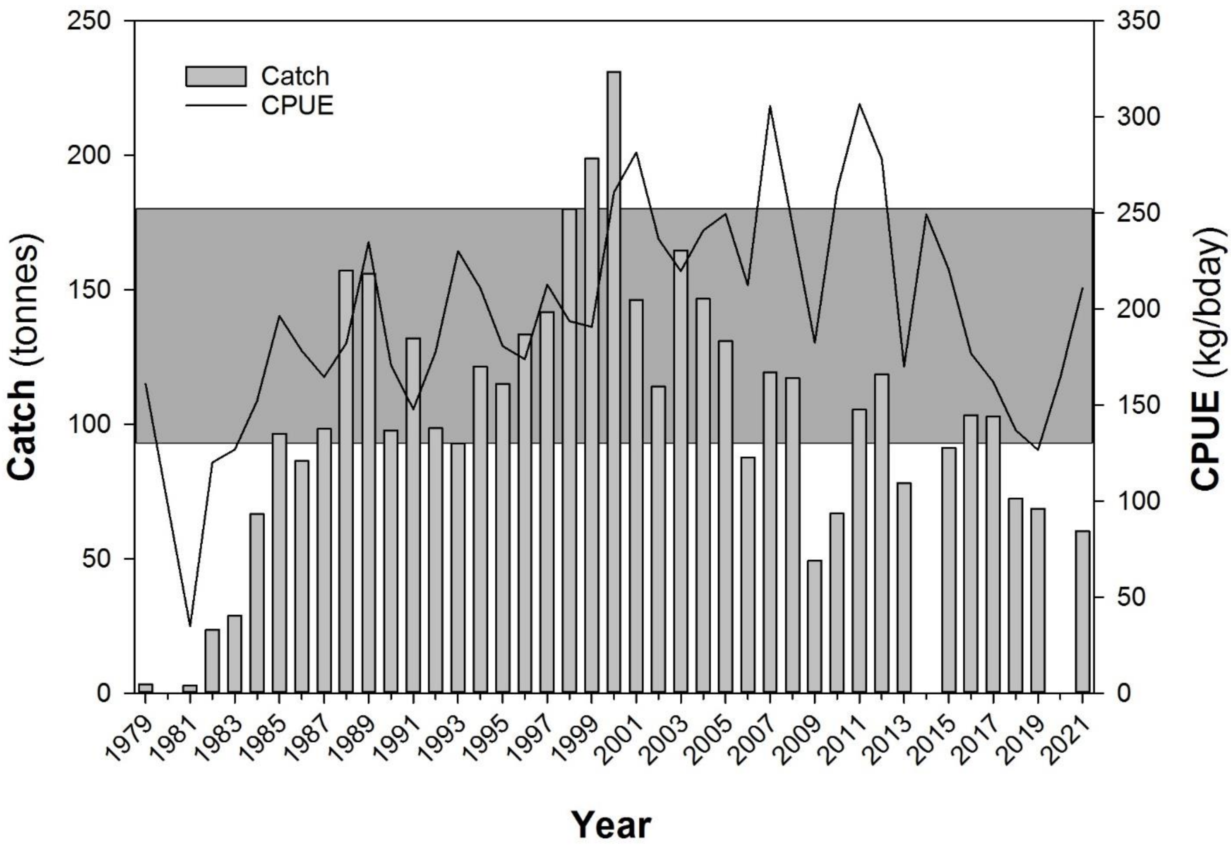
Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (93–180 t)	Total Catch 2021: 60.1 t	Acceptable
Recreational fishery (NA)	Total Catch 2021: NA	Acceptable
EBFM		
Indicator species		
Silver Cobbler	Below target commercial catch range	Adequate
Ecological		
Bycatch	Negligible Risk	Adequate
Listed Species	Low Risk	Adequate
Habitat	Negligible Risk	Adequate
Ecosystem	Negligible Risk	Adequate
Economic (GVP $ <1 m)	Low Risk	Acceptable
Social (low amenity)	Low Risk	Acceptable
Governance	Stable	Acceptable
External Drivers	Low Risk	Acceptable



LAKE ARGYLE SILVER COBBLER FIGURE 1.
Location of the Lake Argyle Silver Cobbler Fishery in northwestern Australia illustrating the remoteness and extent of the fishery.

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 2). From 1984 catches increased to reach a 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 2). Catches from 2009 to 2021 have fluctuated between 49 t and 119 t.



LAKE ARGYLE SILVER COBBLER FIGURE 2.
The annual catch and catch per unit effort (CPUE, kg block day-1) for silver cobbler in the Lake Argyle Silver Cobbler Fishery over the period from 1979 to 2021. The upper and lower bounds of the target commercial catch range are shown by the shaded catch area between 93 and 180 tonnes. Catch is not reportable in those years where less than three vessels fish.

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 2021 is below the acceptable catch range. This level of catch is considered acceptable as the effort in the fishery is relatively low and the catch rate is within the historical range. The lower level of catch in the fishery in recent years is likely to have allowed the spawning stock biomass to increase. The above evidence indicates the biomass of this stock is unlikely to be depleted and recruitment is unlikely to be impaired and that current levels of fishing mortality (catch) are unlikely to cause the stock to become recruitment impaired.

On the basis of the evidence provided above, the silver cobbler stock is classified as **sustainable-adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch

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.

Protected species

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 turtles by the silver cobbler fishery in Lake Argyle. Where practicable, freshwater crocodiles and turtles are released alive, and based on the reports by fishers, only low levels of crocodile and turtle 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 2021, three vessels fished in the LASCF, with an average crew of 2 people per vessel, indicating that four 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 2021 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.

Recreational fishers make a significant contribution to Western Australia's economy, and support economic activity in many regional towns on the coast and near inland fishing spots. These resources contribute in part to the $2.4 billion attributed to the value of recreational fishing to the State's economy each year.

GOVERNANCE SYSTEM

Harvest Strategy

The harvest strategy for silver cobbler in the LASCF in the Northern Inland Bioregion of Western Australia is based on a *constant exploitation approach* where the annual commercial catches of silver cobbler may vary proportional to stock abundance within the target catch range.

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 2021 is below 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**.

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 Aquatic Resource Management Division of the Department of Primary Industries and Regional Development 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 processes for the recreational fishing sector are 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 (Stable)

The Lake Argyle Silver Cobbler Fishery Ecological Code of Practice is being reviewed and updated by industry.

EXTERNAL DRIVERS

A number of external factors may impact on the 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 currently pose a low risk to the stock.

SOUTHERN INLAND BIOREGION

ABOUT THE BIOREGION

The Southern Inland Bioregion 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 native forest areas. Some of the rivers are more saline in their upper reaches owing to the effects of agricultural clearing of the native vegetation.

Across the remainder of the Southern Inland Bioregion, rivers flow primarily during the winter, with occasional summer flows from inland, rain-bearing depressions, resulting from decaying cyclones. Most large fresh water bodies are man-made drinking water dams, 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.

These natural freshwater rivers and man-made lakes are 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, with predicted further reductions in rainfall and increases in temperature as a result of climate change.

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) which are produced and stocked by the Department into public dams and rivers, and feral redfin perch, an introduced, self-perpetuating species. 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 approximately 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.

Rainbow trout have historically been the mainstay of finfish aquaculture production in this region, originating from the 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.

The Government has provided some funding to re-furbish the Pemberton facility, in part to upgrade existing infrastructure and to provide a capability to future-proof the facility from the effects of climate change. The funding will ensure continued maintenance and growth of freshwater fish stocks and the recreational fishing industry, which attracts ~10,000 fishers and generates $20 million in economic activity per annum in the southern inland region. It will also address the feasibility of a new interactive, educational tourism attraction that showcases the historical connection of trout fishing in the bioregion, demonstrates trout and marron aquaculture, and will offer an inland aquarium explaining aquatic ecology and climate change impacts.

Tourism

The bioregion is a popular tourist destination which is 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.

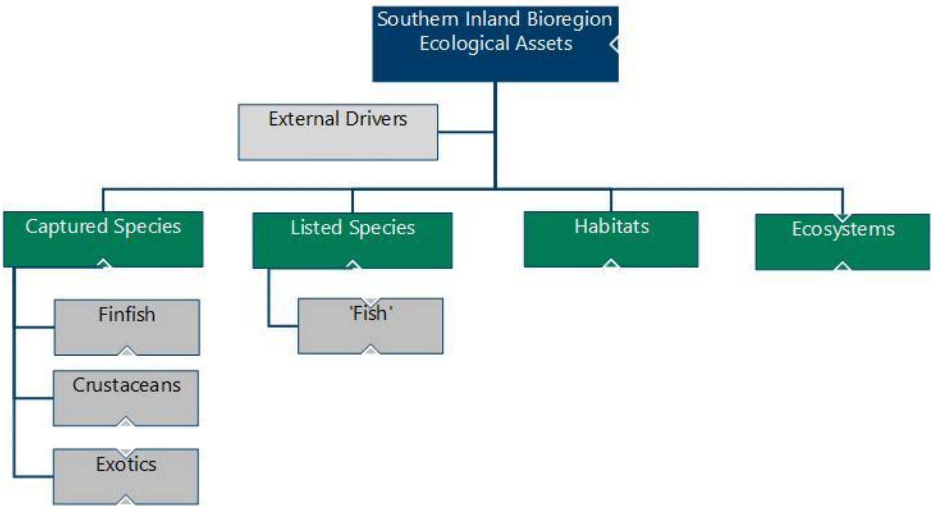
The conservation of the 11 species of freshwater native fishes in freshwater ecosystems in the South-West of WA is an issue for the Department. Most of these species are only found in WA, and all have had major contractions in their distribution as a result of habitat loss. Many species now only consist of small, fragmented populations, and half are now listed as threatened. These species are under pressure from feral fish populations, migration barriers (bridges and dams), and urban land-use development resulting in unfiltered storm water discharge from roads into natural waterbodies.

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. This minimises 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 (see How to use this Volume for more information) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment (See How to Use section for more details). The key ecological assets in the Southern Inland Bioregion are identified in Southern Inland Ecosystem Management Figure 1 and their current risk status reported on in the following sections.



SOUTHERN INLAND ECOSYSTEM MANAGEMENT FIGURE 1
Component tree showing the ecological assets identified and separately assessed for the Southern Inland Bioregion.

External Drivers

External drivers include factors impacting at the bioregional level that are likely to affect the ecosystem as a whole and may not fall within the direct control of Fisheries 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	MEDIUM

The south west of Western Australia is predicted to be heavily influenced by the impacts of climate change (e.g. declines in rainfall, increasing sea temperatures,). Further reductions in rainfall are expected for the Southern Inland Bioregion.

Captured Species

Native Finfish

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

The abundance and distribution of most native fish, include the native cobbler (*Tandanus boostockii*), have been severely impacted due to land and water management practices. These pressures have led to widespread fragmentation of native fish populations (i.e. local extinctions). Competition with feral fishes has also decreased the abundance of native fishes in freshwater systems in the Southern Inland region.

Native Crustaceans

Captured Species	Aquatic zone	Ecological Risk
Native Crustaceans	Freshwater	HIGH (non-fishing)

The recreational marron fishery has its own licence. The abundance of smooth marron (*Cherax 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	LOW

Anglers require a south-west freshwater angling licence to capture trout, native cobbler, and other freshwater angling species. 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 the growth rate by increasing the number of sterile fish produced at the Centre. Trout are unlikely to breed naturally in local conditions. Combined with a decreased number of locations stocked with trout, this has reduced this ecological risk score.

Listed Species

Fish

Listed species	Ecological Risks
Fish*	SEVERE (non-fishing)

*Crustaceans are classified as fish under the FRMA 1994

Listed freshwater species in the Southern Inland region are subject to the same non-fishing ecological pressures as noted under Native Finfish.

Hairy marron (*Cherax tenuimanus*) are only found in the upper reaches of Margaret River and are a totally protected species. The largest negative impact on the hairy marron has been the illegal introduction of the recreationally fished smooth marron (*C. cainii*), which has outcompeted the hairy marron.

Habitats and Ecosystems

Habitat / Ecosystem	Aquatic zone	Current Risk Status
Habitat	Freshwater	SEVERE (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 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 potentially 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 both fish and people.

FISHERIES

SOUTH-WEST RECREATIONAL FRESHWATER RESOURCE STATUS REPORT 2022

R. Duffy, F. Trinnie, K. Ryan and A. Steele

OVERVIEW

The South-West Recreational Freshwater Resource (SWRFR) incorporates the Recreational Marron Fishery and the South West Recreational Freshwater Angling fishery(SWRFA). Both fisheries have separate recreational licences and are managed with rules around gear, bag limits, size limits, and spatial and temporal closures.

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery	Total Catch 2021: NA	NA
Recreational marron fishery (50,000–100,000 marron)	Total Catch 2021: 55,440 (kept only, SE=4,630) marron	Acceptable
Recreational angling (50,000–120,000 fish – review required due to altered stocking practices)	Total Catch 2020/21: 113,528 (kept and released, SE=11,101) fish	Acceptable
EBFM		
Indicator species		
Marron	Above threshold of 50,000 marron	Adequate
Trout (Rainbow & Brown)	NA – stocked fishery	Adequate
Ecological		
Bycatch	Negligible Risk	Adequate
Listed Species	High Risk	Management Action
Habitat	Medium Risk	Adequate
Ecosystem	Low Risk	Adequate
Economic (GVP)	NA	NA
Social (High amenity)	Moderate Risk	Acceptable
Governance	Negligible Risk	Acceptable
External Drivers	High Risk	Acceptable

CATCH AND LANDINGS

Marron (*Cherax cainii*): the retained recreational catch for marron (kept catch by number) of 55,440 (SE=4,630) in 2021 was similar to the estimated catch in 2020 of 55,668 (SE=3,696), and within the catch range of the last 10 years (Recreational Fishery Figure 1). The average number of marron caught per fisher of 8.45 (SE=0.71) in 2021, was similar to the 2020 estimate of 8.42 (SE=0.56). Catch of marron from dams and rivers has remained stable over the last 10 years (approximately 30% from dams and 70% from rivers), as has the distribution of effort (also approximately 30% dams, 70% rivers).

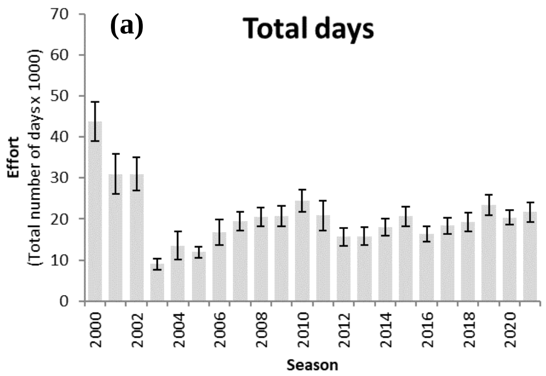
The total number of licensed fishers was 13,110 in 2021, which was higher than the 12,487 in 2020. Total effort in 2021 was 21,737 days (SE=1,216), similar to that over the last 3 years (Recreational Fishery Figure 1). The average number of days fished per fisher of 3.31 days (SE=0.19) is within the range surveyed over the last 10 years.

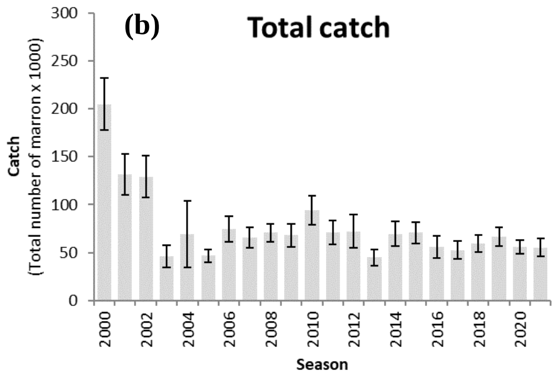
More licensed marron fishers resided in the country (8,352) than the metro area (4,758), similar to previous years. Participation rates of licence holders in 2021 (50%) was lower than 2020 (53%), but higher than 2019 and 2018 (49% and 46% respectively), which equates to 6,561 active fishers in 2021. Participation rate was similar between country and metro licence holders, 48%, and 53% respectivley.

SWRFA: Since March 2016, children under the age of 16 are no longer required to hold a Freshwater Angling licence. Survey design does not permit apportioning the contribution of this age group to historical surveys. Therefore, data from the 2017 survey and onwards are not directly comparable to previous surveys.

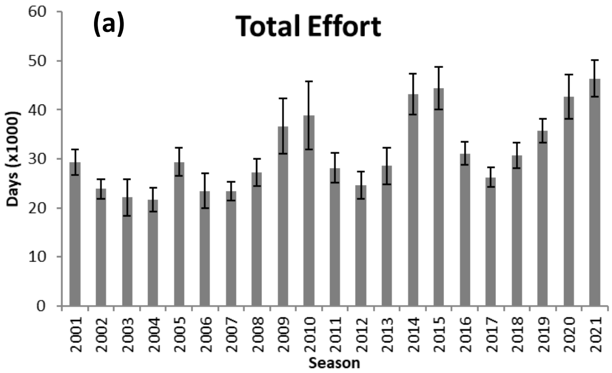
The total recreational catch (kept and released) from SWRFA across all species for 2021 (2020/21) was 113,528 fish (SE=11,101) of which 53,554 fish (SE=6,570) were kept and 59,975 fish (SE=7,912) were released. The catch was similar to the previous season and is one of the highest catches recorded since 2001, despite changes to licensing which means the catch of people under 16 is no longer recorded (Recreational Fishery Figure 2).

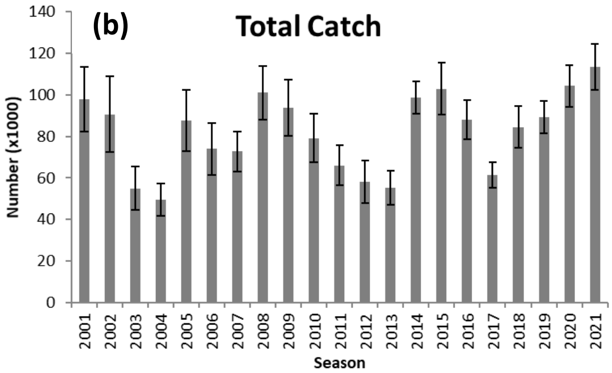
The total number of licensed fishers increased substaintially from the previous year, 9,375 vs 7,791, and the participation rate was similar (47% of licence holders).Total estimated fishing effort of 46,362 days (SE=3,750) continued an increasing trend since 2017 and was the highest effort recorded since 2001 despite people under 16 not requiring a licence (Recreational Fishery Figure 2).





RECREATIONAL FISHERY FIGURE 1.
Estimated (a) total days people went marroning and (b) kept recreational catch of marron, for marron licence holders in the licensed recreational marron fishery since 2000. Note, changes to season length and bag limits have occurred since 2000, so annual differences are not directly comparable. Refer to Southern Inland Freshwater Fishery Resource Assessment Report (*in prep*.) for further information.





RECREATIONAL FISHERY FIGURE 2.
Estimated (a) total days fished (with standard error) and (b) total recreational catch (kept and released) of finfish (with standard error), for licence holders in the licensed SWRFA fishery since 2001. Note the freshwater angling survey collects data for an entire 12-month period (1 July–30 June). For ease of presentation, season 2020 will refer to the year of the most recent survey (i.e. season 2019/20 and throughout).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Marron (Sustainable-Adequate)

Smooth marron (*Cherax cainii*) are managed as a single stock, but are composed of many discrete populations that exhibit biological and life history traits that differ among systems, including fecundity (Beatty *et al.* 2016), and growth (Lawrence 2007). Stock status is assessed annually based on the recreational catch being within a catch range of 50,000 and 100,000 marron.

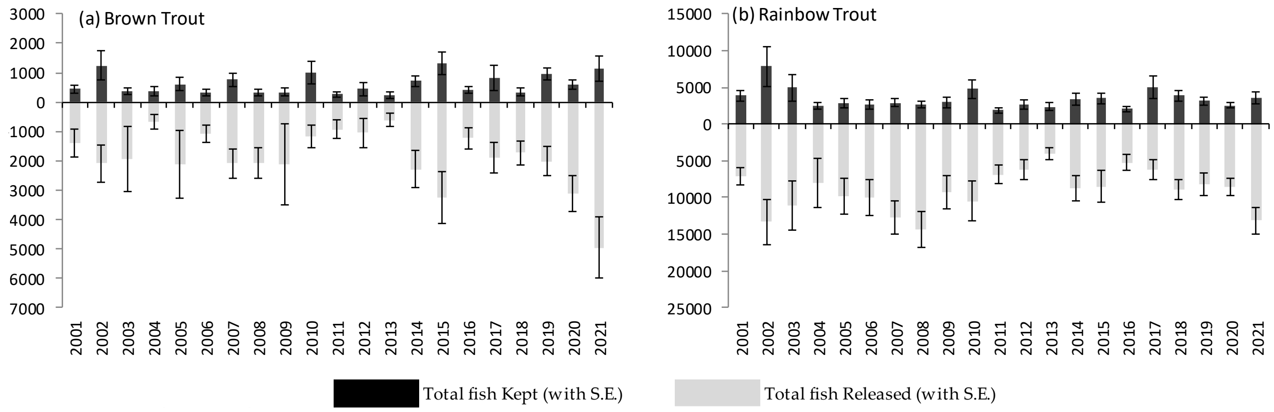
Reduced rainfall and river flow, salinisation, illegal fishing and potentially unsustainable levels of fishing at some easily accessed and popular sites are pressuring marron stocks. Despite this, the recreational catch of marron in 2021 was 55,440 (SE=4,630) and was within the allowable catch range of 50,000 and 100,000 marron.

On this basis, the marron stock is classified as **sustainable-adequate.**

Trout (Annually Stocked)

Rainbow trout (*Oncorhynchus mykiss*) and Brown trout (*Salmo trutta*) are produced at the Pemberton Freshwater Research Centre and released into the rivers and dams of south-west WA. Wild self-sustaining populations are thought to be limited; therefore, stock levels are largely dependent on release rates and are supplemented annually.

The recreational catches of brown and rainbow trout in 2021 were 6,083 (SE=1,221) & 16,695 (SE=2,210), respectively. This year's catch of rainbow trout was similar to catches occuring over the last decade (Recreational Fishery Figure 3). The catch of brown trout (kept and released) was the highest since 2001. Further work is required to determine whether this increase is due to environmental conditions or stocking practices. For information on other freshwater fish species, refer to the Southern Inland Freshwater Fishery Resource Assessment Report (RAR) (*in prep*.).



RECREATIONAL FISHERY FIGURE 3.
Kept and released recreational catch by species (a) Brown trout (b) Rainbow trout since 2001.

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*). 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 comprises a small part of the fishery. There is negligible bycatch in the SWRFA due to the small size of non-target native species. Therefore, the impact of the fishery on bycatch is a **negligible** 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 are still illegally stocked and translocated 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. The largest negative impact on the hairy marron has been the illegal introduction of the recreationally fished smooth marron. 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 reported in this reach of the Margaret River, and combined with the small population size and degrading habitats (e.g. reduced rainfall) is considered a **high** 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. Whilst fishers can provide an environmental benefit through the removal of large numbers of feral redfin perch (*Perca fluviatilis*) some fishers also deliberately spread redfin perch into new water bodies. 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. To minimise adverse impacts of trout on native species, they are generally 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 **moderate** risk to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

The Marron Fishery in particular is iconic and provides a high social amenity.The SWRFA has an enthusiastic base of fishers and a dedicated angling group (Western Australian Trout and Freshwater Angling Association (WATFAA)) and has a moderate social amenity. Both fisheries attract tourists to regional areas.

The effect of reduced rainfall on the availability of marron habitat is expected to increase awareness of changes in climate patterns in the South-West. Social aspects are identified as having **high** amenity value and a **moderate** risk.

Economic

Both the Marron Fishery and SWRFA may support tourism to regional towns in the South-West. A risk score that captures non-GVP related risk has not been developed.

GOVERNANCE SYSTEM

Harvest Strategy

The marron fishery is managed under a constant catch harvest strategy, although the harvest strategy has not been formalised. Review of this approach is required.

The SWRFA is based on stocking (inputs). A stocking committee provides advice to the Department on numbers and locations to be stocked. As it is a stocked fishery, a harvest strategy focused on susatainability is not required.

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. The catch in 2021 was within the historic range and therefore status is considered **acceptable.**

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

The Western Australian Inland Freshwater Research Advisory Committee was established in mid-2019 to enhance freshwater recreational fishing experiences in the South-West. The Committee is run by the Department and includes members from Recfishwest and WATFAA and is initially focusing on reviewing existing trout stocking strategies.

On the 2nd and 3rd October 2021, the Department supported a licence free weekend for the SWRFA to coincide with the beginning of the peak recreational freshwater fishing season and the annual TroutFest family fishing day run by Recfishwest.

The licence-free weekend applied to all inland waters south of Greenough (29°S) and above the tidal influence, including all lakes, dams, rivers and their tributaries. All other freshwater recreational fishing rules still applied.

In 2021, juvenile marron of a commercial strain were released into Logue Brook and Waroona dams through an external project supported by Recfishwest. The release is being monitored by the Department to determine the influence of stocking on the fishery.

EXTERNAL DRIVERS

Rainfall in the south-west of Western Australia has declined by approximatley 20%, and is predicted to decrease by a further 5-6% by 2030 (Sudmeyer et al. 2016). 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 had 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. **High** risk.

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STATEWIDE BIOREGION

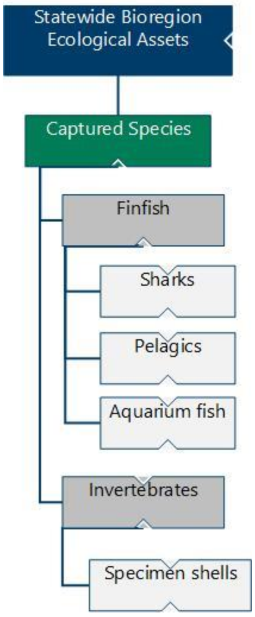
ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Statewide Ecological Assets using the EBFM framework

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). However, 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 level. 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, are 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.

Captured Species

FINFISH

Sharks (and other Elasmobranchs)

Captured Species	Aquatic zone	Ecological Risk
Sharks	South and lower west	MEDIUM
	Mid West – North	MEDIUM

The stock levels of most sharks in the south and lower west regions (some of which migrate seasonally into the north) 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.

Pelagic

Captured Species	Aquatic zone	Ecological Risk
Finfish	Pelagic	MEDIUM

Large pelagic finfish species are targeted throughout the State. In the North Coast and Gascoyne Coast Bioregions, Spanish mackerel, grey mackerel, billfishes and other species are regularly captured by commercial fisheries and recreational fishers. Samsonfish, Spanish mackerel and a range of other large pelagic species are landed by commercial and recreational fishers in temperate bioregions.

Spanish Mackerel are the only large pelagic species heavily targeted, mainly by the Mackerel Managed Fishery (MMF) and recreational fishers. The MMF operates in the North Coast, Gascoyne Coast and West Coast Bioregions. The current risk level for Spanish mackerel is medium based on available evidence, including trends in catch, effort, catch rates, and a vulnerability assessment (see Statewide Large Pelagic Finfish Chapter). Few other pelagic species are exploited at any significant levels and these stocks are lightly impacted by fishing.

Aquarium Fish

Captured Species	Aquatic zone	Ecological Risk
Aquarium Fish	Marine	LOW

An ecological risk assessment for the Marine Aquarium Fish Resource was conducted in 2021[1]. The majority of the ecological components assessed were evaluated as either low or negligible risks, which do not require any specific control measures. In addition, there were four medium risks, which were assessed as acceptable under the current monitoring and control measures.

INVERTEBRATES

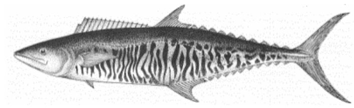
Captured Species	Aquatic zone	Ecological Risk
Specimen Shells	Marine	MEDIUM

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

1 Smith, K.A., Bissell A and Bruce C. (2022). Ecological Risk Assessment for the Marine Aquarium Fish Resource. Fisheries Research Report No. 323. Department of Primary Industries and Regional Development, Western Australia. 149 pp.

FISHERIES

STATEWIDE LARGE PELAGIC FINFISH RESOURCE STATUS REPORT 2022



P. Lewis and M. Watt

OVERVIEW

The statewide large pelagic finfish resource is distributed throughout Western Australia (WA) and includes a range of tropical and temperate pelagic species. The three indicator species for the resource are Spanish mackerel (*Scomberomorus commerson*) and grey mackerel (*S. 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 primarily Spanish mackerel. In the West Coast (WCB) and South Coast Bioregions (SCB) the major retained temperate species is Samson fish, mostly as bycatch in several line and net fisheries (see relevant chapters for more details). The recreational fishery for large pelagic fish is dominated by Spanish mackerel, which by weight is the 3rd highest retained finfish species (Appendix 2) and the 6th highest retained finfish species by charter/fishing tour operators in the 2020/21 catch. For most other large pelagic species, the majority of the recreational catch is released (Ryan *et al*. 2022). For further details in regard to the Statewide Large Pelagic Scalefish Resource Assessment Report see Lewis (2020) https://www.fish.wa.gov.au/Documents/resource_assessment/resource_assessment_report_019.pdf .

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (Spanish mackerel 430 t, Grey mackerel 180 t)	Total catch 2021: 238 t (Spanish mackerel), 10 t (Grey mackerel)	Acceptable
Recreational fishery	Total catch 2020/21: 35–78 t (Spanish mackerel), 1–3 t (Grey mackerel (boat-based only)	Acceptable
EBFM		
Indicator species		
Spanish mackerel	Medium Risk, no formal HS, catches below tolerance ranges and below average nominal catch rates	Breeding stock status - Adequate
Grey mackerel	Low Risk, catch only	Breeding stock status - Adequate
Samson fish	Low Risk, catch only	Breeding stock status - Adequate
Ecological		
Bycatch	Negligible Risk	Adequate
Listed Species	Negligible Risk	Adequate
Habitat	Low Risk	Adequate
Ecosystem	Low Risk	Adequate
Economic (GVP Level 2)	Low Risk	Acceptable
Social (Moderate/high amenity)	Low Risk	Acceptable
Governance	Stable	Acceptable
External Drivers	Moderate Risk	Acceptable

LARGE PELAGIC FINFISH FIGURE 1.
Map showing the boundaries of the Mackerel Managed Fishery.

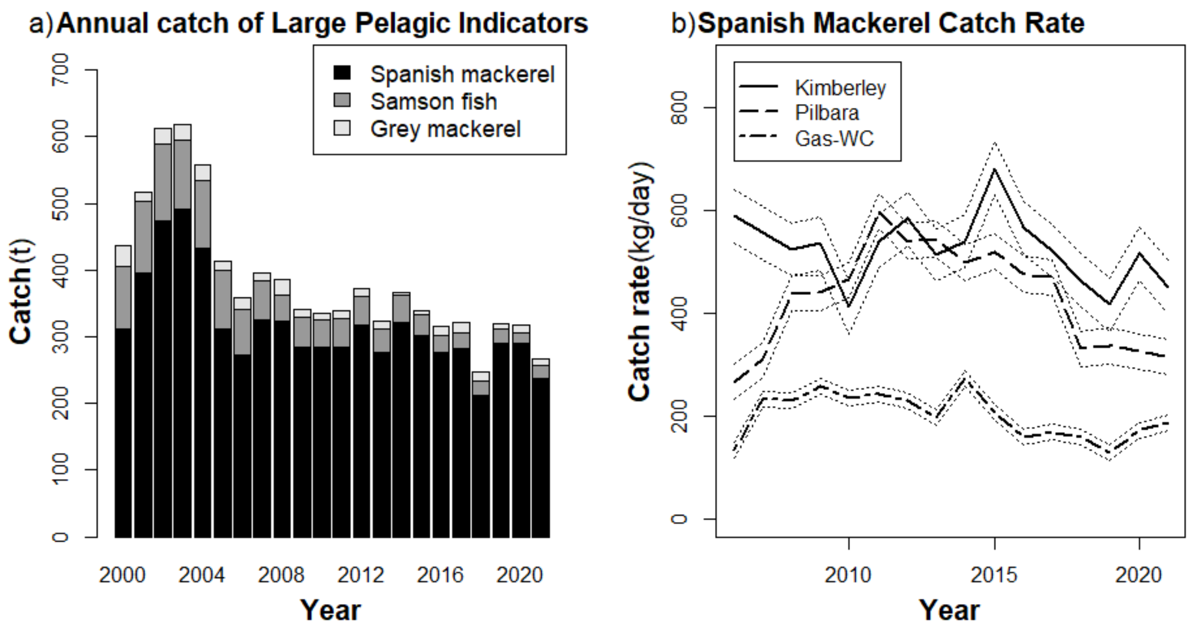
CATCH AND LANDINGS

The combined commercial landings of all large pelagic species in WA has ranged from 296-408 t over the past 10 years, with 310 t landed in 2021, following a reduced catch in 2018. The main commercial catch is of Spanish mackerel by the MMF, which has ranged from 270-330 t since quotas were introduced in 2006. The landed catch in 2021 was 238 t (Large Pelagic Finfish Figure 2a). The commercial catch of grey mackerel in 2021 was 10 t and the catch has been consistently below 20 t since 2006. The commercial landings of other tropical large pelagic species in the NCB and GCB such as Amberjack (*Seriola dumerili*), and Cobia (*Rachycentron canadum*) were 19.7 t, and 18.3 t, respectively, with all remaining species <10 t in 2021. For the temperate large pelagic species, only the combined WCB and SCB catch of 20.2 t for Samson fish in 2021 was >10 t.

The fishing tour operator annual retained catches of the three large pelagic indicator species was 17.3 t in 2021, and apart from 2020 likely due to COVID-19 restrictions, catches have ranged from 16-24 t (since 2010), with grey mackerel contributing <1 t annually and the majority of Samson fish released.

The statewide boat based recreational harvest range (95% CI) for the top 15 pelagic species (representing 99% of the resource kept catch by numbers) was steady at 114 t (95% CI 89–138) in 2020/21 compared with 112 t (95% CI 91–133) in 2017/18, 119 t (95% CI 100–139) in 2015/16 and 152 t (95% CI 126–178) in 2013/14, but lower than 186 t (95% CI 160–212) in 2011/12 (Ryan *et al*. 2022). In each survey a similar or higher amount of large pelagic species were released.

The changes to recreational trip possession limits, introduced in July 2021, will likely lead to higher fishing effort, and retained catches from the statewide large pelagic finfish resource.



LARGE PELAGIC FINFISH FIGURE 2.
a) Annual statewide commercial catch (t) for the three large pelagic indicator species; and b) Annual nominal catch rate (kg/day) of Spanish mackerel in the MMF by management area, with the 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), exhibit high fecundity, and have a young age at sexual maturity (less than 2 years) (Mackie *et al*. 2003), indicating a moderate resilience to fishing pressure. Spanish mackerel in WA form a complex of meta populations (Buckworth *et al* 2007) and are likely a shared biological stock with the Northern Territory.

The 2021 Spanish mackerel commercial catch of 238 t (Large Pelagic Finfish Figure 2a) is a return to the low level of catch reported in 2018, following the relatively stable level of catch throughout the MMF of 270-320 t from 2006 to 2017 and also from 2019-2020. The low catch can be partially attributed to one of the four main Kimberley vessels not fishing and another hitting a reef and sinking during the season along with continued low effort in the other fishing areas. It may also be related to widespread environmental changes in Northern Australia, with catches declining in other states. The nominal catch rates in the Kimberley and Pilbara management areas are generally decreasing (Large Pelagic Finfish Figure 2b), which is partially due to changes in operators, but may also indicate a decline in the spawning stock after the influence of the 2015/16 extreme marine warming (Benthuysen *et al.* 2018) during the spawning period. The catch rate in the southern GCB-WCB area has declined after a peak in 2014 when catches were high, possibly due to the effects of the 2010/11 west coast marine heatwave (Pearce 2011).

In 2021, the annual charter boat operators' landed catch of Spanish mackerel in WA was 14.5 t, following a low in 2020 of 7.4 t, likely due the ongoing influence of COVID-19. Prior to 2020, this catch had been stable ranging from 14-20 t since 2010 with a further 34-61% released/discarded. In 2021, 66% the statewide charter catch was taken in the NCB with only 25% released.

The recreational harvest range of Spanish mackerel was steady in 2020/21 (35-78 t) compared with 2017/18 (33-64 t) and 2015/16 (30-56 t), but lower than that reported in 2013/14 (56-100 t) and 2011/12 (69-109 t) (Ryan *et al*. 2022). In each survey a further 42-48% of the Spanish mackerel catch was released. The decline in catch can be partly attributed to the 20-35% decline in recreational effort in the NCB and GCB between surveys, particularly during the months from April-August, when higher catches of the species occur.

The retained recreational catch (by number) of Spanish mackerel in the WCB was steady in 2020/21 (878, SE=369), 2017/18 (775, SE=233) and 2015/16 (704, SE=243) but considerably lower than that reported in 2013/14 (2,376, SE=425) and 2011/12 (2,927, SE=443) (Ryan *et al*. 2022). This is likely due to environmental conditions reducing the abundance of the tropical species in the southern extent of their range.

On the basis of the available evidence, including trends in catch, effort, catch rates, and a vulnerability assessment the current risk level for

Spanish mackerel is **medium**. Thus, the breeding stock of Spanish mackerel in WA is 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 reach sexual maturity at a young age (less than 2 years; Cameron and Begg 2002) indicating a relatively high resilience to fishing pressure.

Grey mackerel catches in the MMF since 2000 have been relatively low, ranging from 3.5 to 24 t (Large Pelagic Finfish Figure 1a). In 2021 the WA catch of 9.7 t was predominantly taken by two vessels (91%), split between both the Pilbara and GCB-WCB areas. This level of catch is well below the TACC (60 t for each of the three management areas) for grey mackerel and negligible when compared to the 1200 t landed annually in Australia (Roelofs *et al.* 2021). The low levels of catch are likely to reflect the gear limitations (line only) and limited targeting of the species in the MMF by only two vessels.

The annual charter boat operators' catch of grey mackerel in WA has been 1 t or less since 2003. The retained recreational catch of grey mackerel was 1–3 t in 2020/21 and 1–5 t in 2017/18 but was <1 t in 2011/12, 2013/14 and 2015/16, although there is high uncertainty in catch estimates for this species (Ryan *et al.* 2022).

On the basis of the evidence provided above, the current risk level for grey mackerel is **low** and 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, can undertake large scale movements and are able to withstand capture from deep water (Rowland 2002), indicating resilience to effects of barotrauma.

The statewide commercial catch of Samson fish in 2021 was 20.2 t, which is similar to the 2020 catch and is the lowest on record compared to the historical high catch of 115 t in 2002. The catch was split between the WCB and SCB. Since 2008 catches have been at low levels, <45 t (Large Pelagic Finfish Figure 1a), due primarily to reductions in the WCB resulting from management changes in the West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF) and Temperate Demersal Gillnet and Demersal Longline Fishery (TDGDLF), see related chapters for details. Over the past 5 years the catches of Samson fish have been variable at 7-16 t in the South Coast open access line fishery, variable from 3-7 t in the TDGDLF, and stable at 6-8 t in the WCDSIMF.

The annual charter boat operators' total catch of Samson fish in WA for 2021 was an increase on that reported in 2020 at 5.8 t with 98% taken in the WCB and 60-70% released. Previously the total catch has been up to 48 t (in 2003) but has been <20 t since 2010 with 68-76% released/discarded.

The species is also targeted recreationally with the majority (>70%) released/discarded. The recreational harvest range of Samson fish was steady in 2020/21 (4-10 t) compared with 2017/18 (8-18 t) and 2015/16 (10-21 t), but lower than that reported in 2013/14 (13-31 t) and 2011/12 (12-23 t), with similar high release rates of 74-86% (Ryan *et al*. 2022).

On the basis of the evidence provided above, the current risk level for Samson fish is **low** and 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 (2021). Thus, there is **negligible** risk to the breeding stocks of other finfish species, by fishers targeting the statewide large pelagic finfish resource.

Protected species

Due to the selectivity of the fishing methods used by commercial and recreational fishers targeting large pelagic species, and the low level of interactions with protected species by the MMF there is a **negligible** risk to listed species.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat

The surface and midwater troll fishing methods used by the MMF, fishing tour operators and recreational fishers when targeting large pelagic species do 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 or pathways, 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 and ecosystem interactions.

SOCIAL AND ECONOMIC OUTCOMES

Social

Sixteen boats fished in the MMF during the 2021 season, primarily from May-November, with approximately 30-40 people directly employed in the MMF. The estimated participation rate for recreational fishing in the population of WA is 31.1% in 2015/16 (DoF 2016a). Recreational boat-based surveys indicate that Spanish mackerel is the 3rd highest retained finfish species by weight (Appendix 2), with retained catches highest in the NCB and GCB (Ryan *et al*. 2022). Meanwhile other iconic large pelagic species are targeted but released/discarded in high numbers, such as Samson fish with 79% released and Billfish species with 86% or more released.

The statewide large pelagic finfish resource provides a **moderate/high** social amenity value to recreational fishing, diving, and consumers via commercial fish supply to markets and restaurants. There is currently a **low** level of risk to these values through external drivers.

Economic

In 2021, the estimated value (to fishers) of the Spanish mackerel annual catch was Level 2, approximately $2.5-3 million. The value of the annual catch of grey mackerel, Samson fish and other large pelagic species is estimated at less than $500,000.

Recreational fishers make a significant contribution to WA's economy and support economic activity in many regional towns on the coast and near inland fishing spots. These resources contribute in part to the $2.4 billion attributed to the value of recreational fishing to the WA economy each year (McLeod and Lindner 2018). As detailed in this report the sportfishing value of large pelagic fish to the recreational spend is much higher than for other species.

There is currently a **low** level of risk to this return.

GOVERNANCE SYSTEM

Harvest Strategy

For Spanish mackerel the current method of assessment focuses on the analysis of catch and catch rates (Levels 1 and 2), with previous analyses having been used to determine the Tolerance Levels and TACC.

A preliminary harvest strategy has been developed for the MMF using reference levels for the catch rates of Spanish mackerel, which were derived from data collected over a reference period (2006 to 2011) when fishing was considered sustainable. Daily logbook catch rates are being examined and biological data is currently being collected to inform an age based (Level 3) stock assessment, to be conducted in 2023. These will inform the development of the harvest strategy for the resource.

Annual Catch Tolerance Levels (Acceptable)

The 2021 catch is just below the target commercial catch range for Spanish mackerel in the MMF of 246-430 t. In the Kimberley area the 2021 Spanish mackerel catch of 157 t is within the catch range (110-225 t), while the catches of 66 t in the Pilbara and 16 t in the GCB/WCB are below the respective tolerance ranges of 80-126 t and 56-79 t. The Pilbara catch is often below the tolerance range, and the GCB/WCB catch has been below the tolerance range for almost all years since 2006 due primarily to low effort levels. In 2018 there was a significant change in operators within the MMF and in 2021 there was a change in the main Kimberley boats including one that did not fish and another that hit a reef and sank contributing to the lower catches. Environmental conditions across northern Australia, particularly the 2015/16 extreme marine warming (Benthuysen *et al.* 2018), may have also contributed to low catches.

Due to the likely short-term influence of major changes in operators in the MMF and possible environmental factors the catch levels are considered **acceptable**.

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 daily logbook records along with 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

The Department undertakes consultation directly with licensees on operational issues. Industry Management Meetings are held annually between the Department and MMF licensees, in conjunction with the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC), with the latest meeting held in April 2021.

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 Act for a period of ten years. The 2018 Instrument of Exemption issued to all license holders which provides for operational and economic efficiencies relating to nomination requirements was extended in 2021. An industry working group was established in 2021 to assist with development of a harvest strategy for the MMF.

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 can temporarily benefit some tropical species in the southern parts of their range, as seen during the 2010/11 marine heatwave off WA when the Spanish mackerel distribution shifted southwards (Pearce *et al*. 2011). However, such events can be detrimental to recruitment in northern parts if it coincides with the spawning season (Welch *et al.* 2014) as occurred in the 2015/16 extreme marine warming. Other external factors on the fishery include the petroleum industry restricting access to fishing grounds and the likely detrimental influence of marine seismic surveys, particularly in some parts of the Pilbara area.

The high proportion of released/discarded charter and recreationally caught large pelagic fish with an unknown but likely high level of mortality (DoF 2016b) along with the increasing mortality of hooked and discarded large pelagic species by depredation, particularly in areas with higher effort (Carmody *et al.* 2021), are factors affecting the statewide large pelagic finfish resource.

Finally, the past four Indian Ocean Tuna Commission (IOTC) assessments of the Spanish mackerel catch have determined a 73% likelihood the species is overfished and subject to overfishing with catches since 2009 well above the current MSY estimate of 131,000 t (IOTC 2020). However, this outcome does not apply to the WA component of the northern Australian stock, which is distinct from that of other parts of the Indian Ocean.

Overall, these external factors constitute a **medium** risk to WA's statewide large pelagic finfish resource, with possible impacts varying among individual species.

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STATEWIDE MARINE AQUARIUM FISH AND HERMIT CRAB RESOURCES STATUS REPORT 2022

S. Newman, C. Bruce and A. Steele

OVERVIEW

The Marine Aquarium Fish Managed Fishery (MAFMF) operates in all State waters (between the Northern Territory border and South Australian border, Marine Aquarium Fish Figure 1). The fishery is typically more active in waters south of Broome with higher levels of effort around the Capes region, Perth, Geraldton, Exmouth, Dampier and Broome.

The MAFMF resource potentially includes more than 1,500 species of marine aquarium fishes, under the *Marine Aquarium Fish Managed Fishery Management Plan 2018.* Operators in the MAFMF are also permitted to take coral, live rock, algae, seagrass and invertebrates.

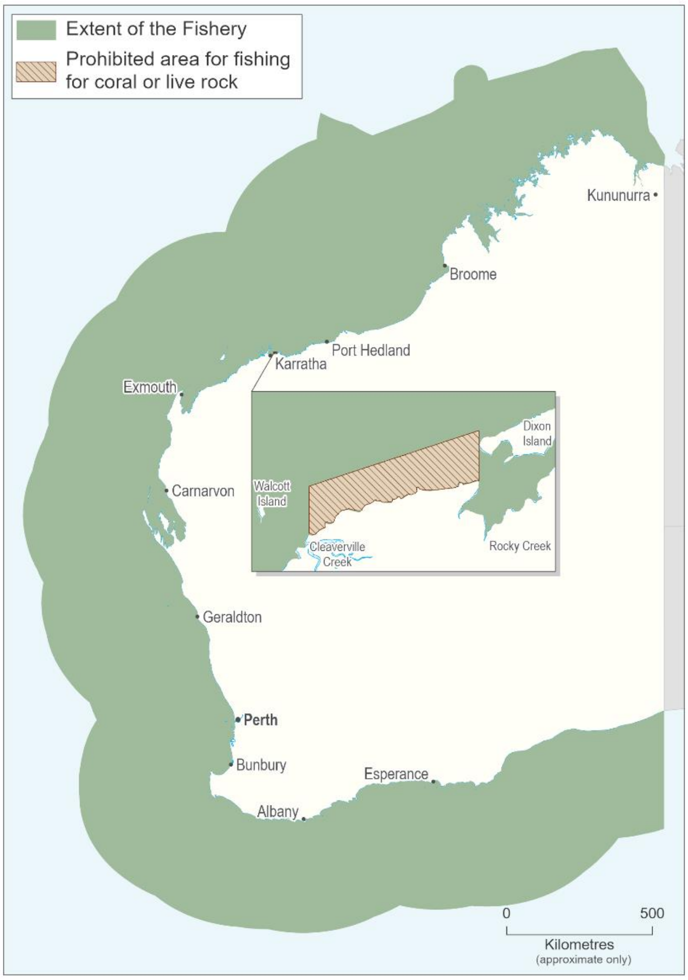
The Hermit Crab Fishery (HCF) specifically targets the Australian land hermit crab (*Coenobita variabilis*) for the domestic and international live pet trade. The fishery operates throughout the year and is one of two land-based commercial fisheries in Western Australia (WA). The HCF operates under Ministerial Exemptions and is currently permitted to fish WA waters north of, and including, Exmouth Gulf (22°30’S, Marine Aquarium Fish Figure 2).

There are no documented recreational or customary fisheries.

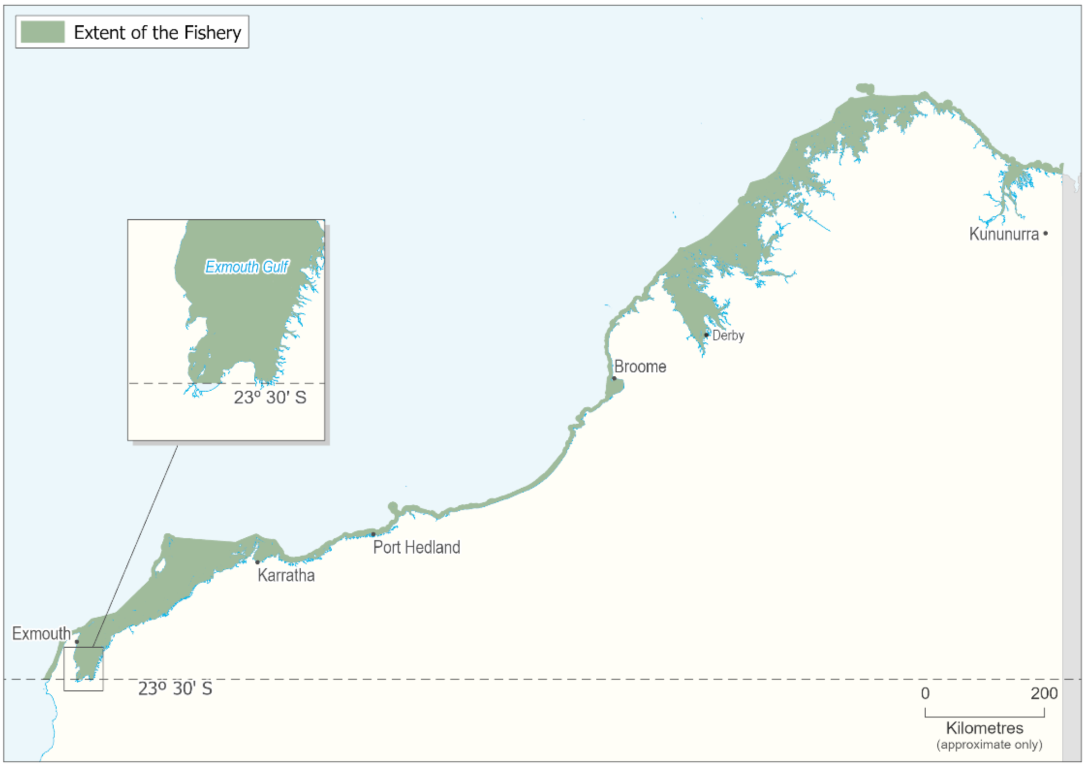
SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery	Total Catch 2021: Fish (n) – 13,362	Acceptable
Recreational fishery (NA)	Total Catch 2021: NA	Acceptable
EBFM		
Indicator species		
Syngnathid (n) – 690; Invertebrates (n) – 75,889; Hard coral (kg) – 12,605; Soft coral (kg) – 4,124; Living rock & Living sand (kg) – 11,241; Sponges (n) – 2,286; Algae/Seagrasses (l) – 42;	Small numbers of individual species taken annually.	Adequate
Hermit crabs (n) – > 79,000*;	Catch is within the range of the last 10 years (2010 to 2020).	Adequate
Ecological		
Bycatch	Negligible Risk	Adequate
Listed Species	Low Risk	Adequate
Habitat	Negligible Risk	Adequate
Ecosystem	Negligible Risk	Adequate
Economic (GVP $1-5 m)	Low Risk	Acceptable
Social (low amenity)	Low Risk	Acceptable
Governance	Low risk	Acceptable
External Drivers	Negligible Risk	Acceptable

* The specific data cannot be reported due to confidentiality provisions.



MARINE AQUARIUM FISH FIGURE 1
The extent of the Statewide Marine Aquarium Fish Managed Fishery of Western Australia. This map is indicative only regarding the extent of the fishery, and does not contain prohibited fishing areas, such as Marine Parks.



MARINE AQUARIUM FISH FIGURE 2.
The Hermit Crab Fishery of Western Australia operates in Western Australian waters north of, and including, Exmouth Gulf (22°30'S).

CATCH AND LANDINGS

There were eleven out of the twelve licences that were active in the MAFMF in 2021 and there were two active licences in the HCF (out of a total of five licences) during 2021. The total catch in the MAFMF in 2021 was 92,227 fishes (including fish, syngnathids, invertebrates and sponges), 27.97 t of coral, live rock & living sand and 42L of marine plants and live feed. MAFMF fish catches were dominated by Spotted Blenny (*Istiblennius meleagris*) n = 2,095, Scribbled Angelfish (*Chaetodontoplus duboulayi*) n =1,750, Black-axil Chromis (*Chromis atripectoralis*) n = >1,300, Margined Coralfish (*Chelmon marginalis*) n = 1,189, Stripey (*Microcanthus strigatus*) n = 635 and Allen's Glidergoby (*Valenciennea alleni*) n = >600 (Marine Aquarium Table 1), with nearly 250 other fish taxa also reported. In addition, more than 100 invertebrate taxa were also landed in the MAFMF dominated by gastropods, anemones and crabs. The main coral species landed in 2021 were the coral-like anemones of the Corallimorphidae family with 2,338 kg (Marine Aquarium Fish Table 2).

The total catch in the HCF in 2021 was more than 79,000 Australian land hermit crabs. The catch range of Australian land hermit crabs over the last 11 years (2010-2021) is ~58,000-106,000.

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 2021, which determined that the risk these fisheries are imposing on the stocks is **low**. The majority (39 of 43) of the ecological components assessed were evaluated as either low or negligible risks, which do not require any specific control measures. In addition, there were four medium risks, which were assessed as acceptable under the current monitoring and control measures.

This low level of risk is a reflection 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 WA), restricts the levels of effort, and therefore catches, that can be expended in the fishery at any given time.

The above evidence indicates that the biomass of individual species in the MAFMF is unlikely to be depleted, and that recruitment is unlikely to be impaired, and that current levels of fishing mortality (catch) are unlikely to cause any individual species to become recruitment impaired. Thus the breeding stocks of landed species in the MAFMF are classified as **sustainable-adequate**.

The level of harvest of the Australian land hermit crab in the HCF is low relative to the large area in which this species is distributed in WA. In addition, a Productivity Susceptibility Analysis (PSA) was conducted for the Australian land hermit crab. The derived PSA score was 2.18. This indicates a low risk score given the known life history attributes (fast growing, early maturation, long life). The above evidence indicates that the biomass of Australian land hermit crab in the HCF is unlikely to be depleted, recruitment is unlikely to be impaired, and that current levels of fishing mortality (catch) are unlikely to cause the Australian land hermit crab to become recruitment impaired. Thus the breeding stocks of the Australian land hermit crab in the HCF are classified as **sustainable-adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch

There is no bycatch in either fishery as both fisheries target specific taxon by hand (with the MAFMF also targeting specific taxon by fishing line), therefore chances of retaining non-targeted species are negligible. This results in a **negligible** risk for bycatch interactions.

Protected species

The potential for listed species interactions is limited due to low fishing effort and small areas accessed on each trip. The MAFMF has a small take of syngnathids under a Wildlife Trade Operation (WTO) approval from the Commonwealth. However, there is a prohibition on the take of leafy sea dragons (*Phycodurus eques*). This results in a **low** risk for protected species interactions.

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

In 2021, thirteen licences were active across the MAFMF and the HCF. Collections by the MAFMF are usually undertaken on SCUBA or surface supplied air (hookah) from small vessels, typically in small teams of two or three people. Operators in the HCF use four-wheel drive vehicles to access remote beaches where collection occurs on foot. There is currently a **low** level of risk to these values.

Economic

The value per individual marine aquarium fish and hermit crab licence is relatively high but difficult to estimate directly 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 (value is estimated to be $1-5 million). 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. There are catch limits for hard corals along with individual species-specific limits (see DPIRD 2018a). Catches of CITES species in 2021 were below the overall WTO limit for hard corals.

A total limit of 15,000 kg applies for hard and soft coral combined – excluding Corallimorpharia and Zoanthidae species. The hard coral catch for 2021 was 12,605.30 kg and the soft coral landed catch for 2021 was 542.70 kg. As such, the total 2021 combined hard and soft coral catch was 13,148 kg. The total Corallimorpharia and Zoanthidae species landed for 2021 was 3,581.20 kg.

A total limit of 2,400 Tridacnid clams applies across all species), the total catch of Tridacnid clams in 2021 was 433 individuals.

A total limit of 2000 individuals applies across all Syngnathiformes species. The total number of seahorses (*Hippocampus* spp.) landed in 2021 was 673 individuals, with a total Syngnathid (total of all species) catch of only 690 individuals.

Harvest Strategy

The harvest strategy for the Marine Aquarium Fish Resource of Western Australia (2018 – 2022) was published in September 2018 (DPIRD 2018a). The Harvest Strategy defines threshold levels for a range of species. In 2021, the threshold limits were only marginally exceeded by one species, *Euphyllia glabrescens,* with this species exceeding the threshold limit by 35.41 kg (Marine Aquarium Table 3). In 2021, the MAFMF landed only 58.6% of the available threshold catch level set for the six CITIES hard coral species (the total landed catch of the six CITIES coral species for 2021 was 3,619.81 kg, with the aggregated total available threshold limit for these six coral species being 6,174 kg; Marine Aquarium Table 3). These levels of catch are considered acceptable as they are low relative to the spatial distribution of each species within WA.

In November 2021, an ecological risk assessment (ERA) workshop was held to assess the impact of the MAFMF on the marine aquarium fish resource of WA. Outcomes of the ERA are reported in Smith et al. (2022). As part of the ERA, several CITES listed species, including hard coral, were specifically considered, with risk ratings ranging from negligible to medium. None of which required a change in management arrangements.

Compliance

On the 1st November 2018 an online detailed daily reporting system (Fisheye) was introduced for the MAFMF and replaced the old logbook system. Operators in the HCF 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 non-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 Department of Primary industries and Regional Development. The most recent Management Meeting for the MAFMF occurred in November 2020.

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

Management Initiatives

A new management plan was introduced in 2018 that includes formal quota management arrangements for coral, *Tridacnid* clams, 'live rock' and syngnathiformes.

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 2021, and catches over the previous four years.

Species	Common Name	2021	2020	2019	2018	2017
Istiblennius meleagris	Spotted Blenny*	2,095	813	>100	> 400	>600
Chaetodontoplus duboulayi	Scribbled Angelfish	1,750	1,961	2,657	3,553	3,602
Chromis atripectoralis	Black-axil Chromis*	>1,300	>600	>900	>1,300	>300
Chelmon marginalis	Margined Coralfish	1,189	1,116	711	1,934	1,888
Microcanthus strigatus	Stripey*	635	594		>20	>500
Valenciennea alleni	Allen's Glidergoby*	>600	>900	>750	>750	>600
Anampses lennardi	Blue And Yellow Wrasse	473	1,167	1,005	1,552	1,448
Chromis viridis	Blue-green Chromis*	>400	>200		>1,250	>100
Gobiidae - undifferentiated	General Gobies*	>340	>10	>10	102	109
Ecsenius bicolor	Bicolor Combtooth Blenny*	>300	>250	>350	>50	>10

* The specific data cannot be reported due to confidentiality provisions.

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 2021, and catches over the previous four years.

Species	Common Name	2021	2020	2019	2018	2017
Corallimorphidae - undifferentiated	Corallimorphidae Coral-like Anemones*	2,337.7	2,794.0	2,616.0	362.0	>50
Goniopora spp.	*Goniopora* Hard Corals	1,089.2	997.4	686.8	401.0	175.9
Fimbriaphyllia ancora	Hammer Hard Coral	1,068.9	1,942.6	2,556.2	770.4	821.0
Euphyllia glabrescens	Torch Hard Coral	1,044.4	1,209.2	1,461.2	752.8	467.4
Lobophyllia hemprichii	Lobophyllia hemprichii*	1,017.9	606.0	277.0	>100	
Duncanopsammia axifuga	Duncanops - Whisker Hard Coral	689.0	659.8	707.4	315.4	382.3
Order Zoantharia - undifferentiated	General Zoanthid Anemones*	651.0	1,007.0	1,251.0	470.0	>10
Australophyllia wilsoni	Symphyllia wilsoni Hard Coral*	626.2	374.7	984.6	169.9	>200
Trachyphyllia geoffroyi	Trachyphyllia Hard Coral	542.5	569.4	729.9	326.6	528.5
Dipsastraea spp.	*Dipsastraea* Hard Coral	480.7	425.7	749.5	311.8	91.7
Fimbriaphyllia paraancora	Branching Hammer Hard Coral*	414.2	770.0	>300	>30	>10
Turbinaria bifrons	Turbinaria bifrons Hard Coral*	>350	>30	128.0	>5	
Acropora spp.	*Acropora* Staghorn Hard Coral	350.0	383.5	462.0	376.8	305.8
Lobophyllia spp.	*Lobophyllia* Hard Coral	332.6	382.0	441.8	422.6	168.9
Alveopora spp.	*Alveopora* Hard Corals*	327.0	344.0	286.0	>20	>10
Sarcophyton spp.	Toadstool Soft Corals	282.0	255.7	429.5	390.5	456.0
Dipsastraea speciosa	Dipsastraea speciosa Hard Coral*	>250	50.2	89.0	<10	>20
Goniopora columna	Goniopora columna Hard Coral*	268.0	122.0	75.0	>30	
Acanthastrea lordhowensis	Lordhowensis Hard Coral*	258.9	227.2	239.6	<10	
Order Corallimorpharia - undifferentiated	General Coral-like Anemones	239.0	374.0	225.0	331.2	49.0

* The specific data cannot be reported due to confidentiality provisions.

MARINE AQUARIUM FISH TABLE 3

Summary of the reported catch (kg) of the CITIES listed species landed from the Marine Aquarium Fish Managed Fishery for 2021, in comparison to the harvest strategy threshold limits.

CITES listed species		Threshold limits	2021
Hard Corals	Catalaphyllia jardinei	530 kg	221.8 kg
	Duncanopsammia axifuga	1,555 kg	689 kg
	Fimbriaphyllia ancora	1,211 kg	1,068.9 kg
	Euphyllia glabrescens	1,009 kg	1,044.41 kg
	Moseleya latistellata	588 kg	53.2 kg
	Trachyphyllia geoffroyi	1,281 kg	542.5 kg
	TOTAL	6,174 kg	3,619.81 kg
Seahorses	Hippocampus angustus	328 ind.	42 ind.
	Hippocampus subelongatus	2,000 ind.	598 ind.
	Hippocampus tuberculatus	100 ind.	–
	TOTAL	2,428 ind.	640 ind.
Giant Clams	Tridacna maxima	2,360 ind.	177
	Tridacna squamosa	578 ind.	58
	TOTAL	2,938 ind.	235 ind.

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STATEWIDE SPECIMEN SHELL RESOURCE STATUS REPORT 2022

A. Hart, C. Bruce and A. Steele

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.

About 200 species of Specimen Shell are collected each year, using a variety of methods. The main methods are via hand collection by small groups of divers operating from small boats in shallow coastal waters, by wading along coastal beaches below the high water mark or, in some instances, by use of remotely operated underwater vehicles. While the fishery covers the entire Western Australian coastline, some concentration of effort occurs in areas adjacent to population centres such as Broome, Exmouth, Shark Bay, Geraldton, Perth, Mandurah, the Capes area, Albany and Esperance.

This fishery is managed through input controls in the form of limited entry, gear restrictions and permanent closed areas. There are also operational limitations – depth, time and tide. The fishery has 30 licences with a maximum of 4 divers allowed in the water per licence at any one time, and specimens may only be collected by hand. In 2021, an exemption for the trial of remotely operated underwater vehicles (limited to one per licence) was also in place.

There are a number of closed areas where the SSMF is not permitted to operate. These include 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 SSMF. The exclusion of Marmion Marine Park in the Perth metropolitan area is also important because of its populations of two rare cowrie species. There are no documented recreational fisheries.

SUMMARY FEATURES

Asset (Allowable catch &/or effort)	Outcome	Status
Commercial fishery (NA)	Total Catch 2021: Shells (n) – 5,443	Acceptable
Recreational fishery (NA)	Total Catch 2021: NA	Acceptable
EBFM		
Assessment Indicator		
Catch: 10,000 to 25,000 shells Catch rate: 10 – 40 shells per day	5,443 shells. 13 shells per day	Adequate Adequate
Ecological		
Bycatch	Negligible Risk	Adequate
Listed Species	Negligible Risk	Adequate
Habitat	Negligible Risk	Adequate
Ecosystem	Negligible Risk	Adequate
Economic (Level 1 GVP <$1 million)	Low Risk	Acceptable
Social (low amenity)	Low Risk	Acceptable
Governance	Stable	Acceptable
External Drivers	Negligible Risk	Acceptable

SPECIMEN SHELL FIGURE 1
Map showing the boundaries of the Specimen Shell Managed Fishery.

CATCH AND LANDINGS

In 2021, the total number of specimen shells collected was 5,443 distributed over 200 species. This is based on 100% of submitted catch returns. In the past 5 years, more than 435 separate species of molluscs have been collected, with an average of more than 200 species per year – the majority in low numbers per individual species.

There is some focus of effort on mollusc families that are 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.

Of the 30 licences in the fishery, 21 licences fished in 2021. Effort in 2021 was 412 days, which was 37 fishing days more than the number of fishing days reported in 2020 (375 days). Over the past five years, there was an annual average of around 511 days fished.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Statewide SSMF

During the 2021 season, the catch rate was approximately 13 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 (1998) as potentially vulnerable comprised a total 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 51% of the shells sighted were not harvested in 2021. The measure of the number of shells sighted is reported correctly in about 96% of cases where one of the vulnerable species is reported. It is anticipated that current sightings are an under estimate of the available populations. Thus the breeding stocks of landed species are classified as **sustainable-adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch

There is no bycatch in this fishery owing to the highly selective fishing methods This results in a **negligible** risk for bycatch interactions.

Protected species

The fishery reported no interactions with listed protected species during 2021. Reports of interactions with listed protected species are required to be recorded on monthly catch and effort returns This results in a **negligible** risk for protected species interactions.

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 method. While the fishery can potentially operate over large areas, catches are relatively low due to the special handling requirements. For example, specimens with slight visual imperfections are often overlooked by collectors, meaning their reproductive potential to the population can still be realised. This results in a **negligible** risk to the overall ecosystem from the fishery.

SOCIAL AND ECONOMIC OUTCOMES

Social

In 2021, 3 licences recorded consistent activity (50 fishing days or more) and 7 licences operated regularly in the fishery (18 fishing days or more). There were an additional 11 licences that exhibited low levels of activity (10 fishing days or less) in the fishery in 2021. It is expected that a minimum of 14 people are employed regularly in this fishery. There is currently a **low** level of risk to these values.

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 through vertically integrated businesses including export. The estimated annual economic value of this fishery is currently not assessed. There is currently a **low** level of economic risk to these values.

GOVERNANCE SYSTEM

The performance measures for the fishery relate to the maintenance of breeding stocks, as indicated by catch levels and catch rates. In 2021, the catch level of approximately 5,443 shells was below the catch range set, i.e. 10,000 – 25,000 shells and the catch rate of 13 shells/day was within the range set, i.e. 10 – 40 shells/day.

Harvest Strategy

The fishery currently operates under an informal harvest strategy based on a constant exploitation approach. There is no formal harvest strategy for this fishery.

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 the SSMF results in a **low** risk and low level of compliance.

Consultation

The Department undertakes consultation directly with licensees on operational issues as well as through the Professional Shell Fisherman's Association of Western Australia. Industry Management Meetings are convened by the Department through the Western Australian Fishing Industry Council (WAFIC), who also undertake consultation on statutory management plan amendments on behalf of the Department under a Service Level Agreement.

Management Initiatives

A review of the management arrangements for the SSMF is planned for 2022/2023.

EXTERNAL DRIVERS

Fishers are typically limited by sea and weather conditions and access to beaches. Consumer demand and unit prices also influence the target species and numbers landed. The external drivers pose a **low** risk to the SSMF.

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APPENDICES

APPENDIX 1

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Scientific Papers

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APPENDIX 2

The following tables contain data reported for commercial catches; estimated recreational and charter catches; aquaculture production; reported bycatch of protected and listed species from commercial fisheries; and fish prices reported from land based processors. The reporting period is dependent on the most recent data available.

Table of catches from commercial fishers' statutory returns for 2020/21

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	97
Ariidae	Forktail Catfishes	Ariidae - undifferentiated	17
Ariidae	Silver Cobbler	*Neoarius midgleyi*	58
Arripidae	Australian Herring	*Arripis georgianus*	104
Arripidae	Western Australian Salmon	Arripis truttaceus	137
Atherinidae	Hardyheads & Tusked Silversides	Atherinidae, Dentatherinidae - undifferentiated	1
Balistidae, Monacanthidae	Triggerfishes & Leatherjackets	*Balistidae, Monacanthidae - undifferentiated*	25
Berycidae	Bight Redfish	Centroberyx gerrardi	42
Berycidae	Redfishes	*Berycidae - undifferentiated*	4
Berycidae	Yelloweye Redfish	*Centroberyx australis*	6
Carangidae	Amberjack	*Seriola dumerili*	15
Carangidae	Black Pomfret	*Parastromateus niger*	6
Carangidae	Giant Queenfish	*Scomberoides commersonnianus*	1
Carangidae	Golden Trevally	*Gnathanodon speciosus*	21
Carangidae	Samsonfish	*Seriola hippos*	21
Carangidae	Silver Trevally	Pseudocaranx georgianus spp. complex	1
Carangidae	Trevallies	*Carangidae - undifferentiated*	317
Carangidae	Yellowtail Kingfish	*Seriola lalandi*	2
Carangidae	Yellowtail Scad	*Trachurus novaezelandiae*	23
Centrolophidae	Blue-Eye Trevalla	*Hyperoglyphe antarctica*	7
Cheilodactylidae	Blue Morwong	*Nemadactylus valenciennesi*	32
Clupeidae	Australian Sardine	*Sardinops sagax*	1,339
Clupeidae	Perth Herring	*Nematalosa vlaminghi*	1
Clupeidae	Sandy Sprat	*Hyperlophus vittatus*	21

Category Family Scientific Name	Common Name	Scientific Name	Live Weight (tonnes)
Clupeidae	Scaly Mackerel	Sardinella lemuru	367
Fishes (multi-family groups)	Flounders	*Bothidae, Psettodidae & Pleuronectidae*	1
Glaucosomatidae	Northern Pearl Perch	*Glaucosoma buergeri*	36
Glaucosomatidae	West Australian Dhufish	Glaucosoma hebraicum	65
Haemulidae	Grunter Breams	*Haemulidae - undifferentiated*	12
Haemulidae	Javelinfishes	*Pomadasys spp.*	38
Haemulidae	Painted Sweetlips	Diagramma labiosum	73
Hemiramphidae	Garfishes	*Hemiramphidae - undifferentiated*	9
Hemiramphidae	Southern Garfish	Hyporhamphus melanochir	13
Kyphosidae	Western Buffalo Bream	*Kyphosus cornelii*	1
Labridae	Baldchin Groper	*Choerodon rubescens*	8
Labridae	Foxfish	*Bodianus frenchii*	1
Labridae	Pigfishes	*Bodianus spp.*	2
Labridae	Tuskfishes	*Choerodon spp.*	11
Labridae	Western Blue Groper	*Achoerodus gouldii*	28
Latidae	Barramundi	*Lates calcarifer*	51
Lethrinidae	Bluespotted Emperor	*Lethrinus punctulatus*	395
Lethrinidae	Drab Emperor	*Lethrinus ravus*	7
Lethrinidae	Grass Emperor	*Lethrinus laticaudis*	3
Lethrinidae	Longnose Emperor	*Lethrinus olivaceus*	22
Lethrinidae	Mozambique Seabream	*Wattsia mossambica*	7
Lethrinidae	Redspot Emperor	*Lethrinus lentjan*	64
Lethrinidae	Redthroat Emperor	*Lethrinus miniatus*	28
Lethrinidae	Robinson's Seabream	*Gymnocranius grandoculis*	57
Lethrinidae	Spangled Emperor	*Lethrinus nebulosus*	75
Lethrinidae	Yellowtail Emperor	*Lethrinus atkinsoni*	11
Lutjanidae	Brownstripe Snapper	*Lutjanus vitta*	185
Lutjanidae	Chinamanfish	*Symphorus nematophorus*	9
Lutjanidae	Crimson Snapper	*Lutjanus erythropterus*	269
Lutjanidae	Darktail Snapper	*Lutjanus lemniscatus*	18
Lutjanidae	Fiveline Snapper	*Lutjanus quinquelineatus*	1
Lutjanidae	Flame Snapper	*Etelis coruscans*	1
Lutjanidae	Goldband Snapper	*Pristipomoides multidens*	885
Lutjanidae	Indonesian Snapper	*Lutjanus bitaeniatus*	4
Lutjanidae	Mangrove Jack	*Lutjanus argentimaculatus*	16
Lutjanidae	Moses' Snapper	*Lutjanus russellii*	63
Lutjanidae	Red Emperor	*Lutjanus sebae*	352
Lutjanidae	Rosy Snapper	*Pristipomoides filamentosus*	6
Lutjanidae	Ruby Snapper	*Etelis carbunculus*	16
Lutjanidae	Saddletail Snapper	*Lutjanus malabaricus*	300
Lutjanidae	Sharptooth Snapper	*Pristipomoides typus*	37
Lutjanidae	Stripey Snapper	*Lutjanus carponotatus*	1
Mugilidae	Sea Mullet	*Mugil cephalus*	199
Mugilidae	Yelloweye Mullet	*Aldrichetta forsteri*	10
Mullidae	Goatfishes	Mullidae - undifferentiated	18
Nemipteridae	Rainbow Monocle Bream	*Scolopsis monogramma*	8
Nemipteridae	Threadfin Breams	Nemipteridae - undifferentiated	208

Category Family Scientific Name	Common Name	Scientific Name	Live Weight (tonnes)
Oplegnathidae	Knifejaw	Oplegnathus woodwardi	1
Pentacerotidae	Boarfishes	*Pentacerotidae - undifferentiated*	4
Platycephalidae	Flatheads	*Platycephalidae - undifferentiated*	11
Plotosidae	Estuary Cobbler	*Cnidoglanis macrocephalus*	37
Polynemidae	Blue Threadfin	*Eleutheronema tetradactylum*	1
Polynemidae	King Threadfin	*Polydactylus macrochir*	13
Polynemidae	Threadfin Salmons	*Polynemidae - undifferentiated*	1
Polyprionidae	Bass Groper	Polyprion americanus	4
Polyprionidae	Hapuku	*Polyprion oxygeneios*	32
Pomatomidae	Tailor	*Pomatomus saltatrix*	13
Pricanthidae	Bigeyes	Priacanthidae - undifferentiated	22
Psettodidae	Australian Halibut	*Psettodes erumei*	2
Rachycentridae	Cobia	*Rachycentron canadum*	21
Scaridae	Parrotfishes	*Scaridae - undifferentiated*	2
Sciaenidae	Black Jewfish	*Protonibea diacanthus*	3
Sciaenidae	Mulloway	*Argyrosomus japonicus*	8
Scombridae	Grey Mackerel	*Scomberomorus semifasciatus*	9
Scombridae	Oriental Bonito	*Sarda orientalis*	3
Scombridae	Spanish Mackerel	*Scomberomorus commerson*	294
Scorpididae	Sea Sweep	*Scorpis aequipinnis*	1
Serranidae	Banded Grouper	*Epinephelus amblycephalus*	9
Serranidae	Barcheek Coral Trout	*Plectropomus maculatus*	18
Serranidae	Birdwire Rockcod	*Epinephelus merra*	1
Serranidae	Blackspotted Rockcod	*Epinephelus malabaricus*	27
Serranidae	Breaksea Cod	*Epinephelides armatus*	5
Serranidae	Duskytail Grouper	*Epinephelus bleekeri*	13
Serranidae	Eightbar Grouper	*Hyporthodus octofasciatus*	7
Serranidae	Flowery Rockcod	*Epinephelus fuscoguttatus*	2
Serranidae	Goldspotted Rockcod	*Epinephelus coioides*	56
Serranidae	Radiant Rockcod	*Epinephelus radiatus*	2
Serranidae	Radiant Rockcod/Comet Grouper	*Epinephelus Radiatus/Morrhua*	1
Serranidae	Rankin Cod	*Epinephelus multinotatus*	251
Serranidae	Spotted Cod	*Epinephelus Microdon/Areolatus/Bilobatus*	43
Serranidae	Tomato Rockcod	*Cephalopholis sonnerati*	1
Serranidae	Yellowspotted Rockcod	Epinephelus areolatus	31
Sillaginidae	King George Whiting	*Sillaginodes punctatus*	14
Sillaginidae	Whitings	*Sillaginidae - undifferentiated*	52
Sillaginidae	Yellowfin Whiting	*Sillago schomburgkii*	76
Sparidae	Black Bream	*Acanthopagrus butcheri*	69
Sparidae	Frypan Bream	*Argyrops spinifer*	99
Sparidae	Pink Snapper	*Chrysophrys auratus*	162
Sparidae	Tarwhine	*Rhabdosargus sarba*	10
Sparidae	Western Yellowfin Bream	*Acanthopagrus morrisoni*	21
Sphyraenidae	Pikes	Sphyraenidae - undifferentiated	7
Sphyraenidae	Snook	*Sphyraena novaehollandiae*	2
Terapontidae	Striped Grunters	Terapontidae - undifferentiated	1
TOTAL SCALEFISH			7,751

Category Family Scientific Name	Common Name	Scientific Name	Live Weight (tonnes)
SHARKS & RAYS			
Carcharhinidae	Bronze Whaler	*Carcharhinus brachyurus*	64
Carcharhinidae	Dusky Whaler	*Carcharhinus obscurus*	141
Carcharhinidae	Sandbar Shark	*Carcharhinus plumbeus*	36
Carcharhinidae	Spinner Shark	*Carcharhinus brevipinna*	16
Carcharhinidae	Tiger Shark	*Galeocerdo cuvier*	6
Lamnidae	Shortfin Mako	*Isurus oxyrinchus*	2
Orectolobidae	Wobbegong	Orectolobidae - undifferentiated	24
Pristiophoridae	Common Sawshark	*Pristiophorus cirratus*	3
Rajidae	Skates	Rajidae, Arhynchobatidae - undifferentiated	7
Rhinobatidae	Guitarfishes	Rhinobatidae - undifferentiated	1
Sphyrnidae	Hammerhead Sharks	Sphyrnidae - undifferentiated	35
Triakidae	Gummy Shark	*Mustelus antarcticus*	315
Triakidae	School Shark	*Galeorhinus galeus*	20
Triakidae	Whiskery Shark	*Furgaleus macki*	162
	Other Sharks	Sharks - undifferentiated	8
TOTAL SHARKS & RAYS			840
OTHER FISH	Other Fish		126
TOTAL FISH			8,717
INVERTEBRATES			
CRABS			
Geryonidae	Crystal Crab	*Chaceon bicolor*	170
Hypothalassiidae	Champagne Crab	*Hypothalassia spp.*	16
Menippidae	Giant Crab	*Pseudocarcinus gigas*	5
Portunidae	Blue Swimmer Crab	*Portunus armatus*	611
TOTAL CRABS			802
LOBSTERS			
Palinuridae	Southern Rock Lobster	*Jasus edwardsii*	7
Palinuridae	Western Rock Lobster	*Panulirus cygnus*	6,623
Scyllaridae	Moreton Bay Bug	*Thenus spp.*	7
TOTAL LOBSTERS			6,637
MOLLUSCS			
Cephalopoda	Squid	Order Teuthoidea - undifferentiated	33
Haliotidae	Brownlip Abalone	*Haliotis conicopora*	17
Haliotidae	Greenlip Abalone	*Haliotis laevigata*	35
Haliotidae	Roe's Abalone	*Haliotis roei*	22
Octopodidae	Octopuses	Octopodidae - undifferentiated	411
Pteriidae	Silverlip Pearl Oyster	*Pinctada maxima*	198
Sepiidae	Cuttlefish	*Sepia spp.*	49
Veneridae	Ballot's Saucer Scallop	*Ylistrum balloti*	1,960
TOTAL MOLLUSCS			2,725
PRAWNS			
Penaeidae	Banana Prawn	*Penaeus merguiensis*	334
Penaeidae	Blue Endeavour Prawn	*Metapenaeus endeavouri*	224
Penaeidae	Brown Tiger Prawn	*Penaeus esculentus*	821
Penaeidae	Velvet Prawn	*Metapenaeopsis spp.*	90
Penaeidae	Western King Prawn	*Melicertus latisulcatus*	841

Category Family Scientific Name	Common Name	Scientific Name	Live Weight (tonnes)
Stomatopoda	Mantis Shrimps	Order Stomatopoda - undifferentiated	15
TOTAL PRAWNS			2,325
OTHER INVERTEBRATES	Other Invertebrates		4
TOTAL INVERTEBRATES			12,493
GRAND TOTAL			21,210

1. 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 2020/21

Common Name	Quantity (numbers)	Weight (kg)	Volume (litres)
MARINE AQUARIUM FISH FISHERY			
Fish	29,638		
Syngnathidae (not included in Fish)	735		
Invertebrates (not including Corals)	71,086		
Hard Coral		13,369.50	
Soft Coral *		4,066.30	
Living Rock & Living Sand		9,807.90	
Sponges	2,762		
Algae/Seagrasses			**
SPECIMEN SHELL FISHERY			
Specimen Shells - Mollusca	4,312		
HERMIT CRAB FISHERY			
Land Hermit Crabs only - *Coenobita variabilis*	**		

* The 'Soft coral' category for the Marine Aquarium Fish Fishery includes 3,482.20 kg of coral like anemone groups such as corallimorphs and zoanthids in the Class Anthozoa. These are not part of the annual coral TAC.

** Industry figures have not been included to protect the confidentiality of individual authorisation holders, as there are less than three active authorisation holders.

Table of catches from charter returns for 2020/21

This table contains the number[1] and estimated weight[2] of species retained in the charter returns for 2020/21 financial year. The table represents the latest year for which a complete set of data is available.

Category / Family	Common Name	Scientific Name	Charter Kept Catch (number)	Charter Estimated Kept Catch (tonnes)
FISH				
SCALEFISH				
Acropomatidae, Percichthyidae, Serranidae, Polyprionidae, Moronidae, Callanthiidae, Centrogeniidae, Ostracoberycidae	Temperate Basses & Rockcods	*Percichthyidae, Serranidae - undifferentiated*	94	< 0.5
Apistidae, Neosebastidae, Pteroidae, Scorpaenidae, Sebastidae, Setarchidae, Synanceiidae, Tetrarogidae	Scorpionfishes	*Apistidae, Neosebastidae, Pteroidae, Scorpaenidae, Sebastidae, Setarchidae, Synanceiidae & Tetrarogidae - undifferentiated*	4	N/A
Ariidae	Forktail Catfishes	*Ariidae - undifferentiated*	9	N/A
Ariidae	Silver Cobbler	*Neoarius midgleyi*	Confidential	Confidential
Arripidae	Australian Herring	*Arripis georgianus*	215	Neg
Arripidae	Western Australian Salmon	*Arripis truttaceus*	Confidential	Confidential
Aulopidae	Sergeant Baker	*Latropiscis purpurissatus*	55	Neg
Balistidae, Monacanthidae	Triggerfishes & Leatherjackets	*Balistidae, Monacanthidae - undifferentiated*	51	Neg
Belonidae	Longtoms	*Belonidae - undifferentiated*	Confidential	Confidential
Berycidae	Bight Redfish	*Centroberyx gerrardi*	2056	3
Berycidae	Swallowtail	*Centroberyx lineatus*	758	< 1
Berycidae	Yelloweye Redfish	*Centroberyx australis*	72	Neg
Caesiondae, Lutjanidae, Symphysanodontidae	Fusiliers, Tropical Snappers & Slopefishes	*Caesionidae, Lutjanidae, Symphysanodontidae - undifferentiated*	62	N/A
Carangidae	Amberjack	*Seriola dumerili*	27	< 0.5
Carangidae	Bludger Trevally	*Carangoides gymnostethus*	Confidential	Confidential
Carangidae	Bluefin Trevally	*Caranx melampygus*	Confidential	Confidential
Carangidae	Brassy Trevally	*Caranx papuensis*	Confidential	Confidential
Carangidae	Diamond Trevally	*Alectis indica*	Confidential	Confidential
Carangidae	Giant Queenfish	*Scomberoides commersonnianus*	Confidential	Confidential
Carangidae	Giant Trevally	*Caranx ignobilis*	56	< 0.5
Carangidae	Golden Trevally	*Gnathanodon speciosus*	84	< 0.5
Carangidae	Longnose Trevally	*Carangoides chrysophrys*	Confidential	Confidential
Carangidae	Queenfish	*Scomberoides spp.*	274	N/A
Carangidae	Rainbow Runner	*Elagatis bipinnulata*	Confidential	Confidential
Carangidae	Samsonfish	*Seriola hippos*	315	2
Carangidae	Silver Trevally	*Pseudocaranx georgianus spp. complex*	705	< 1
Carangidae	Trevallies	*Carangidae - undifferentiated*	260	< 0.5
Carangidae	Turrum	*Carangoides fulvoguttatus*	58	< 0.5
Carangidae	Yellowtail Kingfish	*Seriola lalandi*	87	< 1

Category / Family	Common Name	Scientific Name	Charter Kept Catch (number)	Charter Estimated Kept Catch (tonnes)
Centrolophidae	Blue-Eye Trevalla	*Hyperoglyphe antarctica*	Confidential	Confidential
Cheilodactylidae	Blue Morwong	*Nemadactylus valenciennesi*	702	2
Cheilodactylidae	Dusky Morwong	*Dactylophora nigricans*	7	N/A
Cheilodactylidae	Jackass Morwong	Nemadactylus macropterus	Confidential	Confidential
Cheilodactylidae	Morwongs	*Cheilodactylidae - undifferentiated*	Confidential	Confidential
Coryphaenidae	Mahi Mahis	*Coryphaena spp.*	94	< 0.5
Dinolestidae	Longfin Pike	Dinolestes lewini	Confidential	Confidential
Fishes (multi-family groups)	Flounders	Bothidae, Psettodidae & Pleuronectidae	Confidential	Confidential
Gempylidae	Oil Fish	*Ruvettus pretiosus*	Confidential	Confidential
Glaucosomatidae	Northern Pearl Perch	Glaucosoma buergeri	1684	3
Glaucosomatidae	West Australian Dhufish	*Glaucosoma hebraicum*	2236	13
Haemulidae	Barred Javelin	*Pomadasys kaakan*	Confidential	Confidential
Haemulidae	Goldspotted Sweetlips	*Plectorhinchus flavomaculatus*	56	Neg
Haemulidae	Grunter Breams	*Haemulidae - undifferentiated*	Confidential	Confidential
Haemulidae	Javelinfishes	*Pomadasys spp.*	66	N/A
Haemulidae	Painted Sweetlips	*Diagramma labiosum*	115	< 0.5
Hemiramphidae	Garfishes	Hemiramphidae - undifferentiated	Confidential	Confidential
Hemiramphidae	Southern Garfish	*Hyporhamphus melanochir*	Confidential	Confidential
Holocentridae	Squirrelfishes	*Holocentridae - undifferentiated*	Confidential	Confidential
Istiophoridae	Black Marlin	*Makaira indica*	Confidential	Confidential
Istiophoridae	Blue Marlin	Makaira nigricans	Confidential	Confidential
Istiophoridae	Sailfish	*Istiophorus platypterus*	Confidential	Confidential
Istiophoridae	Striped Marlin	*Tetrapturus audax*	Confidential	Confidential
Kyphosidae	Silver Drummer	*Kyphosus sydneyanus*	Confidential	Confidential
Kyphosidae	Western Rock Blackfish	*Girella tephraeops*	Confidential	Confidential
Labridae	Baldchin Groper	*Choerodon rubescens*	4967	15
Labridae	Blackspot Tuskfish	*Choerodon schoenleinii*	169	< 0.5
Labridae	Blue Tuskfish	*Choerodon cyanodus*	Confidential	Confidential
Labridae	Bluespotted Tuskfish	*Choerodon cauteroma*	Confidential	Confidential
Labridae	Brownspotted Wrasse	*Notolabrus parilus*	90	Neg
Labridae	Foxfish	*Bodianus frenchii*	328	< 0.5
Labridae	Goldspot Pigfish	*Bodianus perditio*	Confidential	Confidential
Labridae	Pigfishes	*Bodianus spp.*	238	< 0.5
Labridae	Saddleback Pigfish	*Bodianus bilunulatus*	88	Neg
Labridae	Senator Wrasse	*Pictilabrus laticlavius*	Confidential	Confidential
Labridae	Southern Maori Wrasse	*Ophthalmolepis lineolatus*	Confidential	Confidential
Labridae	Tuskfishes	*Choerodon spp.*	26	N/A
Labridae	Western Blue Groper	Achoerodus gouldii	45	< 0.5
Labridae	Western King Wrasse	*Coris auricularis*	115	Neg
Labridae	Western Pigfish	*Bodianus vulpinus*	22	Neg
Labridae	Wrasses	*Labridae - undifferentiated*	103	< 0.5
Labrinae	Sunburnt Pigfish	*Bodianus solatus*	107	N/A

Category / Family	Common Name	Scientific Name	Charter Kept Catch (number)	Charter Estimated Kept Catch (tonnes)
Latidae	Barramundi	*Lates calcarifer*	1444	6
Latidae	Sand Bass	*Psammoperca waigiensis*	Confidential	Confidential
Lethrinidae	Bigeye Seabream	Monotaxis grandoculis	Confidential	Confidential
Lethrinidae	Bluespotted Emperor	*Lethrinus punctulatus*	676	< 0.5
Lethrinidae	Drab Emperor	*Lethrinus ravus*	18	N/A
Lethrinidae	Emperors	*Lethrinidae - undifferentiated*	253	< 0.5
Lethrinidae	Grass Emperor	*Lethrinus laticaudis*	3119	4
Lethrinidae	Longnose Emperor	*Lethrinus olivaceus*	1676	N/A
Lethrinidae	Orangespotted Emperor	*Lethrinus erythracanthus*	Confidential	Confidential
Lethrinidae	Redspot Emperor	*Lethrinus lentjan*	Confidential	Confidential
Lethrinidae	Redthroat Emperor	*Lethrinus miniatus*	3239	4
Lethrinidae	Robinson's Seabream	*Gymnocranius grandoculis*	2068	6
Lethrinidae	Seabreams	*Gymnocranius spp.*	Confidential	Confidential
Lethrinidae	Spangled Emperor	*Lethrinus nebulosus*	6107	15
Lethrinidae	Spotcheek Emperor	*Lethrinus rubrioperculatus*	Confidential	Confidential
Lethrinidae	Yellowlip Emperor	*Lethrinus xanthochilus*	Confidential	Confidential
Lethrinidae	Yellowtail Emperor	*Lethrinus atkinsoni*	Confidential	Confidential
Lobotidae	Tripletail	*Lobotes surinamensis*	37	N/A
Lutjanidae	Brownstripe Snapper	*Lutjanus vitta*	29	Neg
Lutjanidae	Chinamanfish	*Symphorus nematophorus*	485	2
Lutjanidae	Crimson Snapper	*Lutjanus erythropterus*	1594	3
Lutjanidae	Darktail Snapper	*Lutjanus lemniscatus*	523	< 1
Lutjanidae	False Fusilier	*Paracaesio xanthura*	Confidential	Confidential
Lutjanidae	Flame Snapper	*Etelis coruscans*	3	N/A
Lutjanidae	Goldband Snapper	*Pristipomoides multidens*	6990	26
Lutjanidae	Golden Snapper	*Lutjanus johnii*	3198	4
Lutjanidae	Green Jobfish	*Aprion virescens*	12	N/A
Lutjanidae	Indonesian Snapper	*Lutjanus bitaeniatus*	Confidential	Confidential
Lutjanidae	King Snappers	*Pristipomoides spp.*	Confidential	Confidential
Lutjanidae	Lavender Snapper	*Pristipomoides sieboldii*	Confidential	Confidential
Lutjanidae	Mangrove Jack	*Lutjanus argentimaculatus*	2006	2
Lutjanidae	Maori Snapper	*Lutjanus rivulatus*	26	N/A
Lutjanidae	Moses' Snapper	*Lutjanus russellii*	634	N/A
Lutjanidae	Red Bass	*Lutjanus bohar*	15	N/A
Lutjanidae	Red Emperor	*Lutjanus sebae*	2767	10
Lutjanidae	Rosy Snapper	*Pristipomoides filamentosus*	2874	5
Lutjanidae	Ruby Snapper	*Etelis carbunculus*	217	1
Lutjanidae	Rusty Jobfish	*Aphareus rutilans*	Confidential	Confidential
Lutjanidae	Saddletail Snapper	*Lutjanus malabaricus*	2053	4
Lutjanidae	Sailfin Snapper	*Symphorichthys spilurus*	Confidential	Confidential
Lutjanidae	Sharptooth Snapper	*Pristipomoides typus*	2917	5
Lutjanidae	Stripey Snapper	Lutjanus carponotatus	992	< 1
Lutjanidae	Tang's Snapper	*Lipocheilus carnolabrum*	9	N/A

Category / Family	Common Name	Scientific Name	Charter Kept Catch (number)	Charter Estimated Kept Catch (tonnes)
Monacanthidae	Horseshoe Leatherjacket	*Meuschenia hippocrepis*	Confidential	Confidential
Monacanthidae	Ocean Jacket	Nelusetta ayraud	Confidential	Confidential
Monacanthidae	Sixspine Leatherjacket	*Meuschenia freycineti*	Confidential	Confidential
Mugilidae	Diamondscale Mullet	*Liza vaigiensis*	Confidential	Confidential
Mugilidae	Mullets	*Mugilidae - undifferentiated*	Confidential	Confidential
Mullidae	Blacksaddle Goatfish	Parupeneus spilurus	Confidential	Confidential
Mullidae	Bluespotted Goatfish	*Upeneichthys vlamingii*	Confidential	Confidential
Mullidae	Goatfishes	*Mullidae - undifferentiated*	18	N/A
Mullidae	Rosy Goatfish	*Parupeneus chrysopleuron*	Confidential	Confidential
Nemipteridae	Western Butterfish	*Pentapodus vitta*	61	N/A
Neosebastidae	Bighead Gurnard Perch	*Neosebastes pandus*	Confidential	Confidential
Neosebastidae	Gurnard Perches	*Neosebastidae - undifferentiated*	Confidential	Confidential
Oplegnathidae	Knifejaw	Oplegnathus woodwardi	6	N/A
Paralichthyidae	Largetooth Flounder	*Pseudorhombus arsius*	Confidential	Confidential
Platycephalidae	Flatheads	*Platycephalidae - undifferentiated*	160	N/A
Platycephalidae	Rock Flathead	*Platycephalus laevigatus*	Confidential	Confidential
Platycephalidae	Southern Bluespotted Flathead	*Platycephalus speculator*	65	Neg
Platycephalidae	Yellowtail Flathead	Platycephalus westraliae	41	Neg
Plesiopidae	Southern Blue Devil	*Paraplesiops meleagris*	42	Neg
Polynemidae	Blue Threadfin	*Eleutheronema tetradactylum*	728	2
Polynemidae	King Threadfin	*Polydactylus macrochir*	309	1
Polynemidae	Threadfin Salmons	*Polynemidae - undifferentiated*	125	N/A
Polyprionidae	Bass Groper	*Polyprion americanus*	9	< 0.5
Pomatomidae	Tailor	*Pomatomus saltatrix*	69	Neg
Priacanthidae	Arrowfin Bigeye	*Priacanthus sagittarius*	Confidential	Confidential
Rachycentridae	Cobia	*Rachycentron canadum*	427	3
Scaridae	Bluebarred Parrotfish	*Scarus ghobban spp. complex*	Confidential	Confidential
Scaridae	Parrotfishes	*Scaridae - undifferentiated*	11	N/A
Sciaenidae	Black Jewfish	*Protonibea diacanthus*	90	< 0.5
Sciaenidae	Mulloway	Argyrosomus japonicus	254	< 1
Scombridae	Bigeye Tuna	*Thunnus obesus*	12	N/A
Scombridae	Bonitos	*Sarda australis & Cybiosarda elegans*	24	N/A
Scombridae	Dogtooth Tuna	*Gymnosarda unicolor*	19	N/A
Scombridae	Grey Mackerel	*Scomberomorus semifasciatus*	28	< 0.5
Scombridae	Longtail Tuna	*Thunnus tonggol*	84	< 0.5
Scombridae	Mackerel Tuna	*Euthynnus affinis*	53	< 0.5
Scombridae	Mackerels	*Scombridae - undifferentiated*	12	N/A
Scombridae	Oriental Bonito	*Sarda orientalis*	Confidential	Confidential
Scombridae	School Mackerel	*Scomberomorus queenslandicus*	114	< 0.5
Scombridae	Shark Mackerel	*Grammatorcynus bicarinatus*	94	< 1

Category / Family	Common Name	Scientific Name	Charter Kept Catch (number)	Charter Estimated Kept Catch (tonnes)
Scombridae	Skipjack Tuna	*Katsuwonus pelamis*	52	< 0.5
Scombridae	Southern Bluefin Tuna	*Thunnus maccoyii*	62	< 0.5
Scombridae	Spanish Mackerel	*Scomberomorus commerson*	1440	13
Scombridae	Spotted Mackerel	*Scomberomorus munroi*	15	Neg
Scombridae	Wahoo	Acanthocybium solandri	78	N/A
Scombridae	Yellowfin Tuna	*Thunnus albacares*	251	3
Scorpaenidae	Western Red Scorpionfish	*Scorpaena sumptuosa*	16	N/A
Scorpididae	Banded Sweep	*Scorpis georgiana*	27	Neg
Scorpididae	Footballer Sweep	*Neatypus obliquus*	Confidential	Confidential
Scorpididae	Moonlighter	*Tilodon sexfasciatus*	10	N/A
Scorpididae	Sea Sweep	*Scorpis aequipinnis*	221	< 0.5
Scorpididae	Stripey	*Microcanthus strigatus*	Confidential	Confidential
Scorpididae	Sweep	*Scorpididae - undifferentiated*	Confidential	Confidential
Serranidae	Banded Grouper	*Epinephelus amblycephalus*	49	N/A
Serranidae	Barber Perch	*Caesioperca rasor*	Confidential	Confidential
Serranidae	Barcheek Coral Trout	*Plectropomus maculatus*	1354	4
Serranidae	Barramundi Cod	*Chromileptes altivelis*	11	N/A
Serranidae	Birdwire Rockcod	*Epinephelus merra*	762	N/A
Serranidae	Blackspotted Rockcod	*Epinephelus malabaricus*	73	< 0.5
Serranidae	Blacktip Rockcod	*Epinephelus fasciatus*	Confidential	Confidential
Serranidae	Bluespotted Coral Trout	*Plectropomus laevis*	Confidential	Confidential
Serranidae	Breaksea Cod	*Epinephelides armatus*	2862	4
Serranidae	Camouflage Grouper	*Epinephelus polyphekadion*	Confidential	Confidential
Serranidae	Chinaman Rockcod	*Epinephelus rivulatus*	489	< 0.5
Serranidae	Comet Grouper	*Epinephelus morrhua*	Confidential	Confidential
Serranidae	Common Coral Trout	*Plectropomus leopardus*	760	2
Serranidae	Coral Rockcod	*Cephalopholis miniata*	15	N/A
Serranidae	Coral Trouts	*Plectropomus maculatus & leopardus*	Confidential	Confidential
Serranidae	Duskytail Grouper	*Epinephelus bleekeri*	42	N/A
Serranidae	Eightbar Grouper	*Hyporthodus octofasciatus*	138	< 1
Serranidae	Flowery Rockcod	*Epinephelus fuscoguttatus*	39	N/A
Serranidae	Frostback Rockcod	*Epinephelus bilobatus*	58	N/A
Serranidae	Goldspotted Rockcod	*Epinephelus coioides*	597	3
Serranidae	Harlequin Fish	*Othos dentex*	173	< 0.5
Serranidae	Highfin Grouper	Epinephelus maculatus	Confidential	Confidential
Serranidae	Longfin Rockcod	*Epinephelus quoyanus*	Confidential	Confidential
Serranidae	Passionfruit Coral Trout	*Plectropomus areolatus*	Confidential	Confidential
Serranidae	Radiant Rockcod	*Epinephelus radiatus*	14	N/A
Serranidae	Rankin Cod	*Epinephelus multinotatus*	4356	18
Serranidae	Tomato Rockcod	*Cephalopholis sonnerati*	743	1
Serranidae	Vermicular Cod	*Plectropomus oligacanthus*	Confidential	Confidential
Serranidae	Western Wirrah	Acanthistius serratus	10	N/A

Category / Family	Common Name	Scientific Name	Charter Kept Catch (number)	Charter Estimated Kept Catch (tonnes)
Serranidae	Wirrah	*Acanthistius spp.*	Confidential	Confidential
Serranidae	Yellowedge Coronation Trout	Variola louti	73	< 0.5
Serranidae	Yellowspotted Rockcod	*Epinephelus areolatus*	392	N/A
Sillaginidae	King George Whiting	*Sillaginodes punctatus*	110	Neg
Sillaginidae	Whitings	*Sillaginidae - undifferentiated*	351	Neg
Sillaginidae	Yellowfin Whiting	*Sillago schomburgkii*	Confidential	Confidential
Sparidae	Black Bream	*Acanthopagrus butcheri*	Confidential	Confidential
Sparidae	Frypan Bream	*Argyrops spinifer*	1637	2
Sparidae	Northwest Black Bream	*Acanthopagrus palmaris*	28	N/A
Sparidae	Pink Snapper	*Chrysophrys auratus*	15813	40
Sparidae	Tarwhine	*Rhabdosargus sarba*	49	Neg
Sparidae	Western Yellowfin Bream	*Acanthopagrus morrisoni*	Confidential	Confidential
Sphyraenidae	Great Barracuda	*Sphyraena barracuda*	Confidential	Confidential
Sphyraenidae	Pikes	*Sphyraenidae - undifferentiated*	36	N/A
Sphyraenidae	Snook	*Sphyraena novaehollandiae*	6	Neg
Terapontidae	Striped Grunters	*Terapontidae - undifferentiated*	Confidential	Confidential
Triglidae	Red Gurnard	*Chelidonichthys kumu*	Confidential	Confidential
Triglidae	Searobins & Armour Gurnards	*Triglidae & Peristediidae - undifferentiated*	Confidential	Confidential
Xiphiidae	Swordfish	*Xiphias gladius*	Confidential	Confidential
Zeidae	John Dory	*Zeus faber*	Confidential	Confidential
SHARKS & RAYS				
Brachaeluridae, Ginglymostomatidae, Hemiscylliidae, Orectolobidae, Parascylliidae, Stegastomatidae	Blind, Nurse, Carpet & Zebra Sharks	Brachaeluridae & related families - undifferentiated	Confidential	Confidential
Carcharhinidae	Blacktip Reef Shark	*Carcharhinus melanopterus*	Confidential	Confidential
Carcharhinidae	Sandbar Shark	*Carcharhinus plumbeus*	Confidential	Confidential
Carcharhinidae, Hemigaleidae	Whaler & Weasel Sharks	*Carcharhinidae, Hemigaleidae - undifferentiated*	65	N/A
Orectolobidae	Wobbegong	Orectolobidae - undifferentiated	Confidential	Confidential
Sphyrnidae	Hammerhead Sharks	Sphyrnidae - undifferentiated	Confidential	Confidential
Squalidae	Dogfishes	Squalidae - undifferentiated	Confidential	Confidential
Triakidae	Gummy Shark	Mustelus antarcticus	8	< 0.5
Triakidae	Hound Sharks	Triakidae - undifferentiated	Confidential	Confidential
Triakidae	School Shark	Galeorhinus galeus	Confidential	Confidential
Triakidae	Whiskery Shark	Furgaleus macki	24	< 0.5
INVERTEBRATES				
CRABS				
Portunidae	Brown Mud Crab	Scylla olivacea	868	< 1
Portunidae	Green Mud Crab	Scylla serrata	Confidential	Confidential
Portunidae	Mud Crab	Scylla spp.	71	N/A

Category / Family	Common Name	Scientific Name	Charter Kept Catch (number)	Charter Estimated Kept Catch (tonnes)
LOBSTERS				
Palinuridae	Ornate Rock Lobster	Panulirus ornatus	Confidential	Confidential
Palinuridae	Painted Rock Lobster	Panulirus versicolor	Confidential	Confidential
Palinuridae	Southern Rock Lobster	Jasus edwardsii	Confidential	Confidential
Palinuridae	Western Rock Lobster	Panulirus cygnus	39,346	21
MOLLUSCS				
	Gastropods	Gastropoda - undifferentiated	Confidential	Confidential
Cephalopoda	Squid	Order Teuthoidea - undifferentiated	924	< 0.5
Haliotidae	Roe's Abalone	Haliotis roei	Confidential	Confidential
Octopodidae	Octopuses	Octopodidae - undifferentiated	4	Neg
Ommastrephidae	Gould's Squid	Nototodarus gouldi	Confidential	Confidential
Ostreidae	Oysters	Ostreidae - undifferentiated	732	N/A
Pteriidae (pearl oysters)	Black Lip Pearl Oyster	Pinctada margaritifera	Confidential	Confidential
Sepiidae	Cuttlefish	Sepia spp.	24	N/A
SEA CUCUMBERS				
Stichopodidae	Prickly Redfish (Sea Cucumber)	Thelenota ananas	Confidential	Confidential

Kept catch (number): refers to the reported number of retained fish in the Tour Operator Returns (Charter Logbooks). "Confidential" indicates insufficient data where <3 Tour Operator licensees.

Kept catch (tonnes): refers to the kept catch (number) converted to a weight from estimates of average weight based on 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).

Common names are from the CAAB – Codes for Australian Biota database.

Table of catches from boat-based recreational fishers for 2020/21

This table contains the estimated number[1] and weight[2] of species retained in the state-wide survey of boat-based recreational fishers for 2020/21 (1 September 2020 – 31 August 2021). 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*. 2022 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	Estimated Kept Catch (number)	Estimated Kept Catch (tonnes)
FISH				
SCALEFISH				
Acropomatidae, Percichthyidae, Serranidae, Polyprionidae, Moronidae, Callanthiidae, Centrogeniidae, Ostracoberycidae	Temperate Basses & Rockcods	Percichthyidae, Serranidae - undifferentiated	id	id
Ariidae	Forktail Catfishes	Ariidae - undifferentiated	id	id
	Giant Sea Catfish	Netuma thalassina	id	id
	Silver Cobbler	Neoarius midgleyi	id	id
Arripidae	Australian Herring	Arripis georgianus	150,256	20
	Western Australian Salmon	Arripis truttaceus	1,654	6
Aulopidae	Sergeant Baker	Latropiscis purpurissatus	1,270	< 1
Bathysauridae, Synodontidae	Lizardfishes & Deepsea Lizardfishes	Bathysauridae, Synodontidae - undifferentiated	id	id

Category / Family	Common Name	Scientific Name	Estimated Kept Catch (number)	Estimated Kept Catch (tonnes)
Belonidae	Longtoms	Belonidae - undifferentiated	id	id
Berycidae	Bight Redfish	Centroberyx gerrardi	8,987	11
	Swallowtail	Centroberyx lineatus	665	< 0.5
	Yelloweye Redfish	Centroberyx australis	id	id
Carangidae	Amberjack	Seriola dumerili	id	id
	Bludger Trevally	Carangoides gymnostethus	id	id
	Giant Trevally	Caranx ignobilis	id	id
	Golden Trevally	Gnathanodon speciosus	1,252	3
	Queenfish	Scomberoides spp.	id	id
	Rainbow Runner	Elagatis bipinnulata	id	id
	Samsonfish	Seriola hippos	926	7
	Silver Trevally	Pseudocaranx georgianus spp. complex	34,704	18
	Trevallies	Carangidae - undifferentiated	id	id
	Turrum	Carangoides fulvoguttatus	id	id
	Yellowtail Kingfish	Seriola lalandi	id	id
	Yellowtail Scad	Trachurus novaezelandiae	id	id
Centrolophidae	Blue-Eye Trevalla	Hyperoglyphe antarctica	id	id
Cheilodactylidae	Blue Morwong	Nemadactylus valenciennesi	3,879	11
	Morwongs	Cheilodactylidae - undifferentiated	id	id
Clupeidae	Australian Sardine	Sardinops sagax	id	id
Clupeidae & Pristigasteridae	Herrings & Ilishas	Clupeidae, Pristigasteridae - undifferentiated	id	id
Coryphaenidae	Mahi Mahis	Coryphaena spp.	id	id
Fishes (multi-family groups)	Flounders	Bothidae, Psettodidae & Pleuronectidae	id	id
Gempylidae	Barracouta	Thyrsites atun	id	id
Glaucosomatidae	Northern Pearl Perch	Glaucosoma buergeri	id	id
	West Australian Dhufish	Glaucosoma hebraicum	21,595	114
Haemulidae	Barred Javelin	Pomadasys kaakan	id	id
	Blotched Javelin	Pomadasys maculatus	id	id
	Grunter Breams	Haemulidae - undifferentiated	id	id
	Painted Sweetlips	Diagramma labiosum	1,894	4
Hemiramphidae	Garfishes	Hemiramphidae - undifferentiated	id	id
	Southern Garfish	Hyporhamphus melanochir	id	id
	Three-By-Two Garfish	Hemiramphus robustus	id	id

Category / Family	Common Name	Scientific Name	Estimated Kept Catch (number)	Estimated Kept Catch (tonnes)
Istiophoridae	Black Marlin	Makaira indica	id	id
	Blue Marlin	Makaira nigricans	id	id
	Sailfish	Istiophorus platypterus	id	id
Kyphosidae	Silver Drummer	Kyphosus sydneyanus	id	id
Labridae	Baldchin Groper	Choerodon rubescens	19,998	42
	Blackspot Tuskfish	Choerodon schoenleinii	2,032	6
	Blue Tuskfish	Choerodon cyanodus	id	id
	Bluespotted Tuskfish	Choerodon cauteroma	id	id
	Brownspotted Wrasse	Notolabrus parilus	id	id
	Foxfish	Bodianus frenchii	1,408	1
	Sunburnt Pigfish	Bodianus solatus	id	id
	Purple Tuskfish	Choerodon cephalotes	id	id
	Southern Maori Wrasse	Ophthalmolepis lineolatus	id	id
	Tuskfishes	Choerodon spp.	id	id
	Western Blue Groper	Achoerodus gouldii	id	id
	Western King Wrasse	Coris auricularis	7,991	2
	Wrasses	Labridae - undifferentiated	id	id
Latidae	Barramundi	Lates calcarifer	1,450	6
	Sand Bass	Psammoperca waigiensis	id	id
Lethrinidae	Bluespotted Emperor	Lethrinus punctulatus	id	id
	Emperors	Lethrinidae - undifferentiated	id	id
	Grass Emperor	Lethrinus laticaudis	19,911	26
	Longnose Emperor	Lethrinus olivaceus	id	id
	Redspot Emperor	Lethrinus lentjan	id	id
	Redthroat Emperor	Lethrinus miniatus	9,534	10
	Robinson's Seabream	Gymnocranius grandoculis	2,008	3
	Spangled Emperor	Lethrinus nebulosus	8,119	16
	Yellowtail Emperor	Lethrinus atkinsoni	id	id
Lobotidae	Tripletail	Lobotes surinamensis	id	id
Lutjanidae	Brownstripe Snapper	Lutjanus vitta	id	id
	Chinamanfish	Symphorus nematophorus	id	id
	Crimson Snapper	Lutjanus erythropterus	1,058	2
	Darktail Snapper	Lutjanus lemniscatus	id	id
	Flame Snapper	Etelis coruscans	id	id
	Goldband Snapper	Pristipomoides multidens	4,827	10
	Golden Snapper	Lutjanus johnii	1,798	2
	Mangrove Jack	Lutjanus argentimaculatus	2,116	2
	Maori Snapper	Lutjanus rivulatus	id	id
	Moses' Snapper	Lutjanus russellii	856	id
	Red Emperor	Lutjanus sebae	6,264	19
	Rosy Snapper	Pristipomoides filamentosus	id	id

Category / Family	Common Name	Scientific Name	Estimated Kept Catch (number)	Estimated Kept Catch (tonnes)
	Ruby Snapper	Etelis carbunculus	id	id
	Saddletail Snapper	Lutjanus malabaricus	id	id
	Sharptooth Snapper	Pristipomoides typus	id	id
	Stripey Snapper	Lutjanus carponotatus	6,600	4
	Tropical Snappers	Lutjanus spp.	id	id
Megalopidae	Oxeye Herring	Megalops cyprinoides	id	id
Monacanthidae	Horseshoe Leatherjacket	Meuschenia hippocrepis	id	id
	Leatherjackets	Monacanthidae - undifferentiated	387	id
	Sixspine Leatherjacket	Meuschenia freycineti	id	id
Moridae	Morid Cods	Moridae - undifferentiated	id	id
Mugilidae	Bluetail Mullet	Valamugil buchanani	id	id
	Diamondscale Mullet	Liza vaigiensis	id	id
	Mullets	Mugilidae - undifferentiated	id	id
	Sea Mullet	Mugil cephalus	id	id
	Yelloweye Mullet	Aldrichetta forsteri	id	id
Mullidae	Bluespotted Goatfish	Upeneichthys vlamingii	id	id
Nemipteridae	Rosy Threadfin Bream	Nemipterus furcosus	id	id
	Western Butterfish	Pentapodus vitta	id	id
Neosebastidae	Bighead Gurnard Perch	Neosebastes pandus	id	id
	Gurnard Perches	Neosebastidae - undifferentiated	id	id
Oplegnathidae	Knifejaw	Oplegnathus woodwardi	id	id
Paralichthyidae	Smalltooth Flounder	Pseudorhombus jenynsii	id	id
Pentacerotidae	Boarfishes	Pentacerotidae - undifferentiated	id	id
Percidae	Redfin	Perca fluviatilis	id	id
Platycephalidae	Flatheads	Platycephalidae - undifferentiated	1,300	id
	Northern Sand Flathead	Platycephalus endrachtensis	id	id
	Southern Bluespotted Flathead	Platycephalus speculator	3,486	2
	Yellowtail Flathead	Platycephalus westraliae	1,511	1
Plesiopidae	Western Blue Devil	Paraplesiops sinclairi	id	id
Plotosidae	Eeltail Catfishes	Plotosidae - undifferentiated	id	id
Polynemidae	Blue Threadfin	Eleutheronema tetradactylum	1,961	2
	King Threadfin	Polydactylus macrochir	1,092	5
Polyprionidae	Bass Groper	Polyprion americanus	id	id
	Hapuku	Polyprion oxygeneios	id	id
Pomatomidae	Tailor	Pomatomus saltatrix	id	id
Rachycentridae	Cobia	Rachycentron canadum	1,146	8

Category / Family	Common Name	Scientific Name	Estimated Kept Catch (number)	Estimated Kept Catch (tonnes)
Scaridae	Bluebarred Parrotfish	Scarus ghobban spp. complex	id	id
	Parrotfishes	Scaridae - undifferentiated	id	id
Sciaenidae	Black Jewfish	Protonibea diacanthus	id	id
	Mulloway	Argyrosomus japonicus	id	id
Scombridae	Blue Mackerel	Scomber australasicus	id	id
	Bonitos	Sarda australis & Cybiosarda elegans	id	id
	Dogtooth Tuna	Gymnosarda unicolor	id	id
	Grey Mackerel	Scomberomorus semifasciatus	id	id
	Longtail Tuna	Thunnus tonggol	id	id
	Mackerel Tuna	Euthynnus affinis	223	< 1
	Mackerels	Scombridae spp. (tribes Scomberomorini & Scombrini)	id	id
	Oriental Bonito	Sarda orientalis	id	id
	School Mackerel	Scomberomorus queenslandicus	id	id
	Shark Mackerel	Grammatorcynus bicarinatus	id	id
	Skipjack Tuna	Katsuwonus pelamis	777	5
	Southern Bluefin Tuna	Thunnus maccoyii	1,700	6
	Spanish Mackerel	Scomberomorus commerson	6,241	56
	Spotted Mackerel	Scomberomorus munroi	id	id
	Tunas	Scombridae spp. (tribes Sardini & Thunnini)	id	id
	Wahoo	Acanthocybium solandri	id	id
	Yellowfin Tuna	Thunnus albacares	1,043	10
Scorpididae	Banded Sweep	Scorpis georgiana	id	id
	Sea Sweep	Scorpis aequipinnis	738	< 1
Serranidae	Barcheek Coral Trout	Plectropomus maculatus	1,805	4
	Barramundi Cod	Chromileptes altivelis	id	id
	Blackspotted Rockcod	Epinephelus malabaricus	id	id
	Blacktip Rockcod	Epinephelus fasciatus	id	id
	Breaksea Cod	Epinephelides armatus	14,356	14
	Chinaman Rockcod	Epinephelus rivulatus	15,856	7
	Common Coral Trout	Plectropomus leopardus	3,087	8
	Eightbar Grouper	Hyporthodus octofasciatus	1,042	5
	Frostback Rockcod	Epinephelus bilobatus	id	id
	Goldspotted Rockcod	Epinephelus coioides	3,014	9
	Harlequin Fish	Othos dentex	1,787	3
	Queensland Groper	Epinephelus lanceolatus	id	id

Category / Family	Common Name	Scientific Name	Estimated Kept Catch (number)	Estimated Kept Catch (tonnes)
	Rankin Cod	Epinephelus multinotatus	4,593	18
	Tomato Rockcod	Cephalopholis sonnerati	468	< 1
	Yellowedge Coronation Trout	Variola louti	id	id
	Yellowspotted Rockcod	Epinephelus areolatus	id	id
Sillaginidae	Goldenline Whiting	Sillago analis	id	id
	King George Whiting	Sillaginodes punctatus	67,195	17
	Southern School Whiting	Sillago bassensis	106,064	10
	Western School Whiting	Sillago vittata	110,748	11
	Western Trumpeter Whiting	Sillago burrus	id	id
	Whitings	Sillaginidae - undifferentiated	id	id
	Yellowfin Whiting	Sillago schomburgkii	44,013	8
Sparidae	Black Bream	Acanthopagrus butcheri	id	id
	Breams	Sparidae - undifferentiated	id	id
	Frypan Bream	Argyrops notialis	id	id
	Northwest Black Bream	Acanthopagrus palmaris	id	id
	Pink Snapper	Chrysophrys auratus	32,197	79
	Tarwhine	Rhabdosargus sarba	2,718	2
	Western Yellowfin Bream	Acanthopagrus morrisoni	id	id
Sphyraenidae	Great Barracuda	Sphyraena barracuda	id	id
	Pikes	Sphyraenidae - undifferentiated	id	id
	Snook	Sphyraena novaehollandiae	id	id
	Yellowtail Barracuda	Sphyraena obtusata	id	id
Stromateidae	Butterfishes & Pomfrets	Stromateidae - undifferentiated	id	id
Terapontidae	Sea Trumpeter	Pelsartia humeralis	id	id
	Striped Grunters	Terapontidae - undifferentiated	id	id
	Western Sooty Grunter	Hephaestus jenkinsi	id	id
	Western Striped Grunter	Pelates octolineatus	id	id
Toxotidae	Archerfishes	Toxotidae - undifferentiated	id	id
SHARKS & RAYS				
Carcharhinidae	Blacktip Reef Shark	Carcharhinus melanopterus	id	id
	Bronze Whaler	Carcharhinus brachyurus	id	id
	Dusky Whaler	Carcharhinus obscurus	id	id
	Sandbar Shark	Carcharhinus plumbeus	id	id
	Whitetip Reef Shark	Triaenodon obesus	id	id
Carcharhinidae, Hemigaleidae	Whaler & Weasel Sharks	Carcharhinidae, Hemigaleidae - undifferentiated	id	id
Heterodontidae	Port Jackson Shark	Heterodontus portusjacksoni	id	id
Odontaspididae	Greynurse Shark	Carcharias taurus	id	id
Orectolobidae	Wobbegong	Orectolobidae - undifferentiated	id	id
Pristiophoridae	SawShark	Pristiophorus spp.	id	id
Rhinobatidae	Western Shovelnose Ray	Aptychotrema vincentiana	id	id

Category / Family	Common Name	Scientific Name	Estimated Kept Catch (number)	Estimated Kept Catch (tonnes)
Sphyrnidae	Hammerhead Sharks	Sphyrnidae - undifferentiated	id	id
Triakidae	Gummy Shark	Mustelus antarcticus	1,451	29
	Western Spotted Gummy Shark	Mustelus stevensi	id	id
	Whiskery Shark	Furgaleus macki	id	id
NULL	Other Sharks	Sharks - undifferentiated	id	id
INVERTEBRATES				
CRABS				
Portunidae	Blue Swimmer Crab	Portunus armatus	199,159	47
	Brown Mud Crab	Scylla olivacea	2,121	1
	Green Mud Crab	Scylla serrata	id	id
	Sand Crab	Ovalipes spp.	id	id
FRESHWATER CRUSTACEANS				
Parastacidae	Marron	Cherax cainii	id	id
LOBSTERS				
Palinuridae	Ornate Rock Lobster	Panulirus ornatus	id	id
	Painted Rock Lobster	Panulirus versicolor	id	id
	Southern Rock Lobster	Jasus edwardsii	id	id
	Western Rock Lobster	Panulirus cygnus	474,331	303
MOLLUSCS				
Cephalopoda	Squid	Order Teuthoidea - undifferentiated	99,377	48
Haliotidae	Brownlip Abalone	Haliotis conicopora	id	id
	Greenlip Abalone	Haliotis laevigata	id	id
	Roe's Abalone	Haliotis roei	id	id
Octopodidae	Octopuses	Octopodidae - undifferentiated	id	id
Sepiidae	Cuttlefish	Sepia spp.	1,656	id

Kept catch (number): refers to the estimated number of fish retained from the state-wide survey of boat-based recreational fishing (Ryan *et al,* 2022), "id" indicates insufficient data where relative standard error > 40% and < 30 diarists recorded catches of the species in the state-wide survey.

Kept catch (tonnes): refers to the kept catch (number) converted to weight (rounded to the nearest tonnage) using average weight of recreationally caught fish from state-wide biological surveys or the Tour Operator Returns.

Common names are from the CAAB – Codes for Australian Biota database.

Table of growout production for the Western Australian aquaculture industry in 2020/21

This table contains the data collected on annual production returns received from all Western Australian aquaculture licence holders.

Some species produced in Western Australian aquaculture have been grouped together as they are produced by less than three contributing licences, so making the data confidential. Species combined in 2020/21 include barramundi and yellowtail kingfish under 'Finfish- Other' and 'Ornamental- Other' include ornamental; molluscs crustaceans and polychaets.

Common name	Productive licences	Quantity	Units*	Average price/ kg or individual	Value
Finfish- Other	4	1,643	Tonnes	n/a	$16,727,353
Abalone/ Mussels/ Oysters	6	377	Tonnes	n/a	$5,481,061
Marron	146	57	Tonnes	$36.19	$2,065,410
Silver Perch	7	15	Tonnes	$25.07	$363,686
Ornamental fish	7	66,894	No.	n/a	$297,443
Rainbow Trout	4	9	Tonnes	$15.65	$144,149
Goldfish / Koi-Carp	4	27,804	No.	n/a	$113,655
Anemones/ Corals/ Zoanthids	4	3,818	No.	n/a	$85,426
Yabbies	3	1	Tonnes	$21.42	$26,264
Ornamental Other	3	2,911	No.	n/a	$13,686
Algae	< 3	**			**
Total (not including algae or pearls)					$25,318,132

* 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 and charter fisheries for 2021

This table contains the numbers of accidental captures and fate of protected and listed animals by commercial and charter fishers, as reported in statutory fishing returns and Catch Disposal Records, during calendar year 2021[1]. To the extent possible, other types of recorded interactions (primarily sightings) with protected and listed species have been excluded. For the purpose of this report, protected and listed species (or taxa) are defined as those listed as: Totally Protected Fish[2] under the WA *Fish Resources Management Act 1994* (FRMA); Specially Protected Fauna under the *Biodiversity Conservation Act 2016* (BCA); cetaceans and other species that are listed under the Australian *Environment Protection and Biodiversity Conservation Act 1999* (EPBC). 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 (number		
			ALIVE	DEAD	UNKNOWN
					COMMERCIAL
Birds	Australian Darter	*Anhinga novaehollandiae*	1	1	0
	Cormorant (Unspecified)	*Phalacrocoracidae*	4	17	0
	Flesh-footed Shearwater	*Ardenna carneipes*	100	11	0
Fish	Potato Cod	*Epinephelus tukula*	3	0	0
	Green Sawfish	*Pristis zijsron*	63	30	0
	Grey Nurse Shark	*Carcharias taurus*	18	10	0
	Narrow Sawfish	*Anoxypristis cuspidata*	12	2	0
	Dwarf Sawfish	*Pristis clavata*	3	0	1
	Sawfish (Unspecified)	Pristidae	48	16	7
	Syngnathids (Unspecified)	Syngnathidae	378	41	0
	White Shark	*Carcharodon carcharias*	23	6	0
Mammals	Dolphin (Unspecified)	*Delphinidae*	2	16	0
	Humpback Whale	Megaptera novaeangliae	1	1	1

Class	Common Name	Scientific Name	Release Condition (number		
			ALIVE	DEAD	UNKNOWN
Reptiles	Crocodile (Unspecified)	*Crocodylus*	97	38	0
	Turtle (Unspecified)	*Cheloniidae*	49	0	0
	Flatback Turtle	*Natator depressus*	1	0	0
	Green Turtle	Chelonia mydas	16	1	0
	Loggerhead Turtle	Caretta caretta	4	0	0
	Freshwater Turtle	Chelidae	12	25	0
	Seasnake (Unspecified)	Hydrophiinae	4174	312	51
CHARTER					
Fish	Green Sawfish	Pristis zijsron	2	0	0
Fish	Sawfish (Unspecified)	Pristidae	3	0	0
	Humphead Maori Wrasse	Cheilinus undulatus	20	0	0
	Queensland Groper	Epinephelus lanceolatus	16	1	0
	Giant Manta Ray	Manta birostris	1	0	0
Reptiles	Crocodile (Unspecified)	Crocodylus	1	0	0

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. 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.

Table of Fish Prices for 2020/21

This table contains the average price per kilogram paid for each marine species caught in Western Australia in 2020/21. 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; 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 Scientific Name	Common Name	Scientific Name	Price per Kilogram
FISH			
SCALEFISH			
Acropomatidae, Percichthyidae, Serranidae, Polyprionidae, Moronidae, Callanthiidae, Centrogeniidae, Ostracoberycidae	Temperate Basses & Rockcods	*Percichthyidae, Serranidae - undifferentiated*	$9.92
Albulidae	Pacific Bonefish	*Albula argentea*	$1.08
Apistidae, Neosebastidae, Pteroidae, Scorpaenidae, Sebastidae, Setarchidae, Synanceiidae, Tetrarogidae	Scorpionfishes	*Apistidae, Neosebastidae, Pteroidae, Scorpaenidae, Sebastidae, Setarchidae, Synanceiidae & Tetrarogidae - undifferentiated*	$4.96
Ariidae	Forktail Catfishes	*Ariidae - undifferentiated*	$2.73
Ariidae	Silver Cobbler	*Neoarius midgleyi*	$4.47
Arripidae	Australian Herring	*Arripis georgianus*	$2.16
Arripidae	Western Australian Salmon	*Arripis truttaceus*	$0.91
Balistidae, Monacanthidae	Triggerfishes & Leatherjackets	*Balistidae, Monacanthidae - undifferentiated*	$5.04
Belonidae	Longtoms	*Belonidae - undifferentiated*	$4.69
Berycidae	Bight Redfish	*Centroberyx gerrardi*	$8.19
Berycidae	Redfishes	*Berycidae - undifferentiated*	$8.55
Berycidae	Swallowtail	*Centroberyx lineatus*	$5.38
Berycidae	Yelloweye Redfish	*Centroberyx australis*	$10.20
Caesiondae, Lutjanidae, Symphysanodontidae	Fusiliers, Tropical Snappers & Slopefishes	*Caesionidae, Lutjanidae, Symphysanodontidae - undifferentiated*	$4.37
Carangidae	Amberjack	*Seriola dumerili*	$3.41

Category Family Scientific Name	Common Name	Scientific Name	Price per Kilogram
Carangidae	Black Pomfret	*Parastromateus niger*	$9.74
Carangidae	Giant Queenfish	*Scomberoides commersonnianus*	$4.36
Carangidae	Golden Trevally	*Gnathanodon speciosus*	$2.61
Carangidae	Longnose Trevally	*Carangoides chrysophrys*	$3.49
Carangidae	Rainbow Runner	*Elagatis bipinnulata*	$5.28
Carangidae	Samsonfish	*Seriola hippos*	$3.43
Carangidae	Silver Trevally	*Pseudocaranx georgianus spp. complex*	$3.52
Carangidae	Trevallies	*Carangidae - undifferentiated*	$3.49
Carangidae	Turrum	*Carangoides fulvoguttatus*	$4.71
Carangidae	Yellowtail Kingfish	*Seriola lalandi*	$6.66
Carangidae	Yellowtail Scad	*Trachurus novaezelandiae*	$2.64
Centrolophidae	Blue-Eye Trevalla	*Hyperoglyphe antarctica*	$8.41
Cheilodactylidae	Blue Morwong	*Nemadactylus valenciennesi*	$4.11
Cheilodactylidae	Morwongs	*Cheilodactylidae - undifferentiated*	$1.43
Clupeidae	Australian Sardine	*Sardinops sagax*	$1.10
Clupeidae	Hairback Herring	*Nematalosa come*	$4.11
Clupeidae	Sandy Sprat	*Hyperlophus vittatus*	$6.86
Clupeidae	Scaly Mackerel	*Sardinella lemuru*	$1.47
Coryphaenidae	Mahi Mahis	*Coryphaena spp.*	$7.62
Elopidae	Hawaiian Giant Herring	*Elops hawaiensis*	$6.33
Fishes (multi-family groups)	Flounders	*Bothidae, Psettodidae & Pleuronectidae*	$14.88
Gempylidae	Barracouta	*Thyrsites atun*	$0.85
Gempylidae	Gemfish	*Rexea solandri*	$2.74
Gerreidae	Common Silverbiddy	*Gerres subfasciatus*	$6.55
Glaucosomatidae	Northern Pearl Perch	*Glaucosoma buergeri*	$8.19
Glaucosomatidae	West Australian Dhufish	*Glaucosoma hebraicum*	$15.93
Haemulidae	Goldspotted Sweetlips	*Plectorhinchus flavomaculatus*	$5.24
Haemulidae	Grunter Breams	*Haemulidae - undifferentiated*	$5.24
Haemulidae	Javelinfishes	*Pomadasys spp.*	$4.42
Haemulidae	Painted Sweetlips	*Diagramma labiosum*	$5.24
Hemiramphidae	Southern Garfish	*Hyporhamphus melanochir*	$5.58
Kyphosidae, Scorpididae	Drummers & Sweeps	*Kyphosidae, Scorpididae - undifferentiated*	$1.14
Labridae	Baldchin Groper	*Choerodon rubescens*	$13.62
Labridae	Bluespotted Tuskfish	*Choerodon cauteroma*	$6.85
Labridae	Goldspot Pigfish	*Bodianus perditio*	$7.24
Labridae	Pigfishes	*Bodianus spp.*	$7.24
Labridae	Tuskfishes	*Choerodon spp.*	$6.85
Labridae	Western Blue Groper	*Achoerodus gouldii*	$5.12
Labridae	Wrasses	*Labridae - undifferentiated*	$4.98
Latidae	Barramundi	*Lates calcarifer*	$8.07
Lethrinidae	Bluespotted Emperor	*Lethrinus punctulatus*	$4.75
Lethrinidae	Drab Emperor	*Lethrinus ravus*	$4.28
Lethrinidae	Emperors	*Lethrinidae - undifferentiated*	$5.28
Lethrinidae	Grass Emperor	*Lethrinus laticaudis*	$7.27
Lethrinidae	Longnose Emperor	*Lethrinus olivaceus*	$6.24
Lethrinidae	Mozambique Seabream	*Wattsia mossambica*	$6.77

Category Family Scientific Name	Common Name	Scientific Name	Price per Kilogram
Lethrinidae	Paddletail Seabream	*Gymnocranius euanus*	$3.39
Lethrinidae	Redspot Emperor	*Lethrinus lentjan*	$5.47
Lethrinidae	Redthroat Emperor	*Lethrinus miniatus*	$8.01
Lethrinidae	Robinson's Seabream	*Gymnocranius grandoculis*	$4.84
Lethrinidae	Seabreams	*Gymnocranius spp.*	$3.39
Lethrinidae	Spangled Emperor	*Lethrinus nebulosus*	$6.90
Lethrinidae	Spotcheek Emperor	*Lethrinus rubrioperculatus*	$4.90
Lethrinidae	Yellowtail Emperor	*Lethrinus atkinsoni*	$4.69
Lutjanidae	Brownstripe Snapper	*Lutjanus vitta*	$4.26
Lutjanidae	Chinamanfish	*Symphorus nematophorus*	$5.84
Lutjanidae	Crimson Snapper	*Lutjanus erythropterus*	$5.65
Lutjanidae	Darktail Snapper	*Lutjanus lemniscatus*	$5.79
Lutjanidae	Fiveline Snapper	*Lutjanus quinquelineatus*	$4.26
Lutjanidae	Goldband Snapper	*Pristipomoides multidens*	$9.83
Lutjanidae	Golden Snapper	*Lutjanus johnii*	$6.55
Lutjanidae	Indonesian Snapper	*Lutjanus bitaeniatus*	$4.38
Lutjanidae	King Snappers	*Pristipomoides spp.*	$9.21
Lutjanidae	Mangrove Jack	*Lutjanus argentimaculatus*	$5.87
Lutjanidae	Moses' Snapper	*Lutjanus russellii*	$5.26
Lutjanidae	Red Emperor	*Lutjanus sebae*	$11.82
Lutjanidae	Rosy Snapper	*Pristipomoides filamentosus*	$9.81
Lutjanidae	Ruby Snapper	*Etelis carbunculus*	$8.49
Lutjanidae	Saddletail Snapper	*Lutjanus malabaricus*	$5.33
Lutjanidae	Sharptooth Snapper	*Pristipomoides typus*	$9.72
Lutjanidae	Stripey Snapper	*Lutjanus carponotatus*	$4.26
Lutjanidae	Tang's Snapper	*Lipocheilus carnolabrum*	$7.15
Lutjanidae	Tropical Snappers	*Lutjanus spp.*	$4.26
Moridae	Ribaldo	*Mora mora*	$6.38
Mugilidae	Sea Mullet	*Mugil cephalus*	$2.44
Mugilidae	Yelloweye Mullet	*Aldrichetta forsteri*	$1.28
Mullidae	Goatfishes	*Mullidae - undifferentiated*	$4.67
Nemipteridae	Rainbow Monocle Bream	*Scolopsis monogramma*	$2.86
Nemipteridae	Threadfin Breams	*Nemipteridae - undifferentiated*	$4.15
Neosebastidae	Bighead Gurnard Perch	*Neosebastes pandus*	$2.66
Odacidae	Blue Weed Whiting	*Haletta semifasciata*	$1.28
Ophidiidae	Pink Ling	*Genypterus blacodes*	$5.87
Oplegnathidae	Knifejaw	*Oplegnathus woodwardi*	$2.58
Pentacerotidae	Boarfishes	*Pentacerotidae - undifferentiated*	$4.50
Platycephalidae	Deepwater Flathead	*Platycephalus conatus*	$3.83
Platycephalidae	Flatheads	*Platycephalidae - undifferentiated*	$4.51
Platycephalidae	Rock Flathead	*Platycephalus laevigatus*	$8.10
Pleuronectidae	Longsnout Flounder	*Ammotretis rostratus*	$21.38
Plotosidae	Estuary Cobbler	*Cnidoglanis macrocephalus*	$3.33
Polynemidae	Threadfin Salmons	*Polynemidae - undifferentiated*	$5.03
Polyprionidae	Bass Groper	*Polyprion americanus*	$8.51
Polyprionidae	Hapuku	*Polyprion oxygeneios*	$8.54
Pomatomidae	Tailor	*Pomatomus saltatrix*	$6.73

Category Family Scientific Name	Common Name	Scientific Name	Price per Kilogram
Pricanthidae	Bigeyes	*Priacanthidae - undifferentiated*	$2.97
Psettodidae	Australian Halibut	*Psettodes erumei*	$6.86
Rachycentridae	Cobia	*Rachycentron canadum*	$4.87
Salmonidae	Rainbow Trout	*Oncorhynchus mykiss*	$5.77
Scaridae	Parrotfishes	*Scaridae - undifferentiated*	$7.75
Scatophagidae	Striped Scat	*Selenotoca multifasciata*	$5.28
Sciaenidae	Black Jewfish	*Protonibea diacanthus*	$5.34
Sciaenidae	Mulloway	*Argyrosomus japonicus*	$5.00
Scombridae	Albacore	*Thunnus alalunga*	$3.63
Scombridae	Bigeye Tuna	*Thunnus obesus*	$10.21
Scombridae	Blue Mackerel	*Scomber australasicus*	$10.20
Scombridae	Grey Mackerel	*Scomberomorus semifasciatus*	$10.71
Scombridae	Mackerels	*Scombridae spp. (tribes Scomberomorini & Scombrini)*	$3.67
Scombridae	Northern Bluefin Tuna	*Thunnus orientalis*	$5.56
Scombridae	Oriental Bonito	*Sarda orientalis*	$15.46
Scombridae	School Mackerel	*Scomberomorus queenslandicus*	$12.70
Scombridae	Shark Mackerel	*Grammatorcynus bicarinatus*	$3.31
Scombridae	Skipjack Tuna	*Katsuwonus pelamis*	$8.59
Scombridae	Spanish Mackerel	*Scomberomorus commerson*	$12.05
Scombridae	Spotted Mackerel	*Scomberomorus munroi*	$12.35
Scombridae	Tunas	*Scombridae spp. (tribes Sardini & Thunnini)*	$3.63
Scombridae	Wahoo	*Acanthocybium solandri*	$7.14
Scombridae	Yellowfin Tuna	*Thunnus albacares*	$15.15
Scorpididae	Banded Sweep	*Scorpis georgiana*	$1.19
Scorpididae	Moonlighter	*Tilodon sexfasciatus*	$5.28
Scorpididae	Sea Sweep	*Scorpis aequipinnis*	$2.02
Serranidae	Banded Grouper	*Epinephelus amblycephalus*	$9.92
Serranidae	Barcheek Coral Trout	*Plectropomus maculatus*	$15.74
Serranidae	Birdwire Rockcod	*Epinephelus merra*	$9.92
Serranidae	Blackspotted Rockcod	*Epinephelus malabaricus*	$8.27
Serranidae	Breaksea Cod	*Epinephelides armatus*	$11.53
Serranidae	Chinaman Rockcod	*Epinephelus rivulatus*	$7.90
Serranidae	Comet Grouper	*Epinephelus morrhua*	$8.13
Serranidae	Common Coral Trout	*Plectropomus leopardus*	$15.74
Serranidae	Convict Grouper	*Epinephelus septemfasciatus*	$6.90
Serranidae	Coral Rockcod	*Cephalopholis miniata*	$9.92
Serranidae	Coral Trout	*Plectropomus spp. & Variola spp.*	$15.74
Serranidae	Duskytail Grouper	*Epinephelus bleekeri*	$6.94
Serranidae	Eightbar Grouper	*Hyporthodus octofasciatus*	$8.93
Serranidae	Flowery Rockcod	*Epinephelus fuscoguttatus*	$6.13
Serranidae	Frostback Rockcod	*Epinephelus bilobatus*	$6.13
Serranidae	Goldspotted Rockcod	*Epinephelus coioides*	$7.32
Serranidae	Harlequin Fish	*Othos dentex*	$5.28
Serranidae	Radiant Rockcod	*Epinephelus radiatus*	$8.13
Serranidae	Radiant Rockcod/Comet Grouper	*Epinephelus Radiatus/Morrhua*	$8.13
Serranidae	Rankin Cod	*Epinephelus multinotatus*	$8.53

Category Family Scientific Name	Common Name	Scientific Name	Price per Kilogram
Serranidae	Spotted Cod	*Epinephelus Microdon/Areolatus/Bilobatus*	$6.13
Serranidae	Striped Grouper	*Epinephelus latifasciatus*	$9.92
Serranidae	Tomato Rockcod	*Cephalopholis sonnerati*	$8.38
Serranidae	White-Edge Coronation Trout	*Variola albimarginata*	$15.74
Serranidae	Yellowedge Coronation Trout	*Variola louti*	$9.92
Serranidae	Yellowspotted Rockcod	*Epinephelus areolatus*	$6.13
Sillaginidae	Goldenline Whiting	*Sillago analis*	$3.15
Sillaginidae	King George Whiting	*Sillaginodes punctatus*	$13.28
Sillaginidae	Southern School Whiting	*Sillago bassensis*	$8.60
Sillaginidae	Yellowfin Whiting	*Sillago schomburgkii*	$4.86
Sparidae	Black Bream	*Acanthopagrus butcheri*	$5.22
Sparidae	Frypan Bream	*Argyrops spinifer*	$5.35
Sparidae	Pink Snapper	*Chrysophrys auratus*	$9.78
Sparidae	Tarwhine	*Rhabdosargus sarba*	$4.06
Sparidae	Western Yellowfin Bream	*Acanthopagrus morrisoni*	$5.70
Sparidae	Yellowback Bream	*Dentex spariformis*	$6.38
Sphyraenidae	Pikes	*Sphyraenidae - undifferentiated*	$2.63
Sphyraenidae	Snook	*Sphyraena novaehollandiae*	$4.88
Terapontidae	Striped Grunters	*Terapontidae - undifferentiated*	$1.07
Xiphiidae	Swordfish	*Xiphias gladius*	$9.90
Zeidae	John Dory	*Zeus faber*	$9.39
SHARKS & RAYS			
Alopiidae	Thresher Shark	Alopias vulpinus	$2.37
Carcharhinidae	Bronze Whaler	*Carcharhinus brachyurus*	$2.85
Carcharhinidae	Dusky Whaler	*Carcharhinus obscurus*	$4.78
Carcharhinidae	Grey Reef Shark	*Carcharhinus amblyrhynchos*	$2.05
Carcharhinidae	Sandbar Shark	*Carcharhinus plumbeus*	$3.04
Carcharhinidae	Spinner Shark	*Carcharhinus brevipinna*	$1.55
Carcharhinidae	Tiger Shark	*Galeocerdo cuvier*	$0.74
Hexanchidae	Sevengill Sharks	*Heptranchias spp.*	$2.37
Lamnidae	Shortfin Mako	*Isurus oxyrinchus*	$0.88
Orectolobidae	Wobbegong	*Orectolobidae - undifferentiated*	$1.70
Pristiophoridae	Common Sawshark	*Pristiophorus cirratus*	$0.73
Rajidae	Skates	*Rajidae, Arhynchobatidae - undifferentiated*	$5.26
Sphyrnidae	Hammerhead Sharks	*Sphyrnidae - undifferentiated*	$1.11
Squatinidae	Angel Shark	*Squatina spp.*	$2.37
Triakidae	Gummy Shark	*Mustelus antarcticus*	$4.92
Triakidae	Pencil Shark	*Hypogaleus hyugaensis*	$1.02
Triakidae	School Shark	*Galeorhinus galeus*	$4.79
Triakidae	Whiskery Shark	*Furgaleus macki*	$4.52
Trygonorrhinidae	Banjo Rays	*Trygonorrhinidae - undifferentiated*	$0.57
	Shark Fins		$10.99
	Other Sharks	*Sharks - undifferentiated*	$2.37
OTHER FISH			
	Other FIsh		$5.28

Category Family Scientific Name	Common Name	Scientific Name	Price per Kilogram
INVERTEBRATES			
CRABS			
Geryonidae	Crystal Crab	Chaceon bicolor	$55.11
Hypothalassiidae	Champagne Crab	Hypothalassia spp.	$23.51
Menippidae	Giant Crab	Pseudocarcinus gigas	$83.20
Portunidae	Blue Swimmer Crab	Portunus armatus	$10.09
Portunidae	Brown Mud Crab	Scylla olivacea	$30.00
Portunidae	Common Sand Crab	Ovalipes australiensis	$13.18
Portunidae	Coral Crab	Charybdis feriata	$9.79
Portunidae	Green Mud Crab	Scylla serrata	$45.00
LOBSTERS			
Palinuridae	Southern Rock Lobster	Jasus edwardsii	$31.09
Palinuridae	Western Rock Lobster	Panulirus cygnus	$33.93
Scyllaridae	Bug	Ibacus & Thenus spp.	$18.07
MOLLUSCS			
	Molluscs	Mollusca - undifferentiated	$6.75
Cephalopoda	Squid	Order Teuthoidea - undifferentiated	$18.36
Haliotidae	Brownlip Abalone	Haliotis conicopora	$53.42
Haliotidae	Greenlip Abalone	Haliotis laevigata	$62.14
Haliotidae	Roe's Abalone	Haliotis roei	$25.81
Octopodidae	Octopuses	Octopodidae - undifferentiated	$12.68
Sepiidae	Cuttlefish	Sepia spp.	$6.28
Veneridae	Ballot's Saucer Scallop	Ylistrum balloti	$4.03
PRAWNS			
Penaeidae	Banana Prawn	Penaeus merguiensis	$12.13
Penaeidae	Black Tiger Prawn	Penaeus monodon	$15.00
Penaeidae	Blue Endeavour Prawn	Metapenaeus endeavouri	$5.84
Penaeidae	Brown Tiger Prawn	Penaeus esculentus	$16.49
Penaeidae	Velvet Prawn	Metapenaeopsis spp.	$5.38
Penaeidae	Western King Prawn	Melicertus latisulcatus	$14.98
Stomatopoda	Mantis Shrimps	Order Stomatopoda - undifferentiated	$2.36
Penaeoidea & Caridea	Other Prawns	Penaeoidea & Caridea - undifferentiated	$2.41
SEA URCHINS			
Echinometridae	Sea Urchins	Echinometridae - undifferentiated	$9.21
SEA CUCUMBERS			
Holothuriidae	Black Teatfish (Sea Cucumber)	Holothuria whitmaei	$8.50
Holothuriidae	Deepwater Redfish (Sea Cucumber)	Actinopyga echinites	$2.60
Holothuriidae	Sandfish (Sea Cucumber)	Holothuria scabra	$5.50

APPENDIX 3

Annual performance for commercial fisheries subject to export approval under the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act* 1999

The following table provides a summary of the issues, performance measures and any conditions for fisheries subject to the above Act and their annual performance. The period assessed in each case is the most recent season for which complete data are available. As a result of the duration required for data collection and analysis, the years being assessed in this volume are the 2019/20 season or the calendar year 2020 for fisheries data but up to June 2019 for relevant research or management actions projects and actions.

In addition to this summary, more detailed information on the annual performance of each fishery is provided in the relevant status reports presented throughout this volume. Within the individual status reports, each performance measure assessed is shown in a highlighted box to assist the reader.

It should also be noted that where naturally occurring fluctuations in fish stocks have required management adjustments or where improvements have been made to methods of analysis, these have in some cases (asterisked) required a revision of the performance measure this year.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2020/21 or 2021	Comment
Fishery: Abalone *Approval type:* Accredited Export Exempt Fishery Initial accreditation: August 2004 Current accreditation: August 2015 *Expiry date:* August 2025	Greenlip/Brownlip abalone Areas 2/3 (spawning stock)	Effort range 907–1,339 diver days; minimum meat weight 140 g greenlip, 160 g brownlip	Inadequate	Performance indicator for Greenlip abalone below threshold in Area 2 and open regions of Area 3. Spatial closures enforced in Area 3 for 2021. Performance indicator for Brownlip abalone below limit in Area 2.
	Roe's abalone Area 1 (spawning stock)	Effort range 14–43 diver days; total catch 5 t	Acceptable	Exploratory quota.
	Roe's abalone Area 2 (spawning stock)	Effort range 80–106 diver days; total catch 13.2 t	Acceptable	Total catch indicator not met in regional areas. This is due to poor economic and weather conditions.
	Roe's abalone Area 5 (spawning stock)	Effort range 100–140 diver days; total catch 15 t	Acceptable	
	Roe's abalone Area 6 (spawning stock)	Effort range 50-80 diver days; total catch 7.5 t	Acceptable	
	Roe's abalone Area 7 (spawning stock)	Effort range 230–270 diver days; total catch 29.1 t	Acceptable	Total catch indicator set annually by stock prediction model. Catch indicator not met due to economic impacts of COVID-19.
	Roe's abalone Area 8 (spawning stock)	Effort range 0 diver days; total catch 0 t	Inadequate due to environmental conditions	Closed since 2012 due to environmentally induced mortality.
Fishery: Abrolhos Islands and Mid West Trawl *Approval* type: Accredited Export Exempt Fishery Initial accreditation: March 2005 Current accreditation: August 2015 *Expiry date:* August 2025	Scallops (spawning stock)	The survey stock abundance index determines a predicted catch that sets the length of the next season and the fishing season ceases at a catch rate threshold level,	Acceptable	Catch within acceptable range.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2020/21 or 2021	Comment
Fishery: Beche-de-mer *Approval type:* Wildlife Trade Operation Exemption Initial accreditation: December 2004 Current accreditation: August 2017 Expiry date: May 2025	Beche-de-mer species (spawning stock)	Sandfish acceptable catch range: 20-100 t. Catch rate above 25 kg/hr. Redfish acceptable catch range: 40-100 t. Catch rate above 60 kg/hr.	Acceptable	Fishery is MSC certified. Harvest strategy under review
Fishery: Broome Prawn *Approval type:* Accredited Export Exempt Fishery Initial accreditation: August 2004 Current accreditation: August 2015 *Expiry date:* August 2025	Western king prawn (spawning stock)	Annual exploitation rate of king prawns to not exceed 60% in any one year	Acceptable	Minimal fishing occurred in 2021.
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–90 t (7-year catch range)	Acceptable	As above.
Fishery: Exmouth Gulf Prawn *Approval Type:* Accredited Export Exempt Fishery Initial accreditation: March 2003 Current accreditation: August 2015 *Expiry date:* August 2025	Tiger prawn (spawning stock)	Catch rate above 25 kg/hr (6 fathom quad gear) revised from original 8–10 kg/hr (7.5 fathom twin gear)	Acceptable	Catch rate above target level.
	King prawn (spawning stock)	Catch rate above 25 kg/hr (6 fathom quad gear).Total catch within acceptable revised (2017) range of 100–450 t	Acceptable	Catch rate above target level. Catch within revised range.
	Endeavour prawn (spawning stock)	Catch rate above 9 kg/hr(6 fathom quad gear). Total catch within acceptable range of 120–300 t	Acceptable	Catch rate above target level. Catch within range.
	Banana prawn (spawning stock)	Total catch within acceptable range of 10–60 t for years with significant rainfall and 0–2 t for years with low rainfall	Acceptable	
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–100 t	Acceptable	Catch below range due to marketing reasons.
	Non –Retained species	The major species of bycatch are found in significant numbers outside of the trawled areas	Acceptable	
	Impact to mud/shell (habitat)	< 40% of mud/shell habitat in Exmouth Gulf trawled	Acceptable	
Fishery: Gascoyne Demersal Scalefish Managed Fishery *Approval type:* Wildlife Trade Operation Exemption Initial accreditation: June 2004 Current accreditation: August 2015 *Expiry date:* August 2025	Pink snapper (spawning stock)	Spawning biomass > 30% of unexploited spawning biomass	Unacceptable	Performance measure was reviewed as part of Harvest Strategy (in 2017). Further reductions in quota and spatial closures were implemented in 2018 under a Recovery Plan. To be reviewed based on results of next stock assesment (in late 2022).
Fishery: Kimberley Prawn *Approval Type:* Accredited Export Exempt Fishery Initial accreditation: November 2004 Current accreditation: August 2015 *Expiry date:* August 2025	Banana prawn (spawning stock)	Total catch within acceptable range of 200–450 t	Acceptable	Catch below range but within catch prediction.
	Brown tiger prawn (spawning stock)	Total catch within acceptable range of 15–60 t	Acceptable	Catch just below acceptable range in part due to targeting on higher catch rates of banana prawns.
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 7–80 t	Acceptable	As above
	Coral prawns (spawning stock)	Total catch within acceptable range of 0–6 t (10-year catch range)	Acceptable	As above
	Black tiger prawn (spawning stock)	Total catch within acceptable range of 0–1 t	Acceptable	
	Squid (spawning stock)	Total catch within acceptable range of 1–50 t	Acceptable	Negligible reported landings.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2020/21 or 2021	Comment
Fishery: Mackerel *Approval type:* Accredited Export Exempt Fishery Initial accreditation: November 2004 Current accreditation: August 2015 *Expiry date:* August 2025	Spanish mackerel (spawning stock)	Total catch within acceptable range of 246-410 t: acceptable regional catch ranges: Kimberley 110–205 t: Pilbara 80–126 t: Gascoyne/West Coast 56–79 t	Acceptable	Total catch just below acceptable range due to changes in fishery. Higher level assessment underway, monitor closely.
Fishery: Marine Aquarium Managed Fishery *Approval type*: Wildlife Trade Operation Exemption Initial accreditation: October 2005 Current accreditation: October 2019 *Expiry date*: October 2022	There are specific performance measures for CITES species taken by the MAFMF, these include hard corals, tridacnid clams, seahorses and syngnathids (total).	The MAFMF is operating in accordance with the 2018-2022 MAFMF Harvest Strategy. In 2021, the defined threshold limits in the harvest strategy were only marginally exceeded by one species (*Euphyllia glabrescens*, by 35kg). Only 58.6% of the threshold limits for the six CITIES hard coral species was landed in 2021.	Acceptable	An ecological risk assessment (ERA) was completed in 2021 for the MAFMF. As part of the ERA, several CITES listed species, including hard coral, were specifically considered, with risk ratings ranging from negligible to medium.
Fishery: Northern Demersal Scalefish *Approval type:* Accredited Export Exempt Fishery Initial accreditation: November 2004 Current accreditation: August 2015 *Expiry date:* August 2025	Indicator species spawning stock (red emperor and goldband snapper)	The NDSMF is operating in accordance with the North Coast demersal scalefish resource harvest strategy 2017 – 2021.	Acceptable	Indicator spoecies were assessed as Medium risk in the last stock assessment.
Fishery: Onslow and Nickol Bay Prawn *Approval Type:* Accredited Export Exempt Fishery Initial accreditation: November 2004 Current accreditation: August 2015 *Expiry date:* August 2025	Banana prawns (spawning stock)	Nickol Bay: total catch in high rainfall years within acceptable range of 150–220 t: in low rainfall years within acceptable range of 0–40 t. Onslow: total catch within acceptable range of 2–90 t	Acceptable Acceptable	Banana prawns within predicted and catch tolerance range.
	Brown tiger prawn (spawning stock)	Acceptable catch ranges of Nickol Bay 2–40 t and Onslow 10–120 t	Acceptable	Both below range but limited targeting of this species.
	Western king prawn (spawning stock)	Acceptable catch ranges of Nickol Bay 20–70 t and Onslow 10–55 t	Acceptable	As above
	Endeavour prawn (spawning stock)	Total catch within acceptable ranges; Nickol Bay 1-10 t and Onslow 5-20 t.	Acceptable	As above
	Coral prawns (spawning stock)	Total catch within acceptable range of Nickol Bay 1–15 t (10-year catch range) and Onslow 4–20 t	Acceptable	As above
	Black tiger prawn (spawning stock)	Total catch within acceptable range of 0–2 t	Acceptable	
Fishery: Octopus *Approval type:* Accredited Export Exempt Fishery Initial accreditation: September 2011 Current accreditation: August 2017 *Expiry date:* August 2025	Octopus (*Octopus djinda*)	Formal harvest strategy with biological reference points (Target, Threshold, and Limit). These based on standardised catch rate per unit effort (kg per potlift)	Acceptable	Catch rates are above the target level

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2020/21 or 2021	Comment
Fishery: Pearl Oyster *Approval type:* Accredited Export Exempt Fishery Initial accreditation: September 2003 Current accreditation: August 2015 *Expiry date:* August 2025	Silver-lipped (gold-lipped) pearl oyster (spawning stock)	Fished area should be < 60% of species distribution; catch rates should not decrease by > 50% from historical averages of 29.5 oysters/hr (Zone 2) and 34.8 oysters/hr (Zone 3); > 30% of Zone 1 catch should be > 150 mm shell length	Acceptable	Catch rates are above the target performance indicators.
Fishery: Pilbara Trawl *Approval type:* Wildlife Trade Operation Exemption Initial accreditation: November 2004 Current accreditation: August 2021 *Expiry date:* August 2024	Indicator species spawning stock (red emperor, Rankin cod, bluespotted emperor)	The Pilbara Fish Trawl Fishery is operating in accordance with the North Coast demersal scalefish resource harvest strategy 2017 – 2021.	Acceptable	An ERA for the fishery is scheduled.
	Bycatch of listed species	All skippers to maintain records of the time, date, shot duration, location and status upon release of each incidental capture to species level. Address any significant risks raised by the ERA. Review the resilience of sawfish and dolphin populations. Develop a policy to support the electronic monitoring program.	Acceptable	Dolphin mortalities reported in statutory logbooks have reduced since 2006. An industry code of practice has been developed to address interactions with dolphins. Mitigation devices implemented in nets in 2006 has reduced the incidental captures of turtles by >95%. Pipefish and seahorses are released alive.
Fishery: Salmon *Approval type:* Accredited Export Exempt Fishery Initial accreditation: November 2004 Current accreditation: August 2015 *Expiry date:* August 2025	Western Australian salmon (spawning stock)	Expected catch range under the current management regime is 0-1,200 t	Acceptable	2021 catch was 137 t. Catches continue to be low relative to historic levels, due to low effort in response to limited market demand. Stock level is acceptable, based on age-based assessment completed in 2017.
Fishery: Shark Bay Crab Managed Fishery *Approval type:* Wildlife Trade Operation Exemption Initial accreditation: November 2004 Current accreditation: August 2015 *Expiry date:* August 2025	Blue swimmer crab (breeding stock)	CPUE to remain above 1 kg/trap lift	Acceptable	A TACC of 650 tonnes was set in 2020/21 of which 84% was achieved. The commercial catch rate was well above the target.
Fishery: Shark Bay Prawn *Approval type:* Accredited Export Exempt Fishery Initial accreditation: February 2003 Current accreditation: August 2015 *Expiry date:* August 2025	Tiger prawn (spawning stock)	Level of spawning stock present based on fishery independent surveys during the spawning season at a target of 25 kg/hr (5.5 fathom quad gear)	Acceptable	
	King prawn (spawning stock)	Level of spawning stock present based on fishery independent surveys during the spawning season at a target of 25 kg/hr (5.5 fathom quad gear)Total catch within historical acceptable range of 950–1,450 t, given no change in effort	Acceptable	Breeding stock was below the target but well above the limit. A precautionary approach to harvestng was adopted in 2021. Total catch was below the acceptable range. Currently under investigation with recruitment surveys higlighting a declining trend in size.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2020/21 or 2021	Comment
	Coral and endeavour prawns (spawning stock)	Total catch within historical acceptable ranges given no change in effort: coral 80–280 t, endeavour 1–30 t	Acceptable	
	Loggerhead turtles (captures)	90% of turtles captured from non-BRD nets returned alive	Acceptable	BRDs are mandatory in all nets so this performance measure is no longer valid. For the 2021 season, 51 turtles were recorded as caught in nets and with all recorded as being returned to the sea alive.
	Discarded fish (abundance)		Acceptable	Majority of bycatch species are found in relatively significant numbers outside of trawled areas
	Impact to sand/shell (habitat)	< 40% of sand/shell habitat in Shark Bay trawled	Acceptable	
	Impact to coral/sponge (habitat)	<20% of the remaining coral/sponge habitat in Shark Bay to be contained within the legally trawled area	Acceptable	
	Discarding fish (provisioning)		Acceptable	Reduction in amount of discards and ratio of discards to target catch from pre-catch reduction device levels and in water hopper system increasing survival of some bycatch species.
Fishery: Shark Bay Scallop *Approval type:* Accredited Export Exempt Fishery Initial accreditation: February 2003 Current accreditation: August 2015 *Expiry date:* August 2025	Scallop (spawning stock)	Monitoring of recruit/ residual stock in northern Shark Bay and Denham Sound to ensure an appropriate TACC is set so that there is adequate level of breeding stock present when spawning commences. Also there is no retention of scallops during the key spawning period.	Acceptable	A TACC of 132 t was set for Denham Sound but revised to 40 t mid-season whilst a TACC of 85 t was set for northern Shark Bay in the Redcliff area during the mid-season review and the majority of each TACC will be achieved by the end of the season.
	Loggerhead turtles (captures)	90% of turtles captured from non-BRD nets returned alive	Acceptable	As for Shark Bay prawn, however, no turtle captures were reported.
Fishery: South Coast Crustacean *Approval type:* Wildlife Trade Operation Exemption Initial accreditation: September 2004 Current accreditation: January 2017 Expiry date: January 2024	Southern rock lobster & crystal crab biomass	* Finalise and implement a formal harvest strategy * ensure finer-scale catch and effort used in stock assessment * develop management measures to rebuild stock levels	Un-Acceptable	Several species have been asssessed as below the threshold reference point with appropriate TAC to be implimented for the 2022/23 season
Fishery: Specimen Shell *Approval type:* Accredited Export Exempt Fishery Initial accreditation: 25 May 2005 Current accreditation: August 2015 *Expiry date:* August 2025	Specimen shell species (spawning stock)	Preliminary acceptable catch range is from 10,000–25,000 shells; acceptable catch rate 10–40 shells per day	Acceptable	Both catch and catch rate within acceptable ranges

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2020/21 or 2021	Comment
Fishery: Temperate Demersal Gillnet and Demersal Longline (Shark) Fisheries *Approval type:* Accredited Export Exempt Fishery Initial accreditation: February 2006 Current accreditation: August 2018 *Expiry date:* August 2021	Dusky and sandbar sharks	Continue to review and report outcomes of actions taken to rebuild stocks	On-going	Recovery of dusky and sandbar sharks is highly likely. Stock assessments completed late 2017.Resource Assessment Report published September 2019. Next stock assessment due in 2022.
	Australian sea lions	Continue monitoring fishing effort around Australian sea lion colonies following implementation of Gillnet Exclusion Zones and investigate potential management measures to further limit the overlap of gillnet fishing and Australian sea lion foraging areas to support recovery of the species. These management measures could include independent validation of interaction rates	Underway and ongoing	A network of Gillnet Exclusion Zones was established on 29 June 2018 to protect Australian sea lion breeding colonies, covering a total of 17,300 square kilometres along the Western Australian coast. A pilot FRDC-funded project (FRDC 2017-119) is currently developing novel remote camera approaches to assess and monitor the population status of ASLs. The Department continues monitoring spatio-temporal levels of gillnet effort
Fishery: West Coast Rock Lobster *Approval Type:* Wildlife Trade Operation Exemption Initial accreditation: August 2002 Current accreditation: May 2018 Expiry date: May 2025	Western rock lobster (spawning stock)	Spawning biomass at Abrolhos Islands and coastal regions to remain above respective levels during the early 1980s with 75% certainty	Acceptable	Current spawning stock levels in all four breeding stock management areas are well above their respective threshold levels
	Octopus (spawning stock)	Catch rate (cpue) not to drop outside of historic range by > 10%	Acceptable	In 2013 the recording of octopus catch was altered with the adoption of Catch Disposal Records (CDR). Octopus cpue is now determined as the catch (kg) per pot lift in waters < 20 fm from CDRs (standardised for month and latitude). Since 2013 the cpue of octopus has ranged from 0.007 to 0.012 kg/potlift. In 2020 the cpue was 0.008, which is within 10% of the historical range.
	Sea lion (captures)	No increase in rate of capture	Acceptable	No sea lion captures were reported.
	Leatherback turtle (entanglements)	No increase in rate of interactions	Acceptable	No entanglements were reported.
	Whales and dolphins (entanglements)	No increase in rate of interactions	Unacceptable	There were 8 confirmed whale entanglements in WRL gear during the 2020 humpback whale migration season. While mitigation measures have reduced whale entanglements by ~2/3 the increase in entanglements necessitates a review of current management measures.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2020/21 or 2021	Comment
Fishery: West Coast Deep Sea Crustacean Managed Fishery *Approval type:* List of Exempt native Species Initial accreditation: March 2004 Current accreditation: August 2015 *Expiry date:* August 2025	Champagne and Giant crab biomass	Unitisation of the fishery has permitted a maximum of 14 t of Champagne crab and Giant crab to be taken in a season	Acceptable	
	Crystal Crab biomass	The fishery is quota based with catches limited to 154 t of crystal crab per season	Un-acceptable	The standardised catch rate has fallen below the threshold level with TAC reductions implimented.
Fishery: West Coast Purse Seine Managed Fishery and Developmental Zones. *Approval type:* Accredited Export Exempt Fishery Initial accreditation: January 2020 *Expiry date:* January 2023	Purse seine catch of Scaly mackerel, Australian sardine, yellowtail scad, Australian anchovies, maray, Perth herring.	Notional total allowable commercial catch	Acceptable	

APPENDIX 4

Aquatic Science and Assessment staff adjunct positions and supervision of students

Staff Member	Position
Matias Braccini	PhD co-supervision, Murdoch University, supervises Robiul Hasan - ‘On the consumption of shark products: stock sustainability, trade mislabelling, human health and fishing slavery’.
	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’.
	MSc co-supervision, Curtin University, supervises Abbey Shuttleworth - ‘Comparative catch efficiency of demersal shark gillnets and longlines fisheries in South Western Australia’.
	MSc co-supervision, Curtin University, supervises Taylor Grosse - ‘An integrated approach for assessing the survival of discarded sandbar sharks, *Carcharhinus plumbeus*, captured in longlines’.
	Associate Researcher, School of Molecular and Life Sciences, Curtin University
	Associate Researcher, Centre for Fish and Fisheries Research, Murdoch University
Simon de Lestang	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’.
	PhD co- supervision, University of Western Australia, supervises Jack Parker - ' Monitoring deep-water habitats and species composition in response to Climate change’.
	PhD co- supervision, Curtin University supervises Katrina Bornt - ' Plastic contamination in commercially important decapod crustaceans.
David Fairclough	Adjunct Senior Lecturer. Department of Environment and Agriculture, Faculty of Science and Engineering. Curtin University.
	PhD co-supervision, Brett Crisafulli, Edith Cowan University, "Understanding Recreational Fishing in the advent of the catch and release era"
Alastair Harry	Honorary Research Fellow, Centre for Sustainable Aquatic Ecosystems, Harry Butler Institute, Murdoch University, Murdoch, Western Australia, Australia
	PhD co-supervision – Murdoch University, Tegan Lee: “Investigating the environmental drivers of growth, habitat use and diet on two euryhaline elasmobranchs via vertebral chemistry”
	PhD co-supervision – Murdoch University, Marie Windstein: “Spatial ecology of sharks and rays in the nearshore environment of a newly created Sea Country Indigenous Protected Area, Kimberley, Western Australia”
Jason How	Adjunct Research Fellows, University of Western Australia
	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’.
	PhD co- supervision, University of Western Australia, supervises Jack Parker - ' Monitoring deep-water habitats and species composition in response to Climate change’.
	PhD co- supervision, Curtin University supervises Katrina Bornt - ' Plastic contamination in commercially important decapod crustaceans.
Gary Jackson	MSc co-supervision, University of Western Australia, supervises Victoria Guthrie ‘Shore-based recreational shark fishing in Western Australia’
	PhD candidature reviewer, University of the Sunshine Coast, Jaeden Vardon ‘Depredation in Queensland Fisheries: use of multidisciplinary assessment methods to identify species responsible across multiple fisheries and gear types’
Mervi Kangas	PhD co-supervision Murdoch University, 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.
Stephen Newman	Adjunct Professor – Department of Environment and Agriculture, Faculty of Science and Engineering, Curtin University.
Karina Ryan	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.
	Adjunct Supervisor, Brett Crisafulli "Understanding Recreational Fishing in the advent of the catch and release era". PhD, Edith Cowan University
	Adjunct Supervisor, Shannon Burchert “A spatio-temporal analysis of recreational fishing data to inform fine scale fisheries management in Western Australia”. PhD, Edith Cowan University.
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’.
Corey Wakefield	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’.

GLOSSARY OF ACRONYMS

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
ASL	Australian sea lion
BPMF	Broome Prawn Managed Fishery
BRD	Bycatch Reduction Device
BSC	Blue Swimmer Crab
CAES	Catch and Effort Statistics
CALM	Department of Conservation and Land Management (now Department of Biodiversity, Conservation and Attractions)
CDR	Catch and disposal record
CI	Confidence Interval
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
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
DOF	Department of Fisheries now Department of Primary Industries and Regional Development
DPIRD	Department of Primary Industries and Regional Development
DITRDC	Department of Infrastucture, Transport, Regional Development and Communications (Commonwealth)
EBFM	Ecosystem Based Fisheries Management
EGP	Exmouth Gulf Prawn
EGPMF	Exmouth Gulf Prawn Managed Fishery
ENSO	El Niño/Southern Oscillation
EPBC	(Commonwealth Government) Environment Protection and Biodiversity Conservation (Act 1999)

ERA	Ecological Risk Assessment
ESD	Ecologically Sustainable Development
ETP	Endangered, Threatened and Protected
FBL	Fishing Boat License
FED	Fish escapement device
FFS	Flesh-footed shearwaters
FHPA	Fish Habitat Protection Area
FRDC	Fisheries Research and Development Corporation
FRMA	Fish Resources Management Act
FRR	Fisheries Research Report
FTO	Fishing Tour Operator
GAB	Great Australian Bight
GCB	Gascoyne Coast Bioregion
GDSMF	Gascoyne Demersal Scalefish Managed Fishery
GDSR	Gascoyne Demersal Scalefish Resource
GVP	Gross Value of Product
HCF	Hermit Crab Fishery
HMAS	Her Majesty's Australian Ship
HS	Harvest Strategy
IFM	Integrated Fisheries Management
IMCRA	Interim Marine and Coastal Regionalisation for Australia
ISO	International Organisation for Standardisation
ITQ	Individually Transferable Quota
IUCN	International Union for the Conservation of Nature
JASDGDLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery
KCMF	Kimberley Crab 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
MMF	Mackeral Managed Fishery
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
OIMF	Octopus Interim Managed Fishery
OPMF	Onslow Prawn Managed Fishery
PCMF	Pilbara Crab Managed Fishery
PDSF	Pilbara Demersal Scalefish Fisheries
PFRC	Pemberton Freshwater Research Centre
PFTIMF	Pilbara Fish Trawl (Interim) Managed Fishery
PI	performance indicator
RAR	Resource Assessment Report
RFBL	Recreational Fishing from Boat Licence
RFFSS	Recreational Freshwater Fisheries Stakeholder Subcommittee
SBBSMNF	Shark Bay Beach Seine and Mesh Net Managed Fishery
SBPMF	Shark Bay Prawn Managed Fishery
SBCMF	Shark Bay Crab Managed Fishery
SBSMF	Shark Bay Scallop Managed Fishery
SCB	South Coast Bioregion
SCCMF	South Coast Crustacean Managed Fishery
SCDSR	South Coast Demersal Scalefish Resource
SCPUE	standardised catch per unit effort
SCPSMF	South Coast Purse Seine Managed Fishery

SCTF	South Coast Trawl Fishery
SDGDLF	Southern Demersal Gillnet and Demersal Longline Managed Fishery
SL	Standard Length
SLED	Sea Lion Exclusion Device
SPR	Spawning Potential Ratio
SSMF	Specimen Shell Managed Fishery
SSPA	Southern Seafood Producers Association WA
SST	sea surface temperature
SWRFA	South West Recreational Freshwater Angling
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
VFAS	Voluntary Fisheries Adjustment Schemes
VMS	Vessel Monitoring System
WAFIC	Western Australian Fishing Industry Council
WAMSI	Western Australian Marine Science Institute
WCB	West Coast Bioregion
WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery
WCDSR	West Coast Demersal Scalefish Resource
WCDSMF	West Coast Demersal Scalefish Managed Fishery
WCEMF	West Coast Estuarine Managed Fishery
WCRLMF	West Coast Rock Lobster Managed Fishery
WDWTF	Western Deepwater Trawl Fishery
WTO	Wildlife Trade Operation

Important disclaimer

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