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

Status reports of the fisheries and aquatic resources of Western Australia **2011/12**

State of the fisheries



Fish for the future



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

Status reports of the fisheries and aquatic resources of Western Australia 2011/12

State of the fisheries

Fish for the future

Edited by W.J. Fletcher and K. Santoro

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

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OVERVIEW FROM THE DIRECTOR GENERAL

The *Status Reports of the Fisheries and Aquatic Resources of Western Australia* provide the public with an annual update on the state of the fish and other aquatic resources of Western Australia managed by the Department. These reports outline the cumulative risk status for each of the ecological resources (assets) within WA's six Bioregions using an Ecosystem-Based Fisheries Management (EBFM) approach. This world leading approach details all the fisheries and fishing-related activities within each of the Bioregions but also includes analyses and reports on the activities and processes undertaken by the Department to manage the broader aquatic environment, such as habitats and ecosystems.

The *Status Reports of the Fisheries and Aquatic Resources of Western Australia* essentially summarise the outcomes of Departmental activities undertaken during 2011/12 and preceding years. It documents recent changes to management or policy settings, compliance and education operations, the assessment and monitoring of stock levels and ecosystem condition. This document should, therefore, provide a valuable reference point for the current status of Western Australian aquatic resources including those of major importance to the commercial and recreational fishing sectors, the aquaculture industry, the tourism industry, and for those in the community interested in the overall health of the aquatic environment.

Western Australia is one of the first fisheries jurisdictions in the world to fully implement a comprehensive and practical EBFM framework. EBFM provides a thorough, risk based framework for the overall management of aquatic resources because it explicitly considers all ecological resources and community values within a Bioregion to determine which may require direct management intervention. This approach is expected to provide the Department with a good basis for progressing the third party certification initiative that has recently been announced by the WA Government.

It is pleasing that a key finding from these reports is that the risk to most aquatic ecological resources in Western Australia are currently at acceptable levels. Given the comprehensive systems of management that are in place, fishing in WA does not present an unacceptable risk to the marine, estuarine and freshwater ecosystems underpinning them. The fishing methods that may affect the habitat (e.g. trawling) are highly regulated with over 90% of WA coastline effectively protected from these types of activities. The overwhelming majority of Western Australian fisheries have also been

assessed as posing only negligible or minor risks to bycatch species, protected species, habitats or the broader ecosystem. The small number of fisheries which have generated risks to these non-'capture species', and therefore require direct management, continue to meet their annual performance targets or have targeted research programs to reduce their interactions. The only ecosystems and component species in WA considered to be at unacceptable levels continue to be the estuarine and river systems of the south west region. These risks are not the result of fishing related activities.

The report also documents that the vast majority of Western Australia's significant fisheries continue to be in a healthy condition. For the first time all (100%) of managed fisheries had catches that are considered to be appropriate based on the status of the stocks involved and the current environmental and market conditions. Moreover, approximately 94% of commercial fisheries are now targeting stocks where no additional management is required to either maintain or achieve an acceptable breeding stock level. The research program to examine the status of the herring stocks in south west WA will be soon available to determine whether this stock is at acceptable levels.

A summary report from this document is included in the Department's *Annual Report* to Parliament, which includes the Department's non-financial (fishery) performance indicators. The *Annual Report* is available through the Department's website (www.fish.wa.gov.au).

I would like to take this opportunity to express my appreciation to all Departmental staff who contributed to this important, annual performance review of WA's aquatic resources. In addition, many commercial and recreational fishers, science collaborators and other stakeholders throughout the State are to be commended for their positive support for the Department's monitoring and research programs and management initiatives, without which such a high level of sustainability would not be achieved.



Stuart Smith
Director General

October 2012

EDITOR'S INTRODUCTION

The *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2011/12* uses the Ecosystem Based Fisheries Management (EBFM) framework which is now the basis for management of Western Australia's aquatic resources (Fletcher, *et al.*, 2010, 2012¹). Consequently, the format for this document is fully consistent with the implementation of a risk-based approach to resource management (Fletcher 2012²).

The introductory section for each Bioregion outlines each of the key ecological resources (assets) within the region and summarises their current overall (cumulative) risk status. The assets that are examined in each bioregion include each of the IMCRA³ meso-scale ecosystems plus the key habitats, captured species and protected species categories. There is also a section for the external drivers, such as climate change, coastal development and introduced pests/diseases, which may affect the Department's ability to effectively manage WA's aquatic resources.

For each Bioregion the set of individual fishery reports are now resource-based rather than activity (sector) based. Each of the different fisheries accessing the same category of ecological assets is now covered in a single report (e.g. West Coast Nearshore and Estuarine Finfish) with each report containing descriptions of all the commercial and recreational activities. Taking a Bioregional approach to the management of ecological assets ensures that the aggregate catch harvested from each stock is identified to enable their cumulative effect to be assessed. This approach is also consistent with the Department's IFM initiative and the structure of the reports should enable readers to more easily assess the interrelationships between fisheries and how the catch is shared among sectors.

The long-standing involvement by our commercial, recreational and aquaculture stakeholders in specific research projects and monitoring programs is recognised. This includes the provision of logbook data, biological samples,

access to vessels and information which are essential to the generation of many of the status reports presented in this document. The input from other science groups from WA, other parts of Australia and internationally is also acknowledged. There has been an increasing trend over the past decade for collaborative research projects to be undertaken to assist in the development of new monitoring and assessment techniques or to help further our understanding of issues that affect management (e.g. determining the causes of the recent low rock lobster puerulus settlement levels).

While the *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2011/12* provides the general public, interested fishers and other stakeholders with a ready reference source, it also meets the reporting requirements of the Department, including the need to annually report on the 'state of fisheries managed under' the FRMA⁴ to the Western Australian Parliament and to the Commonwealth Government, on the performance of fisheries that are relevant under their EPBC Act.

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

Finally, I would like to thank all of my Departmental colleagues across all Divisions who have assisted in the production of this volume and its many status reports. Thanks are once again due to Ms Karen Santoro who has managed both the coordination and publication processes to enable the production of this important report.



Dr Rick Fletcher
Executive Director Research

October 2012.

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

Fletcher, W.J., Gaughan, D.J., Shaw, J. and Metcalf, S.J. (2012) *Ecosystem Based Fisheries Management: Case Study Report West Coast Bioregion*. Fisheries Research Report No. 212, Department of Fisheries, Western Australia 104p.

² Fletcher, W.J., (2012) National Application of Sustainability Indicators for Australian Fisheries- Part 2: Ecosystem based frameworks for aquaculture, multi-fishery and international applications. FRDC Report – Project 2000/145 Part 2. Fisheries Research Report No 235 Department of Fisheries, Western Australia.

³ Commonwealth of Australia (2006) A guide to the Integrated Marine and Coastal Regionalisation of Australia - version 4.0 June 2006 (IMCRA v4.0).
<http://www.environment.gov.au/coasts/mbp/publications/imcra/pubs/imcra4.pdf>

⁴ Section 263 of the FRMA.

HOW TO USE THIS VOLUME

To obtain full benefit from the information provided in this edition of the *Status Reports of Fisheries and Aquatic Resources of Western Australia*, readers need to understand various terms and headings used in the text and summarised in the fishery status overview table (which also appeared in the Department of Fisheries *Annual Report 2011/12* to Parliament) and especially those associated with the ecological resource level reports.

The terms and headings are a combination of the reporting structures first outlined in the national Ecologically Sustainable Development (ESD) reporting structure (Fletcher *et al.* 2002)¹, plus the more recent Ecosystem Based Fisheries Management (EBFM) framework (Fletcher *et al.* 2010)² and Resource Assessment Framework (DoF, 2011)³. In addition to the explanations provided below, acronyms are expanded at their first occurrence in a section of the text and are also listed in a glossary at the end of the volume.

Bioregions

As noted above, with the adoption of the EBFM approach, readers need to note the fully bioregional structure of this report. A 'Bioregion' refers to a region defined by common oceanographic characteristics in its marine environment or by climate/rainfall characteristics in its inland river systems.

The marine bioregional boundaries used here are broadly consistent with "A guide to *The Integrated Marine and Coastal Regionalisation of Australia*" - version 4.0 June 2006 (IMCRA v4.0)⁴ except for the inclusion of the Gascoyne Coast as a separate Bioregion, reflecting its nature as the transition zone between tropical and temperate waters.

The precise boundaries of the Bioregions reflect functional geographic separations and data recording systems. Each individual Bioregion has been provided with a general introduction outlining the main features of its aquatic environment, plus the major commercial and recreational fisheries and aquaculture industries that operate in the area.

It now also has a section that outlines the current risk status of each of the high level, ecological resources/assets located within each Bioregion (see below).

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

Consistent with the adoption of the EBFM framework for each bioregion we have identified the high level set of ecological resources/assets that are to be managed under the FRMA (see Introduction Figure 2). The ecological resources/assets in each Bioregion include the ecosystems and their constituent habitats, captured species and protected species. The potential complexity of EBFM is dealt with by using a step-wise, risk-based approach to integrate the individual issues identified and information gathered into a form that can be used by the Department. Similarly, the levels of knowledge needed for each of the issues only need to be appropriate to the risk and the level of precaution adopted by management. Implementing EBFM does not, therefore, automatically generate the need to collect more ecological, social or economic data or require the development of complex 'ecosystem' models, it only requires the consideration of each of these elements to determine which (if any) required direct management to achieve acceptable performance. Full details of how the EBFM process is undertaken are presented in Fletcher *et al.* (2012)⁵ with a summary description outlined below.

Ecosystems: Within each Bioregion, one or more ecosystems, as defined by the IMCRA process, were identified with some of these further divided into estuarine and marine ecosystems where relevant.

Habitats: The habitat assets in each Bioregion were divided into estuarine and marine categories and again where necessary the latter category was further divided into nearshore and offshore components.

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

Protected Species: This category was subdivided into protected 'fish' (e.g. White Sharks) and protected 'non-fish' as defined in the FRMA (e.g. mammals).

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

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

³ Department of Fisheries (2011) Resource Assessment Framework for Finfish Resources in Western Australia. Fisheries Occasional Publication. No. 85 24pp.

⁴<http://www.environment.gov.au/coasts/mbp/publications/imcra/pubs/imcra4.pdf>

⁵ Fletcher, W.J., (2012) National Application of Sustainability Indicators for Australian Fisheries- Part 2: Ecosystem based frameworks for aquaculture, multi-fishery and international applications. FRDC Report – Project 2000/145 Part 2. Fisheries Research Report No 235 Department of Fisheries, Western Australia.

Risk Assessment Status

The risks associated with each individual ecological asset are examined separately using formal qualitative risk assessment (consequence x likelihood) or more-simple problem assessment processes, as detailed in Fletcher (2005, 2010)¹. This enables the analysis of risk (using a five year time horizon) for objectives related to captured species, habitat and community structure/ecosystem sustainability, plus social and economic outcomes to be completed in a practical and consistent manner (Introduction Table 1).

The accepted international definition of risk is “the uncertainty associated with achieving objectives” (ISO, 2009)², therefore any uncertainties from a lack of specific data are explicitly incorporated into the assessment enabling the calculation of risk to be completed with whatever data are available. All risk scoring considers both current level of activities and management controls already in place or planned.

Within each Bioregion, the EBFM process initially identified hundreds of separate ecological assets, social, economic and governance issues and risks³. This complexity has been addressed by first assessing each of the individual risks and then consolidating these into bioregional or category level risks. The Department’s primary objective is to manage the sustainability of the community’s ecological assets from which economic or social outcomes are generated. Therefore the various ecological, social and economic risks and values associated with each of these ecological assets are integrated using a multi-criteria analysis into approximately 80 Departmental-level priorities distributed across the six Bioregions.

Breeding stock status

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

Adequate: reflects levels of parental biomass of a stock where annual variability in recruitment of new individuals (recruits) to the stock is considered to be mostly a function of

environmental effects or recruit survival, not the level of the breeding stock.

Recovering: reflects situations where the parental biomass has previously been depleted to unacceptable levels by fishing or some other event (e.g. the virus attacks on pilchards in the 1990s) but is now considered to be recovering at an acceptable rate due to management action and/or natural processes.

Inadequate: reflects situations where excessive fishing pressure (catch) or some external event has caused parental biomass to fall to levels where the breeding stock is depleted to levels that may affect recruitment and management of the stock is not currently in an acceptable recovery phase (often called recruitment overfished if caused by fishing).

Retained Species (Stock Assessment Methods)

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

Level 1	Catch data only
Level 2	Level 1 plus fishery-dependent effort or other relative abundance data
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 etc.
Level 5	Levels 1 to 3 and/or 4 integrated within a simulation, stock assessment model.

Multi species assessments: For each marine bioregion, each species of finfish and invertebrate is now allocated to one of five ‘suites’ estuarine, nearshore, inshore demersal, offshore demersal or pelagic (DoF, 2011⁴). For each of these suites one or more ‘indicator species’ (which in general usually includes the most vulnerable species in the suite) have been selected to reflect the status of the entire suite. If one or more indicator species is considered to be at risk, the entire suite is considered to be at risk.

¹ Fletcher W.J. (2005) Application of Qualitative Risk Assessment Methodology to Prioritise Issues for Fisheries Management. *ICES Journal of Marine Research* 2005; 62:1576-1587

Fletcher W.J. (2010) Planning processes for the management of the tuna fisheries of the Western and Central Pacific Region using an Ecosystem Approach. *Forum Fisheries Agency*, Honiara. Facilitators version 6.1 January 2010, 61pp <http://www.fisheries-esd.com/a/pdf/EAFM%20BASED%20GUIDE%20FOR%20TMP%20DEVELOPMENT%20v6%201.pdf>

² AS/NZS ISO 31000 (2009) Risk management – Principles and guidelines. Sydney, Australia: Standards Australia.

³ Fletcher, W.J., Shaw, J., Gaughan, D.J. and Metcalf, S.J. 2011 Ecosystem Based Fisheries Management case study report – West Coast Bioregion. Fisheries Research Report No. 225. Department of Fisheries, Western Australia. 116pp.

⁴ Department of Fisheries (2011) Resource Assessment Framework for Finfish Resources in Western Australia. Fisheries Occasional Publication. No. 85 24pp.

Non-retained species

This refers to any species caught during a fishing operation which are not the target of, or retained by, the fishing operation, and can include both potential impact on unwanted 'bycatch' species and any interaction with 'protected' species. In each case, an explanation is provided of the situation and the level of risk to the stock from fishing operations. This section does not include release of target species for reasons such as under size, over bag limits etc. these issues are already covered in the assessments of retained species.

Ecosystem effects

This refers to the indirect impacts generated by removing fish from the ecosystem, and physical interactions of fishing gear with the sea floor. Each fishery is considered in terms of its potential/relative effects on the food chain and the habitat, and an outline of the assessment of current ecological risk ('negligible', 'low', 'medium' or 'high') is provided.

Economic Effects

As part of the EBFM framework we have categorised the different levels of GVP into six levels. This provides a mechanism for reporting on all fisheries including those where the small number of operators would not allow specific values to be provided. It also covers situations where the calculation method for GVP are currently under review and specific values may not be appropriate

Level 0	nil
Level 1	< \$1 million
Level 2	\$1 – 5 million
Level 3	\$5 -10 million
Level 4	\$10 - 20 million
Level 5	> \$20 million

Target catch (or effort) range (Current fishing level)

A target catch or effort range has been determined for each of the major commercial fisheries. This indicator provides an assessment of the success of the Department's management plans and regulatory activities in keeping fish catches at appropriate levels (including those in a recovery phase). This identifies if the stock is being subjected to overfishing or not.

For most of the fisheries in WA, the management plan seeks to directly control the amount of fishing effort applied to stocks, with the level of catch taken providing an indication of the effectiveness of the plan. Where the plan is operating effectively, the catch by the fishery should fall within a projected range. The extent of this range reflects the degree to which normal environmental variations affect the recruitment of juveniles to the stock which cannot be 'controlled' by the management plan.

Target catch range: the expected range in annual catch levels, taking into account natural variations in recruitment to the fished stock, which can be expected under a fishing-effort-based management plan.

For quota-managed fisheries, the measure of success for the management arrangements is firstly that the majority of the Total Allowable Catch (TAC) is achieved, but additionally, that it has been possible to take this catch using an acceptable amount of fishing effort. If an unusually large expenditure of effort is needed to take the TAC, or the industry 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 the TAC has also been incorporated for assessing the performance of quota-managed fisheries.

Target effort range: the expected range in annual fishing effort, assuming natural variability in stock abundance, required to achieve a total allowable catch under a catch quota management plan.

The catch or effort for each major fishery is assessed annually and if the catch or effort remains inside the acceptable range it is defined as having acceptable performance. Where the annual catch or effort for a fishery falls outside of this range and the rise or fall cannot be adequately explained (e.g. environmentally-induced fluctuations in recruitment levels – like prawns, or low market prices reduce desired catch levels – e.g. pearl oysters), a management review or additional research to assess the underlying cause is generally required.

External factors

This refers to known factors outside of the direct control of the fishery legislation which impact on fish stocks or fishing. An understanding of these factors, which are typically environmental (cyclones, ocean currents) but might also include, for example, market factors or coastal development, is necessary to fully assess the performance of the fishery.

Season reported

Readers should also be aware that the individual fishery and aquaculture production figures relate to the latest full year or season for which data are available, noting the inevitable time-lags involved in collection and analysis. Therefore, the statistics in this volume refer either to the financial year 2010/11 or the calendar year 2011, whichever is more appropriate. This includes estimates of the value of the fishery which may vary from published estimates of GVP due to differences between financial year and entitlement year for a fishery, estimated value of secondary by products for individual sectors, and estimating the total value of several fisheries operating on a single resource.

Similarly, the statistics on compliance and educational activities are also for 2010/11, following the analysis of data submitted by Fisheries and Marine Officers.

In contrast, the sections on departmental activities in the areas of fishery management, new compliance activities and research summaries are for the current year, and may include information up to June 2012.

HOW TO USE THIS VOLUME

Performance measures

Many of the State's significant fisheries have now undergone assessment and achieved environmental certification under the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Consequently, the *State of Fisheries and Aquatic Resources Report* also reports on the ecological performance of the

relevant fisheries against the specific performance measures used or developed during the EPBC Act assessment process. These may vary among future editions as EPBC conditions change and individual fisheries determine the need and value of maintaining and resourcing such accreditation.

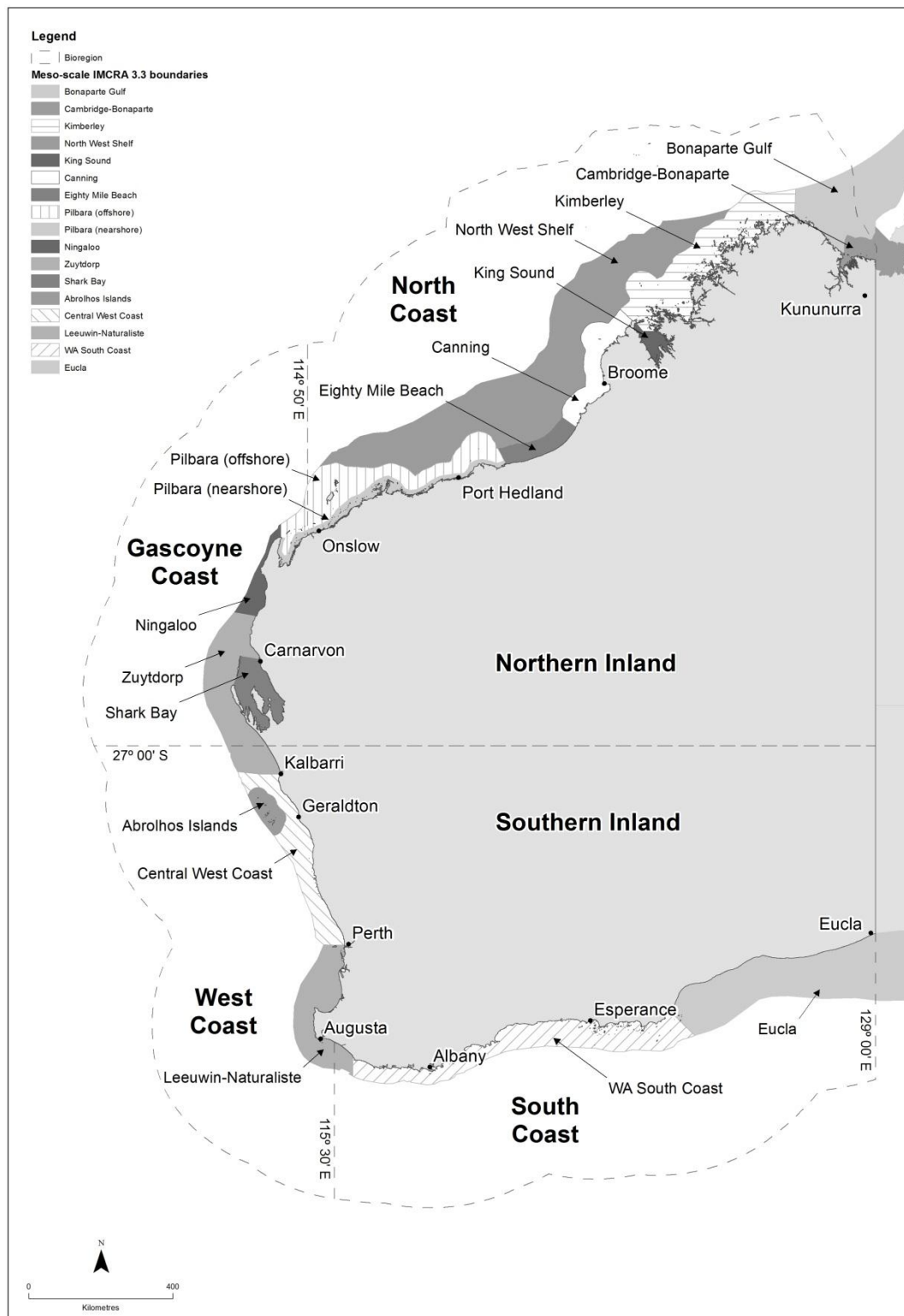
Within the individual fishery status reports, each of these performance measures is shown in a highlighted box to assist the reader. The results are also summarised in Appendix 4.

INTRODUCTION TABLE 1

Risk Categories, descriptions and likely management responses (modified from Fletcher 2005¹).

Risk Category	Description	Likely Reporting Requirements	Likely Management Response
Negligible	Not an issue	Minimal	Nil
Low	Acceptable; no specific control measures needed	Justification required	None specific
Moderate	Acceptable; with current risk control measures in place (no new management required)	Full performance report	Specific management and/or monitoring required
High	Not desirable; continue strong management actions OR new and/or further risk control measures to be introduced in near future	Full performance report	Increases to management activities needed
Significant	Unacceptable; major changes required to management in immediate future	Full performance report	Increases to management activities needed urgently

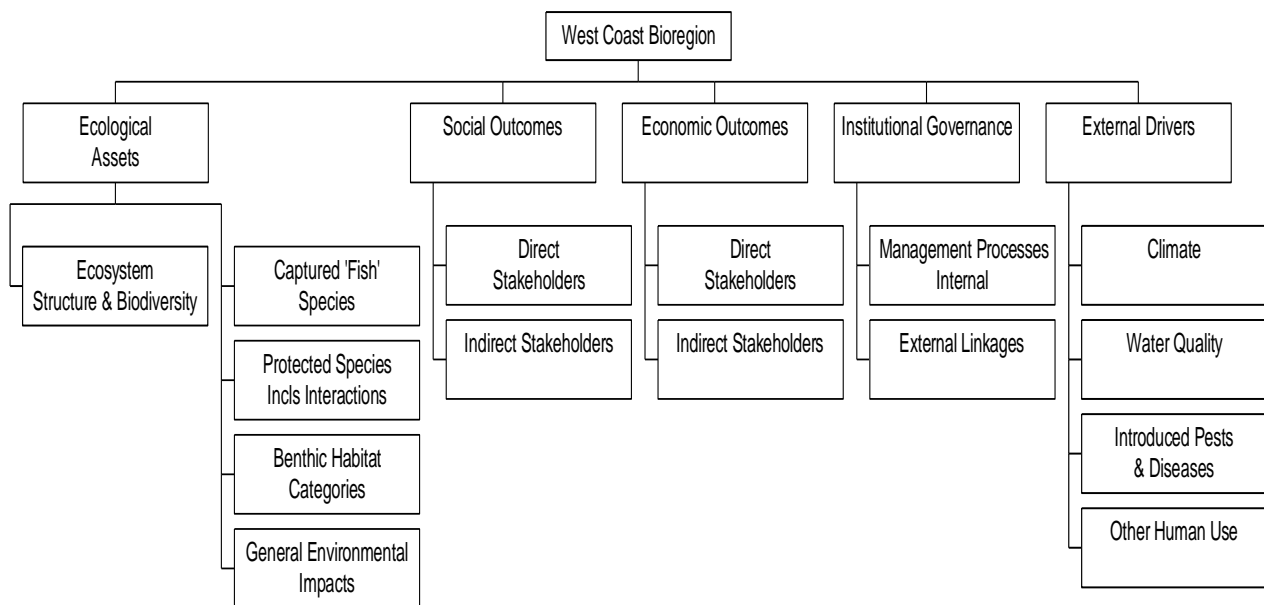
¹ Fletcher W.J. (2005) Application of Qualitative Risk Assessment Methodology to Prioritise Issues for Fisheries Management. *ICES Journal of Marine Research* 2005; 62:1576-1587



INTRODUCTION FIGURE 1

Map of Western Australia showing the general boundaries of the Bioregions referred to throughout this document and the meso-scale ecosystems based on IMCRA 4.0 boundaries¹.

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



INTRODUCTION FIGURE 2

The basic EBFM component tree framework. Each of the Bioregions has their own tailored EBFM component tree in which each of the ecological components have been subdivided into the set of ecological resources/assets relevant to that Bioregion.

OVERVIEW OF THE STATUS OF KEY ECOLOGICAL RESOURCES (ASSETS)

ECOSYSTEM STRUCTURE AND BIODIVERSITY

Fisheries and Stocks

Annual stock assessments, including analyses of trends in catch and fishing activity, are used each year to determine the status of each of the State's most significant fisheries and are presented in detail in the rest of this document. This section provides an overview of the outcomes of the Department's management systems by collectively examining the status of all the commercial fisheries and commercially harvested fish stocks in WA. The material presented in this section is based on the analyses and text presented in the Key Performance Indicators section of the Department of Fisheries Annual Report to the Parliament 2011/12.

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

To measure the performance of management, the proportion of fisheries for which the breeding stocks of each of their major target or indicator species are being maintained at acceptable levels (or they are now recovering from a depleted state at an appropriate rate following management intervention), is measured annually.

For the 38 fisheries reviewed, the 'Stock Status and Catch Ranges for Major Commercial Fisheries' section of the Annual Report records that breeding stock assessments are available for the major species taken in 36 (94%) of these fisheries. For the other two fisheries, insufficient data were available on the target species to make a critical assessment. In situations where unmonitored stocks are assessed as having the potential to become overfished, they are given priority for new research and/or management.

Within the group of 36 assessed fisheries, 31 involve stocks that were considered to have adequate breeding stock levels (86 per cent of fisheries). Three additional fisheries have breeding stocks considered to be recovering at acceptable rates (West Coast Demersal Scalefish Fishery, Shark Bay Snapper Fishery, Southern Shark Fishery¹). These are all relatively long lived species so their recovery takes a number of years to complete following the introduction of additional management restrictions. The reductions in catch levels for Shark Bay Snapper and the West Coast Demersal Scalefish Fishery have now been in place for a number of years and more detailed reassessments are scheduled to be undertaken in 2012/13 to determine the extent to which these actions have been successful. For the Southern Shark Fishery, a detailed review of catch and effort data for the southern shark fishery and a re-assessment of the stocks has revealed that

previous management interventions have had a positive impact on the sustainability of dusky shark and whiskery sharks but their full recovery will take further time. In conclusion, a combined total of 6 per cent of fisheries have breeding stock management that are not considered satisfactory (Overview Figure 1) which is better than the target level.

Of the two remaining fisheries, while the current catch of sandbar sharks in the Northern Shark fishery is currently zero, uncertainty regarding long term management of this fishery is still required. Finally, research to examine the status of the stocks of herring in the south-west region will determine whether the recent low catch levels result from environmental conditions, a reduction in the breeding stock leading to lowered recruitment, reduced fishing effort, or some combination of the above. This result should be known before the end of 2012.

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

A target catch or effort range has been determined for each of the major commercial fisheries (see Overview Table 1). 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).

For most of the fisheries in WA, each management plan seeks to directly control the amount of fishing effort applied to stocks, with the level of catch taken providing an indication of the effectiveness of the plan. Where the plan is operating effectively, the catch by the fishery should fall within a projected range. The extent of this range reflects the degree to which normal environmental variations affect the recruitment of juveniles to the stock which cannot be 'controlled' by the management plan. An additional consideration is that market conditions, fleet rationalization or other 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 certain fisheries.

For quota-managed fisheries, the measure of success for the management arrangements is firstly that the majority of the Total Allowable Catch (TAC) is achieved, but additionally, that it has been possible to take this catch using an acceptable amount of fishing effort. If an unusually large expenditure of effort is needed to take the TAC, or the industry 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 the TAC has also been incorporated for assessing the performance of quota-managed fisheries (see 'Stock Status and Catch Ranges for Major Commercial Fisheries' section of the Annual Report).

Comparisons between the actual catches (or effort) with the target ranges have been undertaken for 32 of the 38 fisheries

¹ The Southern Shark Fishery is reported in the South Coast Bioregion as the Demersal Gillnet and Longline Fishery.

OVERVIEW

referred to in 'Stock Status and Catch Ranges for Major Commercial Fisheries' section one less than the number used last year. The fisheries which have target catch or effort ranges account for most of the commercial value of WA's landed catch.

Of the 32 fisheries where 'target ranges' were available and a material level of fishing was undertaken in 2010/11, ten were catch-quota managed [through a TAC allocated through Individually Transferable Quotas (ITQ)] with 22 subject to effort control management.

All of the ITQ-managed fisheries operated within their target effort/catch ranges or were acceptably below the effort range (Roe's abalone, pearl oysters). In the 22 effort-controlled fisheries, all 22 produced catches that were within (13) or acceptably above (2) or below (7) their target catch ranges. Given the changes in the operations of the Pilbara trawl fishery this was not assessed this year as there is some uncertainty about the impact on gear efficiencies following the introduction of new bycatch reduction devices to minimise protected species interactions.

In summary all 32 fisheries assessed (100%) were considered to have met their performance criteria, or were affected by factors outside the purview of the management plan/arrangements (Figure 2) which is above the target level.

Benthic Habitat and Biodiversity

Monitoring

A number of monitoring tools is used to assess the condition of ecosystems and associated biodiversity within the context of Ecosystem Based Fisheries Management. Detailed assessments of risk to the structure and benthic habitat of specific ecosystems can be found within each bioregional risk assessment of ecological assets. Across the marine bioregions, risks to benthic habitat and ecosystem structure and biodiversity have been generally assessed as ranging from negligible to moderate. The exceptions to this are the estuarine ecosystems of the West Coast bioregion which are identified as being at significant risk due to pressures from external non-fishing pressures largely associated with deteriorating water quality.

Management

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

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

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

Marine protected areas can also be created in Commonwealth waters under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC).

A summary of the effective protection afforded to state waters is detailed in Overview Table 2.

Protected Species

In accordance with EBFM principles, risk-based assessment of the impact of commercial and recreational fishing activities on protected fish and non-fish species is undertaken. Specific detail may again be found within each bioregional risk assessment of ecological assets. Risks to protected species were generally assessed as being negligible to low with the exception of risks to mammals (dolphins) resulting from the Pilbara trawl fishery. Dolphin exclusion devices have reduced the incidence to acceptable levels and further refinements to net design are in progress. Risks to birds and mammals (sea lions) in the South coast bioregion were also assessed as moderate and appropriate management measures are being undertaken to attempt to mitigate these risks.

GENERAL ENVIRONMENTAL IMPACTS

Introduced Pests and Diseases

The Department of Fisheries is the lead state government agency responsible for the management of aquatic biosecurity in Western Australia. Aquatic biosecurity threats include disease outbreaks in wild and farmed fish and the introduction of marine and freshwater pest species that are not native to WA.

Introduced marine species are organisms that have moved, or been moved from their natural environment to another area. Many of these organisms remain inconspicuous and innocuous causing no known adverse effects. However, they can potentially threaten human health, economic values or the environment, in which case they are then referred to as marine pests. Introduced marine species are a global problem, and second only to habitat change and loss in reducing global biodiversity (Millennium Ecosystem Assessment, 2005).

The introduction of marine species into a new region can be deliberate or accidental. Deliberate introductions may result from aquaculture practices or releases from aquariums. Accidental introductions are primarily due to shipping and

recreational craft moving from country to country, with the pests being transported in ballast water, on ship hulls, or within a vessel's internal seawater pipes. Introduced marine species also arrive naturally via marine debris and ocean currents.

In recognition of an increasing risk presented by aquatic pests and diseases to WA associated with increasing international travel, transport and trade, the Department has developed its capacity for rapid detection and identification of aquatic pests and diseases. Rapid detection of introduced aquatic pests and diseases is important in preventing their spread and establishment. This section provides an overview of the Department's activities with respect to marine pests and diseases monitoring in the state in 2011/12. Further detail is reported at the bioregional level and further information on Departmental activity in this field may be found in the appendix (Activities of the Fish Health Unit during 2011/11 and Activities of the Biosecurity Research Group 2011/12).

The Marine Biosecurity Research group has implemented a system to monitor high risk ports around the state for the presence of marine pests. As an ocean bound nation Australia relies heavily on maritime transport, with over 95% of our imports and exports carried by sea. The large ocean going vessels that transport these goods represent one of the largest vectors of introduced species, while recreational vessels represent the major secondary vector that can spread pests from ports and marinas around the coastline. For these reasons our ports and marinas become high risk areas for the introduction of a marine pest. The Commonwealth Government, together with the states and territories have

developed a national system of policies and procedures to try and reduce the risk of marine pests arriving in Australian waters. Part of this system includes the monitoring of high risk ports, which are those ports that receive large numbers of vessels, high risk vessels (such as dredges) or are geographically close to areas with known invasive marine species. This section details the results of the monitoring conducted in 2011/12 for detection of introduced marine pests (Overview Table 3). Further detail of both the surveillance and research activities undertaken by the Marine Biosecurity research group may be found in the appendix.

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

The Department coordinates the fish kill response program within Western Australia. This program forms part of a national program endorsed by Primary Industries Standing Committee and Natural Resource Management Standing Committee in December 2006. The number and cause of fish kills is also a key indicator in the "State of the Environment Report" (SOE) issued from time to time by the environmental protection authority (IW19 Number and location of significant fishkills). The number of significant fishkills investigated in Western Australia since the last SOE report is shown in Overview Table 4.

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OVERVIEW TABLE 1

Stock Status, Catch & Effort Ranges for the Major Commercial Fisheries

NA - Not assessed, Q - Quota management, TAC - Total Allowable Catch, TACC - Total Allowable Commercial Catch

Fishery/ Resource	Stock assessment method and level	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported ¹ - 2010/11 or 2011	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION						
West coast rock lobster	Size- structured Population Model (Level 5)	> early 1980s level	Adequate	5,500 (Q)	5,501 t	Acceptable. A TACC of 5,500 t was set for the 2010/11 season to accommodate the recent series of low puerulus settlements.
Roe's abalone	Catch Rates & Direct Survey (Level 4)	Effort (by zone) remains < within range Survey catch rate > minimum	Adequate	92.8 (Q) (530 – 640 days)	81.6 t (426 days)	Acceptable. TAC, catch and effort down by 10 t due to closure of Kalbarri region of the fishery following a marine 'heatwave' generated mortality event.
Octopus	Catch Rates (Level 2)	CPUE > 70kg/day	Adequate	50 - 250	166 t	Acceptable. Fishery in developing phase. Target range to be reviewed following completion of current study.
Abrolhos Islands and mid west trawl	Direct Survey & Catch Rates (Level 4)	Fishing ceases at catch rate threshold.	Adequate	95 – 1,830	2203 t	Acceptable. Total landings were above the target range due to good recruitment.

Fishery/ Resource	Stock assessment method and level	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported ¹ - 2010/11 or 2011	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION (continued)						
Cockburn Sound crab	Direct Survey (Level 4)	Residual stock above threshold	Adequate	Not Applicable	53 t	NA This is the 2nd year since the fishery re-opened following a 3 year closure. The catch did not increase due to the large number of small sized crabs.
Deep sea crab	Catch (Level 1)	Catch range	Adequate	154 (Q)	145 t	Acceptable. The TACC began in 2008. An acceptable effort range will be determined.
Estuarine finfish (west coast)	No	Not Applicable	Not Applicable	75 – 220 (Peel-Harvey only)	73 t (PH)	Acceptable. Catches of west coast estuarine finfish have been stable since 2000.
West coast beach bait	Catch (Level 1)	Catch range	Adequate	60 – 275 (whitebait only)	35 t (whitebait only)	Acceptable. Yearly fluctuations in whitebait catch still match environmental variations.
West coast purse seine	Catch (Level 1)	Catch range	Adequate	0 - 3000 (Q)	Less than three licences operated	NA Continued low catches due to market competition, irregular availability of fish resulting in low fishing effort levels.

OVERVIEW

Fishery/ Resource	Stock assessment method and level	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported ¹ - 2010/11 or 2011	Catch (or effort) level acceptable and explanation if needed
WEST COAST BIOREGION (continued)						
West coast demersal scalefish	Catch by sector (Level 1) Fishing Mortality (F) (Level 3)	F < 3/2 M	Recovering	< 449 – 469 (All Demersal Scalefish) <450 (Demersal Suite)	438 t 340 t – West Coast Demersal Scalefish (interim) Managed Fishery 81 t – Other fisheries, including West Coast Demersal Gillnet and Longline (Interim) Managed Fishery	Acceptable Total catch includes all relevant commercial fisheries. The stock is deemed to be recovering with the next full assessment scheduled for completion in 2012/13.
GASCOYNE BIOREGION						
Shark Bay prawn	Direct Survey/Catch Rate (Level 4)	Survey catch rates > minimum level	Adequate	1,501 – 2,330	2,014 t	Acceptable. King and tiger prawns were within the historical target range.
Exmouth Gulf prawn	Direct Survey/Catch rate (Level 4)	Survey catch rates > minimum level	Adequate	771 – 1,276	976 t	Acceptable. The total catch was in the target range but catches of tiger prawns were above and king prawns were below their individual target levels.
Shark Bay scallop	Catch Rates and Direct Survey (Level 4)	Fishing ceases at threshold level	Adequate	1,250 – 3,000	295 t	Acceptable Catch well below target range due to small size of scallops and poor recruitment due to La Nina effects. A heat wave and floods in late 2011 will impact stock abundance in 2012.

Fishery/ Resource	Stock assessment method and level	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported ¹ - 2010/11 or 2011	Catch (or effort) level acceptable and explanation if needed
GASCOYNE BIOREGION (continued)						
Shark Bay Crabs	Catch Rates/Size Distributions (Level 3)	Catch rate > minimum level	Adequate	Under development	860 t	NA The catch comes from a dedicated trap fishery and prawn trawlers. A heat wave and floods over the 2010/11 summer have impacted on the crab stock available for the 2012 season.
Shark Bay beach seine and mesh net	Catch Rates (Level 2)	Catch rate > minimum level	Adequate	235 – 335	250	Acceptable. Total catch was similar to 2010. Catch rates of key species were generally maintained.
Shark Bay snapper	Composite Assessment (Level 5)	% unfished levels. Target 40%; Limit 30%	Recovering	277 (Q) (380 - 540 days)	236 t (419 days) plus 60 recreational catch	Acceptable. At the current TACC, the spawning biomass is projected to recover to the target level by 2014. The next full assessment is scheduled for late 2012.
NORTH COAST BIOREGION						
Onslow prawn	Catch (Level 1)	Catch range	Adequate	60 – 180	16 t	Acceptable. The low catch was associated with lowest recorded fishing effort because of the cost of fishing, high fuel prices and low returns.

OVERVIEW

Fishery/ Resource	Stock assessment method and level	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported ¹ - 2010/11 or 2011	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION (continued)						
Nickol Bay prawn	Catch (Level 1)	Catch range	Adequate	90 – 300	178 t	Acceptable. Catch of banana prawns were lower than the projected catch range but within the target catch range
Broome prawn	Catch (Level 1)	Catch range	Adequate	55 – 260	6 t	NA The very low level of effort continued because of the cost of fishing, high fuel prices and long distances to steam and low returns.
Kimberley prawn	Catch (Level 1)	Catch range	Adequate	240 – 500	155 t	Acceptable. The number of boats fishing here was the lowest for 30 years because of high catch rates in the NPF.
Kimberley gillnet and barramundi	Catch Rates (Level 2)	Rates > minimum level	Adequate	25 – 40 (barramundi)	28 t	Acceptable. Listed catch is an underestimate due to missing returns but total still likely to be within the acceptable range.

Fishery/ Resource	Stock assessment method and level	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported ¹ - 2010/11 or 2011	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION (continued)						
Northern demersal scalefish	Catch and Catch Rates/ Integrated Model (Level 2 & 5)	% unfished levels. Target 40%; Limit 30%	Adequate	Total 600 – 1,000 (goldband <561) (red emperor <195)	Total 1,037 t (goldband 487) (red emperor 128)	Acceptable. Total catch close to upper limit. Catches of goldband snapper and red emperor were both within the acceptable catch range. Full assessments and review of catch ranges scheduled over next two years.
Pilbara fish trawl	Catch and Catch Rates/ Fishing Mortality/ Integrated Model (Level 2, 3 & 5)	% unfished levels. Target 40%; Limit 30%	Adequate	2,000 – 2,800	1,085 t	Under Revision Reduced catch partly due to reductions in effort since 2009. Full assessment and review of catch range scheduled in the next two years.
Pilbara demersal trap and line	Catch and Catch Rates/ Fishing Mortality/ Integrated Model (Level 2, 3 & 5)	% unfished levels. Target 40%; Limit 30%	Adequate	400 – 600 (trap) 50 – 115 (line)	459 t (trap) 112 t (line)	Acceptable Both the trap and line catch were within the acceptable ranges.
Mackerel	Catch (Level 1)	Catch range	Adequate	410 (Q) 246 - 410 (all except grey mackerel)	284 t	Acceptable. Catch rates are stable or increasing in all three management areas.

OVERVIEW

Fishery/ Resource	Stock assessment method and level	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported ¹ - 2010/11 or 2011	Catch (or effort) level acceptable and explanation if needed
NORTH COAST BIOREGION (continued)						
Northern shark	Sandbar shark: Catch (relative to previous direct survey) (Level 3) Blacktip sharks: Catch (Level 1)	Under review	Sandbar shark: Inadequate Blacktip shark: Adequate	< 20 (sandbar)	No fishing or catch reported	NA No fishing effort continued for this year. To enable a recovering status, management needs to ensure on-going low catches. The black tip assessment is based on NT analysis
Pearl oyster	Catch rate predictions, standardised CPUE (Level 3)	Area < 60% Rates > min.	Adequate	1,600,000 oysters (Q) (14,071 – 20,551 dive hours)	796,158 oysters (13,917 dive hours)	Acceptable Pearl oyster catches are at 2nd highest historical level, but still only 50% of TAC due to exceptional abundance.
Beche-de- mer	Catch Rate (Level 2)	Catch range	Adequate	Sandfish 20 – 100 Redfish 40 - 150	Sandfish 56 Redfish 0	Acceptable. No fishing occurred for Redfish in 2011. Sandfish within historical range.
SOUTH COAST BIOREGION						
South coast crustacean	No	NA	NA	50 – 80 (southern rock lobster)	70.3 t (lobster and crab combined catch; 52 t for lobsters)	Acceptable The management arrangements, including the acceptable catch range, are currently being reviewed.

Fishery/ Resource	Stock assessment method and level	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported ¹ - 2010/11 or 2011	Catch (or effort) level acceptable and explanation if needed
SOUTH COAST BIOREGION (continued)						
Abalone (greenlip/ brownlip)	Standardised Catch Rate/ Fishing Mortality (Level 3)	Indicators > threshold value	Adequate	213 (Q) (907 – 1,339 days)	202 t (1,224 days)	Acceptable. No issues
Estuarine finfish (south coast)	Catch Rates (Level 2)	> Minimum level	Adequate	200 – 500	201 t (finfish) 15 t (crab)	Acceptable Stock levels of key species are considered adequate.
WA salmon	Catch Rates (Level 2)	Catch Range	Adequate	1,200 – 2,800	171 t	Acceptable Recent catches continue to be low relative to historic levels, due to low effort from limited market demand. A review of the target catch range needs to be undertaken.
Australian herring	Catch Rates (Level 2)	Catch Range	Uncertain	475 – 1,200 (south coast only)	110 t (south coast only)	Acceptable Formal stock assessment and review of acceptable catch range due for completion in late 2012. Commercial catch continues to be low relative to historic levels.
Albany/King George Sound purse seine	Catch (Level 1)	Catch < TAC	Adequate	2,683 (Q)	1,241 t	Acceptable. Catch was lower than 2009/10 due to lower effort.

OVERVIEW

Fishery/ Resource	Stock assessment method and level	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported ¹ - 2010/11 or 2011	Catch (or effort) level acceptable and explanation if needed
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SOUTH COAST BIOREGION (continued)

Bremer Bay purse seine	Catch (Level 1)	Catch < TAC	Adequate	1,500 (Q)	Less than three licences operated	Acceptable. Catch levels similar to previous years and acceptable given effort levels.
Esperance purse seine	Catch (Level 1)	Catch < TAC	Adequate	1,500 (Q)	Less than three licences operated	Acceptable. Catch levels are higher than previous years and acceptable given effort levels.
Southern and West Coast demersal gillnet and longline	Gummy shark - CPUE (relative to previous Level 5 assessment) (Level 2)					
	Dusky shark - CPUE (relative to previous Level 4 assessment) (Level 2)	Mature biomass above 40% or is increasing	Gummy and whiskery sharks - adequate. Dusky and sandbar likely to now be recovering	725 – 1,095 (key species only)	828 t (key species only)	Acceptable. Total catch was within range as were the catches of gummy sharks, dusky and sandbar. Whiskery catch was slightly below the historical range due to the intended effects of seasonal closure and effort reductions.
	Sandbar shark - CPUE (relative to previous Level 4 assessment) (Level 2)					
	Whiskery shark - Age Structured Model (Level 5)					

Fishery/ Resource	Stock assessment method and level	Breeding stock performance measures/limits	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) and Effort (days/hours) for season reported ¹ - 2010/11 or 2011	Catch (or effort) level acceptable and explanation if needed
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NORTHERN INLAND BIOREGION

Lake Argyle catfish	Catch (Level 1)	Catch range	Adequate	95 - 155	Less than three licences operated	Acceptable. Catch is within the acceptable range.
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¹ Catch figures supplied for latest year/ season available.

OVERVIEW TABLE 2 - EFFECTIVE PROTECTION STATUS OF BENTHIC HABITAT IN WESTERN AUSTRALIAN STATE WATERS

The areas and proportions of the West Coast Bioregion making up continental shelf waters (< 200 m depth) where habitats are protected from the physical disturbance of trawl fishing. The areas which are formally closed to trawling would be equivalent to meet the IUCN criteria for classification as marine protected areas as category IV. The area of habitat effectively protected refers to the area where trawling doesn't occur.

Bioregion	Total Area of Shelf (sq nm)	Area of shelf equivalent to IUCN marine protected area ≤Category IV (sq nm) (%)	Maximum area of Actual trawling activity (sq nm)	Total area of habitat effectively protected (%)
West Coast	19600	11000 (56%)	300	19300 (98%)
Gascoyne	15800	5600 (35%)	1100	14700 (93%)
North Coast	98600	40700 (41%)	10500	88100 (89%)
South Coast	31800	-	500	31200 (98%)

OVERVIEW

OVERVIEW TABLE 3 - DETECTION OF MARINE PEST SPECIES IN 2011/12 RESULTING FROM SURVEILLANCE AT MAJOR PORTS

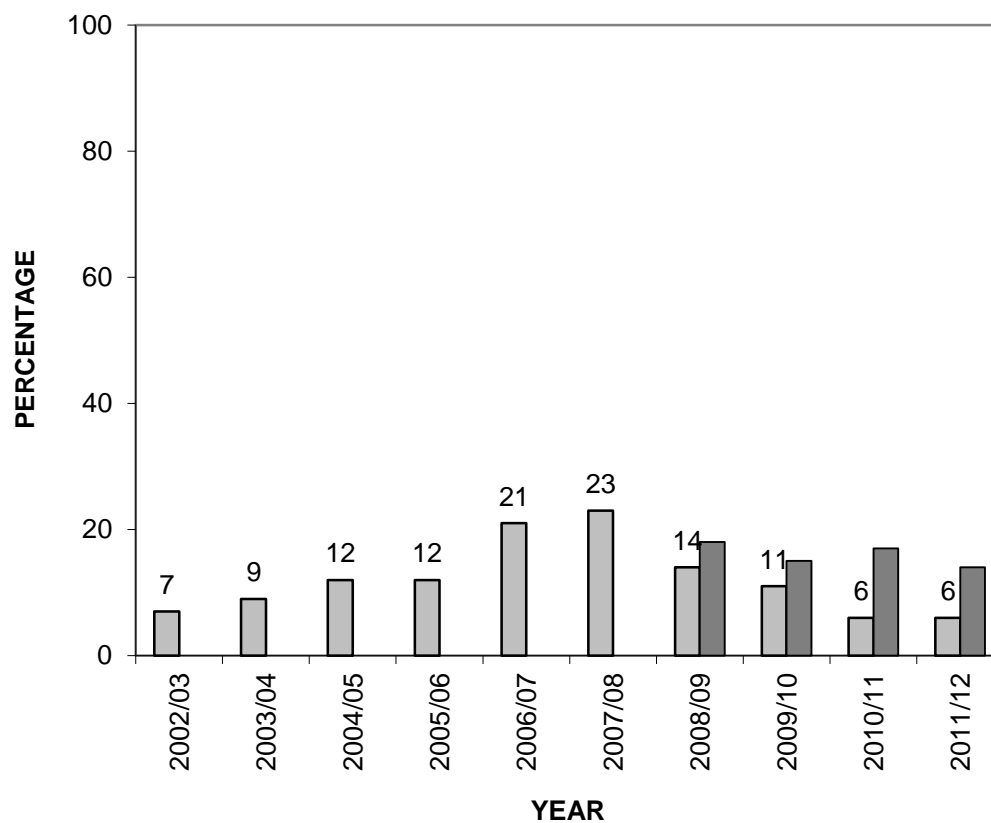
No pest monitoring was conducted in the Gascoyne or South Coast Bioregions in 2011/12.

Bioregion	Common Name	Scientific Name	Type of Organism	Pest status
West Coast	Mediterranean fanworm	<i>Sabella spallanzanii</i>	Polychaete	Pest
	Scallop	<i>Scaechlamys livida</i>	Mollusc	Introduced species
	Aeolid nudibranch	<i>Godiva quadricolor</i>	Mollusc	Introduced species
		<i>Alexandrium catanella</i>	Dinoflagellate	Pest
	Ciona	<i>Ciona intestinalis</i>	Ascidian	Introduced species
	Asian paddle crab	<i>Charybdis japonica</i>	Crab	Pest
	Ivory barnacle	<i>Balanus improvisus</i>	Barnacle	Pest
		<i>Balanus pulchellus</i>	Barnacle	Introduced species
	Asian green mussel	<i>Perna viridis</i>	Mussel	Pest
	Asian date mussel	<i>Musculista senhousia</i>	Mussel	Pest
		<i>Didemnum perlucidum</i>	Ascidian	Introduced species – likely pest
	North Coast	<i>Theora fragilis</i>	Mollusc	Introduced species
		<i>Didemnum perlucidum</i>	Ascidian	Introduced species – pest-like characters

OVERVIEW TABLE 4

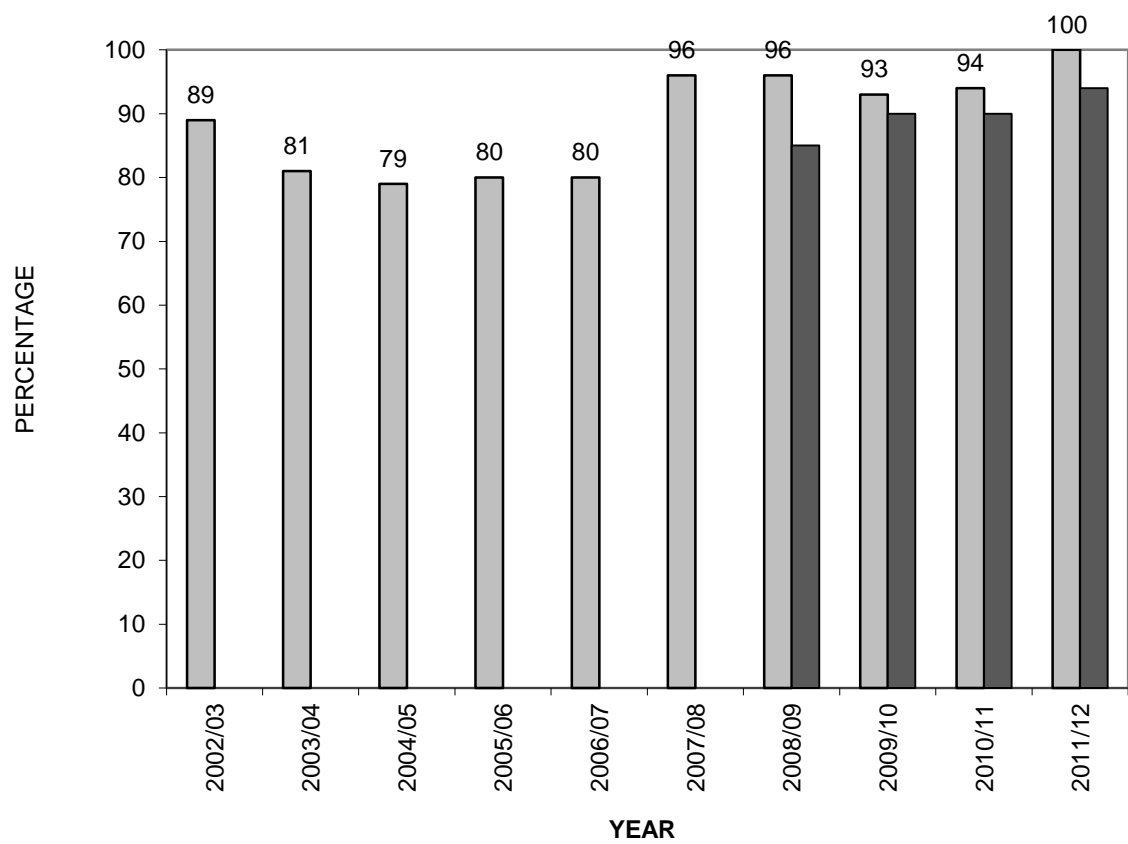
The number of significant fishkills investigated in Western Australia since the last SOE report

Year	Number of FishKills
2007	23
2008	36
2009	18
2010	18
2011	29



OVERVIEW FIGURE 1

The proportion (%) of commercial fisheries where breeding stocks of the major target species are both assessed and considered to be at risk. Dark bars indicate target levels.



OVERVIEW FIGURE 2

The proportion (%) of commercial fisheries where the catch or effort reported is acceptable relevant to the management range being applied. Dark bars indicate target levels.

WEST COAST BIOREGION

ABOUT THE BIOREGION

The marine environment of the West Coast bioregion between Kalbarri and Augusta is predominantly a temperate oceanic zone, but it is heavily influenced by the Leeuwin Current, which transports warm tropical water southward along the edge of the continental shelf. Most of the fish stocks of the region are temperate, in keeping with the coastal water temperatures that range from 18° C to about 24° C. The Leeuwin Current is also responsible for the existence of the unusual Abrolhos Islands coral reefs at latitude 29° S and the extended southward distribution of many tropical species along the west and south coasts.

The Leeuwin Current system, which can be up to several hundred kilometres wide along the West Coast, flows most strongly in autumn/winter (April to August) and has its origins in ocean flows from the Pacific through the Indonesian archipelago. The current is variable in strength from year-to-year, flowing at speeds typically around 1 knot, but has been recorded at 3 knots on occasions. The annual variability in current strength is reflected in variations in Fremantle sea levels, and is related to El Niño or Southern Oscillation events in the Pacific Ocean.

Weaker counter-currents on the continental shelf (shoreward of the Leeuwin Current), such as the Capes Current that flows northward from Cape Leeuwin as far as Shark Bay, occur during summer and influence the distribution of many of the coastal finfish species.

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

The West Coast is characterised by exposed sandy beaches and a limestone reef system that creates surface reef lines, often about 5 kilometres off the coast. Further offshore, the continental shelf habitats are typically composed of coarse sand interspersed with low limestone reef associated with old shorelines. There are few areas of protected water along the west coast, the exceptions being within the Abrolhos Islands, the leeward sides of some small islands off the mid-west coast, plus behind Rottnest and Garden Islands in the Perth metropolitan area.

The major significant marine embayments of the West Coast are Cockburn Sound and Geographe Bay. Beyond Cape Naturaliste, the coastline changes from limestone to predominantly granite and becomes more exposed to the influences of the Southern Ocean. Along the West Coast, there are 4 significant estuarine systems – the Swan/Canning, Peel/Harvey and Leschenault estuaries and Hardy Inlet (Blackwood estuary). All of these are permanently open to the sea and form an extension of the marine environment except when freshwater run-off displaces the oceanic water for a short period in winter and spring.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

The principal commercial fishery in this region is the western rock lobster fishery which is Australia's most valuable single-species wild capture fishery. There are also significant commercial trawl, dive and pot fisheries for other invertebrates including scallops, abalone, blue swimmer crabs and octopus. Commercial fishers take a range of finfish species including sharks, dhufish, snapper, baldchin groper and emperors using demersal line and net methods. Beach based methods such as beach seining and near-shore gillnetting, and hand-hauled nets are used to capture whitebait, mullet and whiting in a restricted number of locations.

The West Coast Bioregion, which contains the state's major population centres, is the most heavily used bioregion for recreational fishing (including charter based fishing). The range of recreational fishing opportunities includes estuarine fishing, beach fishing and boat fishing either in embayments or offshore for demersal and pelagic/game species often around islands and out to the edge of the continental shelf.

The principal aquaculture development activities in the West Coast Bioregion are the production of blue mussels (*Mytilus galloprovincialis*) and marine algae (*Dunaliella salina*) for beta-carotene production, and the emerging black pearl industry based on the production of *Pinctada margaritifera* at the Abrolhos Islands. The main mussel farming area is in southern Cockburn Sound, where conditions are sheltered and the nutrient and planktonic food levels are sufficient to promote good growth rates. Owing to the generally low productivity of the Western Australian coastline under the influence of the Leeuwin Current, areas outside embayments (where nutrient levels are enhanced) are unsuitable for bivalve aquaculture.

ECOSYSTEM MANAGEMENT

The marine benthic habitats and their associated biodiversity are largely protected along most of the West Coast from any physical impact of commercial fishing due to the extensive closures to trawling. These closures inside 200m depth were introduced in the 1970s and 1980s, in recognition of the significance of extensive areas of seagrass and reef as fish habitat (West Coast Ecosystem Management, Figure 1). The extent of these areas means that over 50% of the West Coast Bioregion inside 200 m depth could be classified as a marine

WEST COAST BIOREGION

protected area with an IUCN category of IV (Ecosystem Management Table 1; as per Dudley, 2008)¹.

Protection of fish habitat and biodiversity is also provided by marine protected areas consistent with IUCN categories of I, II and III along the west coast including:

Fish Habitat Protection Areas (FHPAs) at the Abrolhos Islands, Lancelin Island Lagoon, Cottesloe Reef, and Kalbarri Blueholes; Reef Observation Areas within the Abrolhos Islands FHPA and closures to fishing under s.43 of the Fish Resources Management Act 1994 at Yallingup Reef, Cowaramup Bay, the Busselton Underwater Observatory, and around the wrecks of the Saxon Ranger (Shoalwater Bay) and Swan (Geographe Bay); and marine conservation areas proclaimed under the Conservation and Land Management Act 1984 at Jurien Bay, Marmion, Swan Estuary, Shoalwater Islands, and the soon to be gazetted Ngari Capes Marine Park between Cape Leeuwin and Cape Naturaliste; and the Rottnest Island Marine Reserve. (West Coast Ecosystem Management, Figure 2).

The Commonwealth Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) has also undertaken a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark Bay. The federal minister for the environment has recently announced the final reserve network proposed for the south-west which spans the West Coast and South Coast bioregions.

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets/Resources using the EBFM framework

Utilising the Integrated Marine and Coastal Regionalisation for Australia (IMCRA V. 4.0)² scheme, the West Coast Bioregion has been divided into 3 meso-scale regions: the Abrolhos Islands, the Central West Coast and the Leeuwin–Naturaliste (West Coast Ecosystem Management Figure 3). This sub-regional scale of management has now been adopted by the Department through the implementation of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher, *et al.*, 2010)³ see How to Use section for more details. EBFM is a risk based management approach, which

recognizes the social, economic and ecological values at a regional level and links between exploited fish stocks and the broader marine ecosystem, to ensure the sustainable management of all fisheries resources into the future. EBFM identifies these individual ('lower level') values, and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied.

The West Coast was the first bioregion where the EBFM process, including the comprehensive risk assessment of each of the ecological assets was applied (see West Coast Ecosystem Management Table 2). In terms of ecological assets (= resources), the Department utilises the following categories for the three IMCRA regions within the West Coast Bioregion:

- Ecosystem structure and biodiversity (on a meso-scale basis – subdivided into marine, estuarine/embayments);
- Captured fish species
- Protected species (direct impact – capture or interaction);
- Benthic habitat; and
- External impacts.

For some issues a finer level of division of the IMCRA ecosystems is used by the Department. This relates to recent management initiatives necessary to recognise different suites of exploited fish and invertebrates across the continental shelf. These sub-components are defined by depth contours (Estuarine/Nearshore 0-20m; Inshore 20-250m; Offshore >250m). The full set of ecological assets identified for ongoing monitoring are presented in West Coast Ecosystem Management Figure 4.

Risk Assessment of Regional Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined Figure 4 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (West Coast Ecosystem Management Table 2) provides an overview and cumulative assessment of the current risks to the ecological assets of the West Coast Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department's Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

Summary of Monitoring and Assessment of Ecosystem Assets

The Department of Fisheries Research Division's Biodiversity and Biosecurity Branch has a number of research and monitoring initiatives underway.

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

² Commonwealth of Australia (2006). A Guide to the Integrated Marine and Coastal Regionalisation of Australia Version 4.0. Department of the Environment and Heritage, Canberra, Australia.

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

An ecological risk assessment undertaken on the western rock lobster fishery identified that the ecological impacts of removing rock lobster biomass could be a moderate risk for deeper water reef community structure. A recently completed Fisheries Research and Development Corporation (FRDC)-funded project provided critical information on the relationships between rock lobster abundance, size distributions and benthic habitat characteristics in deep water. The project also provided preliminary data on the trophic role of rock lobster in deep water ecosystems.

Additional ecological research in deep waters comparing fished and unfished areas to assess the impacts of lobster fishing on the ecosystem was supported by funding from the Western Australian Marine Science Institution (WAMSI) and the FRDC. A suitable reference area in deep water was closed to lobster fishing in March 2011. Research since then has concentrated on the production of detailed substrate and benthic biota maps for the reference area and the development of sampling methodologies to effectively monitor benthic habitats in fished and unfished areas. Continued monitoring will provide the contrast required to enable the potential impacts of lobster fishing on deep water ecosystems to be quantified.

Work on examining the role of lobsters in shallow waters also continued as part of WAMSI through a number of projects run by ECU. These were completed in Jurien Bay and the Marmion Marine Parks. There is also work being undertaken on lobster interactions by the Department, CSIRO and UWA at the Rottne Island protected areas.

Research focusing on key habitats and their associated fish and invertebrate assemblages at the Houtman Abrolhos Islands has been expanded. This program is divided into two components the first of which, uses permanent coral transects located at each of the island groups to collect important baseline information on coral communities. This information allows researchers to quantify the effects of natural (i.e. climate change) and anthropogenic (i.e. fishing activities) impacts on sensitive coral habitats. The second component, funded by state NRM in 2009, focused on the establishment of baseline maps and information on the current distribution and composition of the fish, coral, algal and other communities within the Abrolhos Islands. Detecting change will also need the development of cost effective indicators that can measure significant changes generated by either natural or anthropogenic causes that could affect the fisheries and other activities in this region.

The Biodiversity and Biosecurity Branch are involved in several studies that involve mapping of habitats in this bioregion. The focus of these projects is to map the dominant marine habitats, and conducting biodiversity surveys in order to build spatial habitat models of the marine environment. Outputs from these habitat mapping and biodiversity surveys will assist in the identification of key marine indicators, and will support regional natural resource management groups in establishing marine ecosystem monitoring targets. The habitat maps produced will provide information on the distribution and extent of various substrates (e.g. reef versus sediment), relief, dominant vegetation types and different classes of sessile invertebrates.

The Department has recently received funding to establish ongoing ecosystem monitoring and research to underpin management of the recently gazetted Ngari Capes Marine

Park.

In the West Coast bioregion, sampling mostly by other agencies (e.g. UWA, ECU, CSIRO) has focused on the Abrolhos Islands, Jurien Bay, Rottne and Cape Naturaliste. Bathymetric and towed video surveys have been completed at all of these sites, as well as biodiversity sampling including research trawls using the RV Naturaliste and Baited Remote Underwater Video Stations (BRUVS). This work was being coordinated through the WAMSI Node 4 project 4.2. (<http://www.wamsi.org.au/>).

The Department continues to undertake research to assess the impacts on fisheries from other activities and determine appropriate management responses. The Department also inputs into the Western Australian Environmental Protection Authority's environmental impact assessment process when a development proposal has the potential, if implemented, to impact on the aquatic environment.

The Department actively engages with the natural resource management groups within the West Coast to promote sustainable use of the aquatic environment, and has 'introduced aquatic organism incursion' and 'fish kill incident response' programs to minimise risks to the marine environment through the introduction of exotic aquatic organisms, or other incidents which have the potential to have an adverse effect.

The Biodiversity and Biosecurity branch have implemented a series of biosecurity related projects during 2011 – 2012. These projects aim to detect the presence of introduced marine pests (IMPs) using a suite of tools and sampling techniques. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. A large-scale, nationally approved survey of Fremantle Port was completed in early 2011, and an interim survey conducted in early 2012. In addition the Marine Biosecurity Research group, with financial and *in-kind* assistance from Fremantle Port Authority and the Defence Services Group is running an Early Warning System program using *in-situ* settlement arrays to provide a mechanism for the early detection of marine pests in Fremantle Port and HMAS Stirling waters. The Marine Biosecurity Research group has developed Commonwealth approved marine pest monitoring designs for Geraldton Port and HMAS Stirling. Surveillance at these ports is expected to be undertaken in the near future. Further detail of monitoring and research may be found in the Introduced Pests Status report provided at the end of this chapter. Other biosecurity activities include a survey of the Careening Bay Naval waters at Garden Island for the possible presence of the invasive mussel *Perna viridis*, an additional survey of Fremantle Port Waters for the possible presence of the introduced barnacles *Balanus improvisus* and *Amphibalanus pulchellus*, and a survey of Mandurah waters and canals for the possible presence of the invasive Asian paddle crab *Charybdis japonica*.

A project supported by WAMSI 4.4, developed a bycatch risk assessment method to rapidly assess the cumulative risk to sustainability of multiple fisheries¹. The method draws on

¹ Evans, R. and Molony, B. W. 2010. Ranked Risk Assessment for Bycatch in Multiple Fisheries: a Bioregional Risk Assessment Method. Fisheries Research Report No. 212. Department of Fisheries, Western Australia. 88pp.

WEST COAST BIOREGION

other techniques already published in scientific literature and adds a new cumulative ranked estimate of total catch across multiple fisheries. The Ranked Risk Assessment of Multiple Fisheries (RRAMF) allows ranking of bycatch species within each fishery and to accumulate the ranks across multiple fisheries incorporating the relative impact of each fishery. The RRAMF method was tested on the West Coast and Gascoyne Coast Bioregions of Western Australia using fishery independent data for general teleost and elasmobranch bycatch; and fishery dependent data for threatened,

endangered and protected species (TEPS). The RRAMF analyses reveal all bycatch species received low to moderate risk scores in these Bioregions. The RRAMF for the TEPS showed that while most species have high biological risk, the low interaction rates reported by fisheries maintained low to moderate risk categories for most species groups. A trial has also been conducted using a camera placed on a demersal gillnet vessel to investigate the efficacy of electronic monitoring to (a) identify protected species interactions, and (b) determine by-product and target species catches.

WEST COAST ECOSYSTEM MANAGEMENT TABLE 1

The areas and proportions of the West Coast Bioregion making up continental shelf waters (< 200 m depth) where habitats are protected from the physical disturbance of trawl fishing. The areas which are formally closed to trawling would be equivalent to meet the IUCN criteria for classification as marine protected areas as category IV. The area of habitat effectively protected refers to the area where trawling doesn't occur.

Total Area of Shelf	Area of shelf equivalent to IUCN marine protected area <= category IV (%)	Maximum area of actual trawling activity	Total area of habitat effectively protected (%)
19600 sq nm	11000 sq nm (56%)	300 sq nm	19300 sq nm (98%)

WEST COAST ECOSYSTEM MANAGEMENT TABLE 2

ANNUAL UPDATE OF RISK LEVELS FOR EACH WEST COAST ECOLOGICAL ASSET.

Risk levels in this Table are developed by combining the risks of lower level elements (usually indicator species) that make up each of these higher level (regional) components. Low and Moderate values are both considered to be acceptable levels of risk, whereby Moderate Risks will generally have some level of directed management actions associated with these which will be outlined in the detailed reports in the rest of the West Coast section. High and Significant risks indicate that the asset is no longer in a condition that is considered acceptable and additional management actions are required by the Department except where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, was not generated by fishing or related activities but by activities managed by other agencies.

Ecosystem Structure and Biodiversity

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Abrolhos Islands	Marine	MODERATE	<p>The Abrolhos Islands are protected within a 'Fish Habitat Protection Area', and are not considered to be at unacceptable risk from fisheries related activities.</p> <p>There are a number of research programs including monitoring of the health of coral communities at the Abrolhos Islands. This program, which utilises permanent transects located at each of the island groups collected important baseline information on coral communities, allowing researchers to quantify whether lobster fishing with pots results in damage to sensitive coral habitats, and to determine the vulnerability of coral communities at the Abrolhos to climate change.</p> <p>Surveys of the community structure of finfish are also underway within and outside of non-fishing areas.</p>

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Central West Coast	Marine	MODERATE	An assessment of the community structure and trophic level of all commercially caught fish species over the past 30 years found no evidence of systematic changes that could be evidence of an unacceptable impact on this ecosystem (Hall and Wise, 2011) ¹ . Further ecological research in shallow (ECU) and deep waters, supported by funding from the Western Australian Marine Science Institution (WAMSI) and the latter by Fisheries Research and Development Corporation (FRDC). This will allow ecosystem structure in a newly created deep water closed area to be compared with that in nearby fished areas. A key objective of this project will be to enable potential ecosystem impacts of lobster fishing in these deeper water ecosystems to be quantified.
	Estuaries/ Embay.	SIGNIFICANT (non-fishing)	The estuaries and embayments within this area have been identified as being at significant risk, due to external factors (water quality issues due to high nutrient runoff from surrounding catchment) which have the potential to affect fish and other communities. Poor water quality within the Peel – Harvey and Swan – Canning estuaries, and to a lesser extent Cockburn Sound are of particular concern.
Leeuwin Naturaliste	Marine	LOW	The impacts from fishing and other sources on the marine communities are relatively low in this region.
	Estuaries	HIGH (non-fishing)	External factors such as water quality issues in the Blackwood Estuary, due to high nutrient run-off from surrounding land, as well as acid-sulphate soil contamination are of concern to sustainable fish stocks and the ecosystem in general.

Captured fish species: Details of the analyses for these scores are located in the individual fishery reports.

Captured Species	Aquatic zone	Risk	Status and Current Activities
Finfish	Estuarine	SIGNIFICANT (non-fishing)	There is concern for some indicator fish stocks within estuaries in the West Coast Bioregion mainly due to external (non-fishing) factors (poor water quality).
	Nearshore (0-20m depth)	HIGH	With the increasing concerns for Australian herring, tailor and whiting in the nearshore regions, research projects are underway to assess these stocks and to develop methods to measure shore based fishing catch and effort.
	Inshore demersal (20-250m depth)	MODERATE	Following assessments of the demersal indicator species (dhufish, pink snapper, baldchin groper), management actions designed to reduce both the commercial and recreational catch levels by 50% have now been implemented. Determining catch shares for commercial and recreational users has been underway and a review in late 2010 confirmed that the catch levels have been reduced to desired levels. These stocks are now therefore considered to be in a recovery phase. An updated assessment is planned for 2013.

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.

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Captured Species	Aquatic zone	Risk	Status and Current Activities
	Offshore demersal (>250m depth)	LOW	While the indicator species in this deepwater location are vulnerable to overfishing the current catch levels are low and therefore the stocks are not at risk. Long term management arrangements for fishing in these depths, particularly for the recreational sector are still being finalised.
	Pelagic	LOW	There is still minimal capture of pelagic fish in this bioregion.
Crustaceans	Nearshore/ Estuarine	MODERATE	The stocks of crabs in Cockburn Sound have now recovered and the fishery has re-opened. Research on the other stocks of crabs in this region (e.g. Peel/Harvey) has been completed and the stocks are all considered to be in an adequate state and fishing levels are acceptable.
	Shelf (Lobsters)	MODERATE	The stock levels of western rock lobster and prawns are both currently at appropriate levels. The strong management that was applied to the rock lobster fishery has ensured that the lobster spawning stock is currently at record high levels despite on-going relatively low puerulus recruitment over the past 6 seasons.
Molluscs	Nearshore	MODERATE	The stocks of abalone are conservatively managed with strong management controls on both commercial and recreational fishers but the heat wave in 2010/11 caused the almost total loss of Roes abalone in the Kalbarri region.. Scallops are managed to acceptable levels using an input controlled system and a catch rate threshold.

Protected species - Details on the analyses for these scores are either located within the individual fishery reports or in the bioregional level analyses documented in the EBFM report for this Bioregion (Fletcher et al., 2012¹).

Protected species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Turtles/ Seabirds	LOW	There is minimal impact from fishing activities on any turtle species within this bioregion and the small trawl fishery has to operate using grids. Little Penguins are considered most at risk from boat strikes and non-fishing activities. Few other issues were identified.
	Mammals	LOW	Sea lion exclusion devices now implemented for rock lobster pots near sea lion breeding islands which has reduced the risk to low levels. The reduction in fishing effort for lobsters had considerably reduced potential entanglement of whales but the extension of the season post June may require a re-assessment of this risk.
Protected 'Fish' Species	Fish	LOW	Blue groper (Rottnest Island), Cobbler (Swan Canning) and White Sharks are within this category and are already unable to be landed by commercial or recreational fishers.

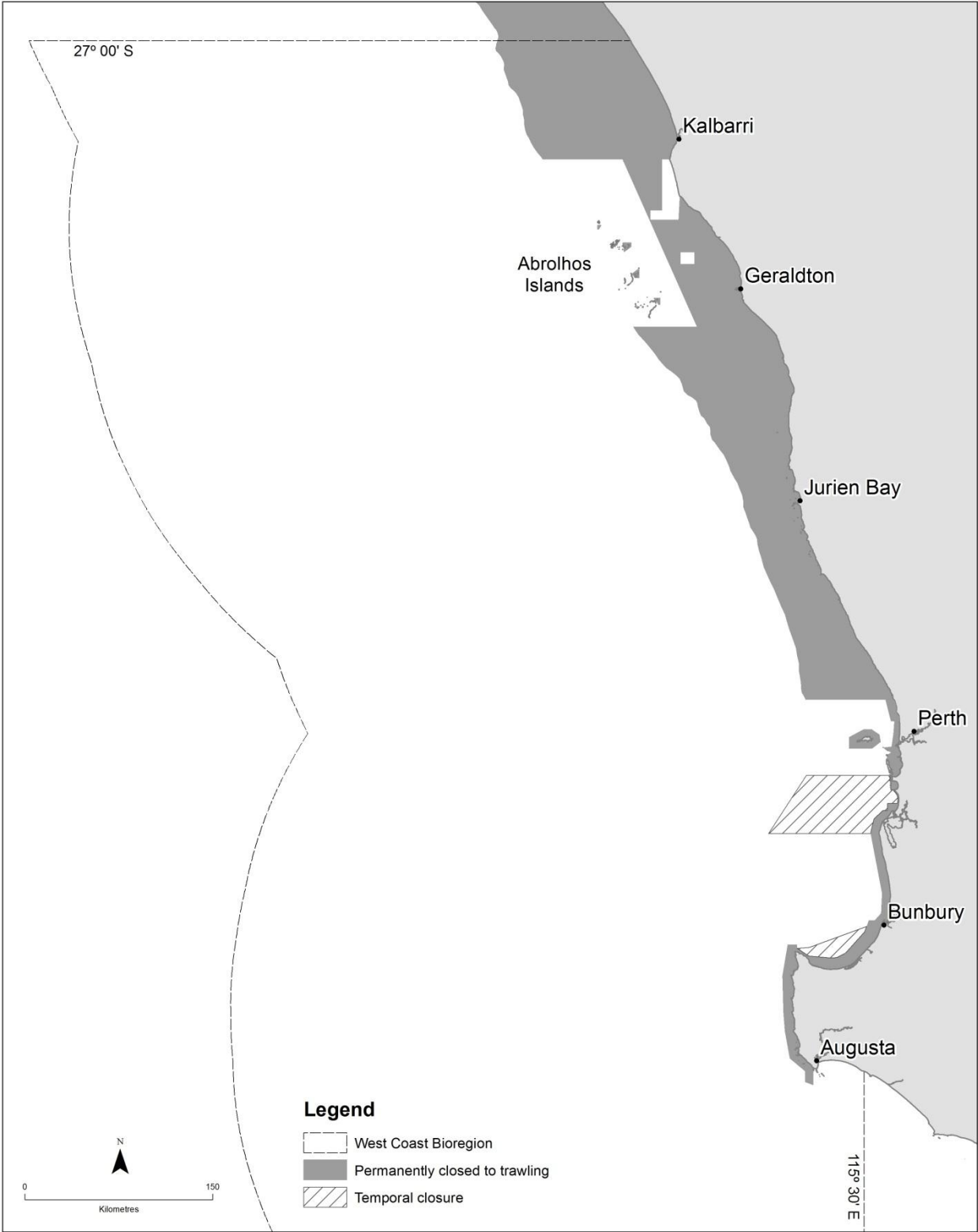
¹ Fletcher, W.J., Gaughan., D.J., Shaw, J. and S.J. Metcalf (2012) Ecosystem Based Fisheries Management: Case Study Report West Coast Bioregion. *Fisheries Research Report No. 212, Department of Fisheries, Western Australia 104pp.*

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

Benthic Habitat	Category	Risk	Status and Current Activities
Estuaries and Embayments	Sand	SIGNIFICANT (non-fishing)	Estuarine and embayment habitats are threatened by various non-fishing factors (poor water quality, direct loss of habitat through coastal infrastructure and physical disturbance, e.g. dredging), sedimentation and smothering by algae. There are minimal impacts of fishing on these habitats
	Seagrass	MODERATE (non-fishing)	Seagrass habitat threatened from non-fishing related activities (coastal infrastructure and associated dredging (direct habitat loss, turbidity), eutrophication. Strong controls exist for direct destruction of seagrass.
Nearshore (0-20 m depth)	Sand	LOW	Minimal direct impacts (see Table 1) and high recovery rates.
	Seagrass	LOW	No destructive fishing methods allowed in these areas.
	Mangroves	LOW	No destructive fishing methods allowed in these areas
	Rocky Reef	LOW	Minimal direct impacts and high recovery rates.
	Coral Reef (Abrolhos)	LOW MODERATE	Minimal direct impacts. Regular monitoring of corals at the Abrolhos Is.
Inshore demersal (20-250 m depth)	Sand/ Seagrass/ Rocky Reef/ Coral Reef/ Sponge	LOW	Minimal direct impacts. See Ecosystem Table 1 for details
Offshore demersal (>250 m depth)	Sand/ Rocky Reef/ Sponge	LOW	Minimal direct impacts. See Ecosystem Table 1 for details

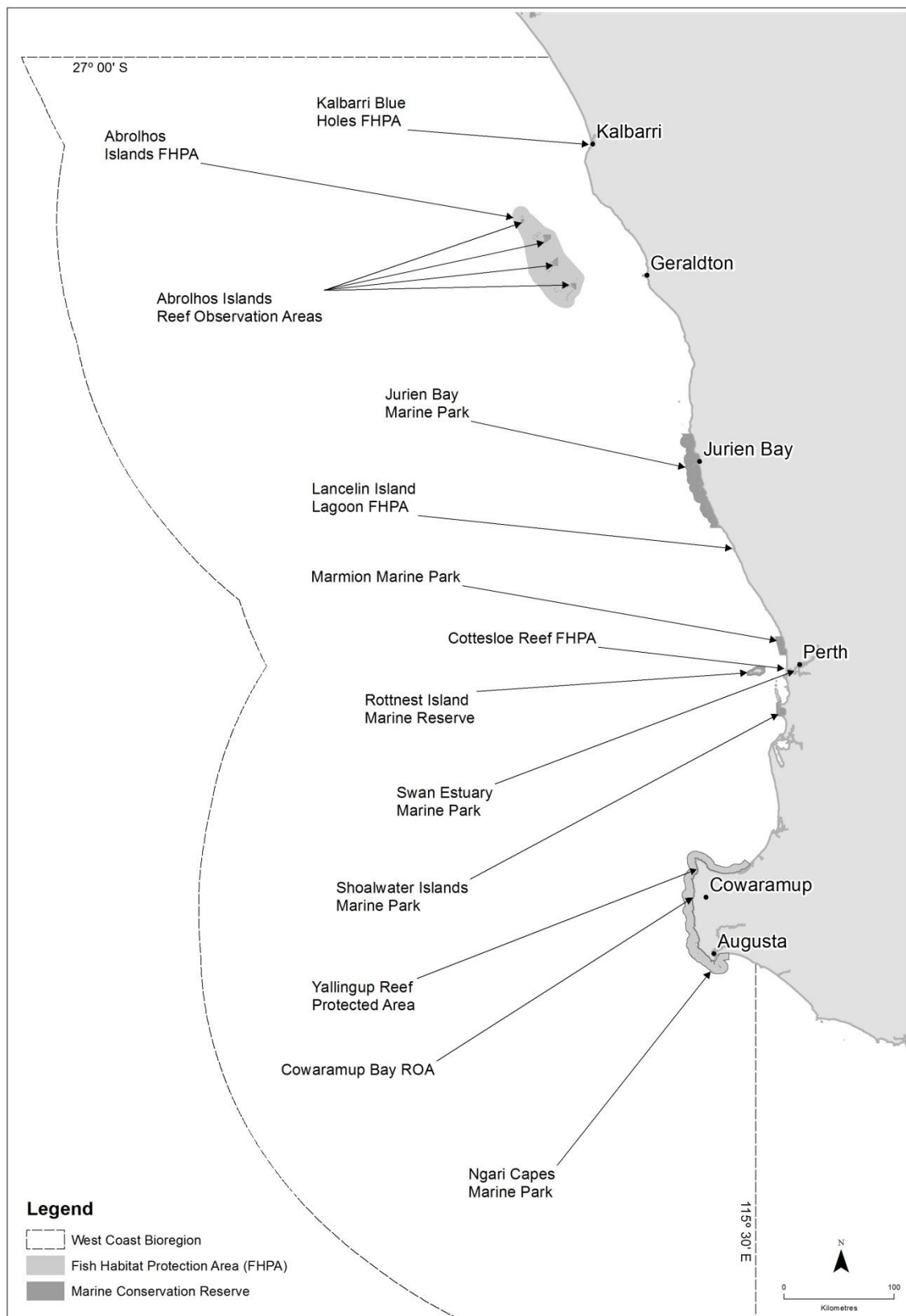
External Drivers - Details on some of the analyses used for these scores are located in the individual fishery reports plus there were whole of region assessments completed in the draft West Coast EBFM report.

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	MODERATE in short term	Port monitoring plans have been implemented targeting high risk port locations. These designs have been developed in line with the National System for introduced marine pest monitoring. The extent and findings of monitoring activities in this bioregion are detailed in the Introduced Pests Status Report at the end of this chapter.
	HIGH in medium term	
Climate	MODERATE in short term	Projects to examine potential impacts on this bioregion are now underway or planned. Some climate change impacts on rock lobster biology had already been taken into account in the stock assessment process.
	HIGH in medium term	



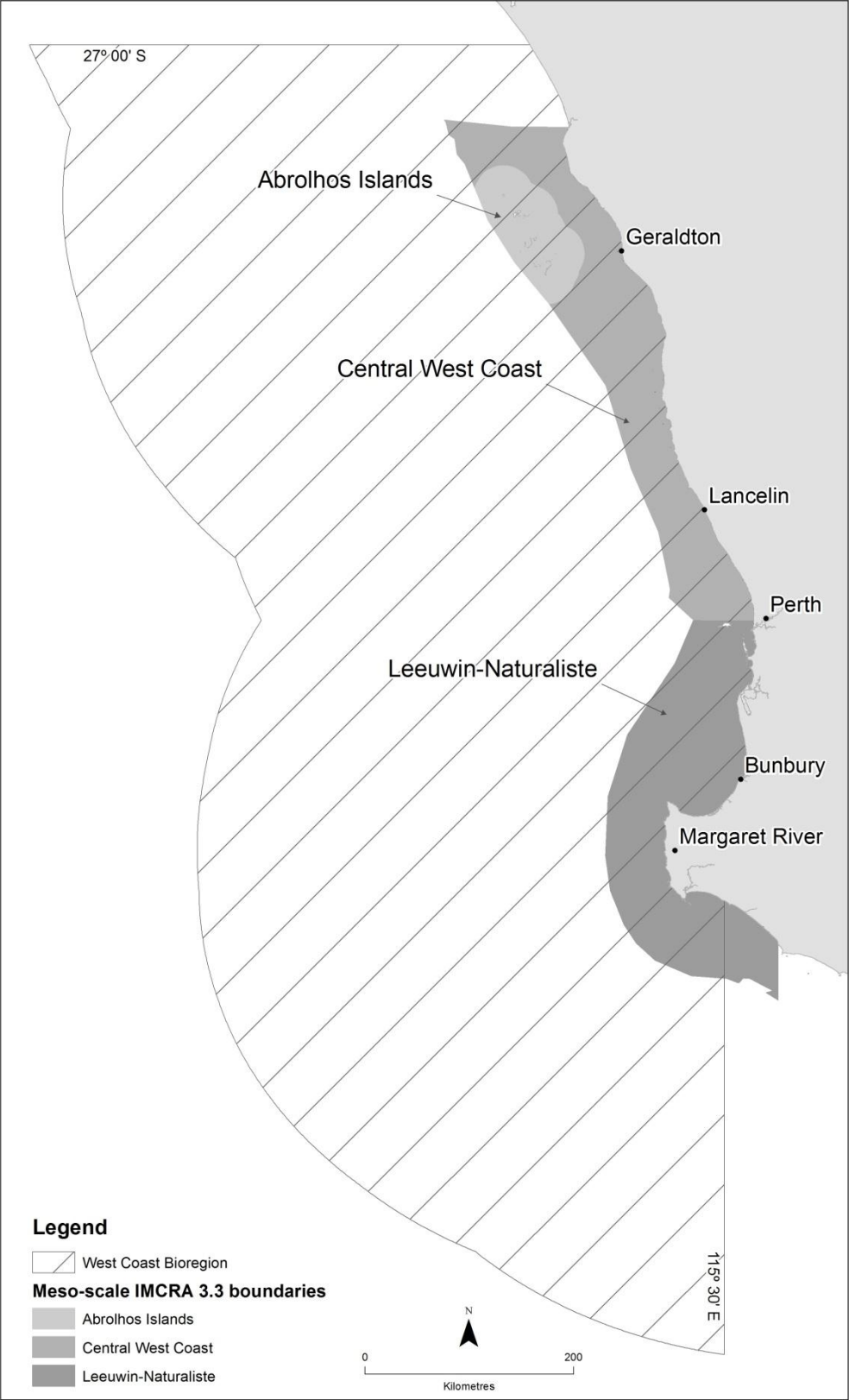
WEST COAST ECOSYSTEM MANAGEMENT FIGURE 1

Map showing areas of permanent and extended seasonal closures to trawl fishing in the west coast bioregion. The areas permanently closed are consistent with IUCN marine protected area category IV.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 2

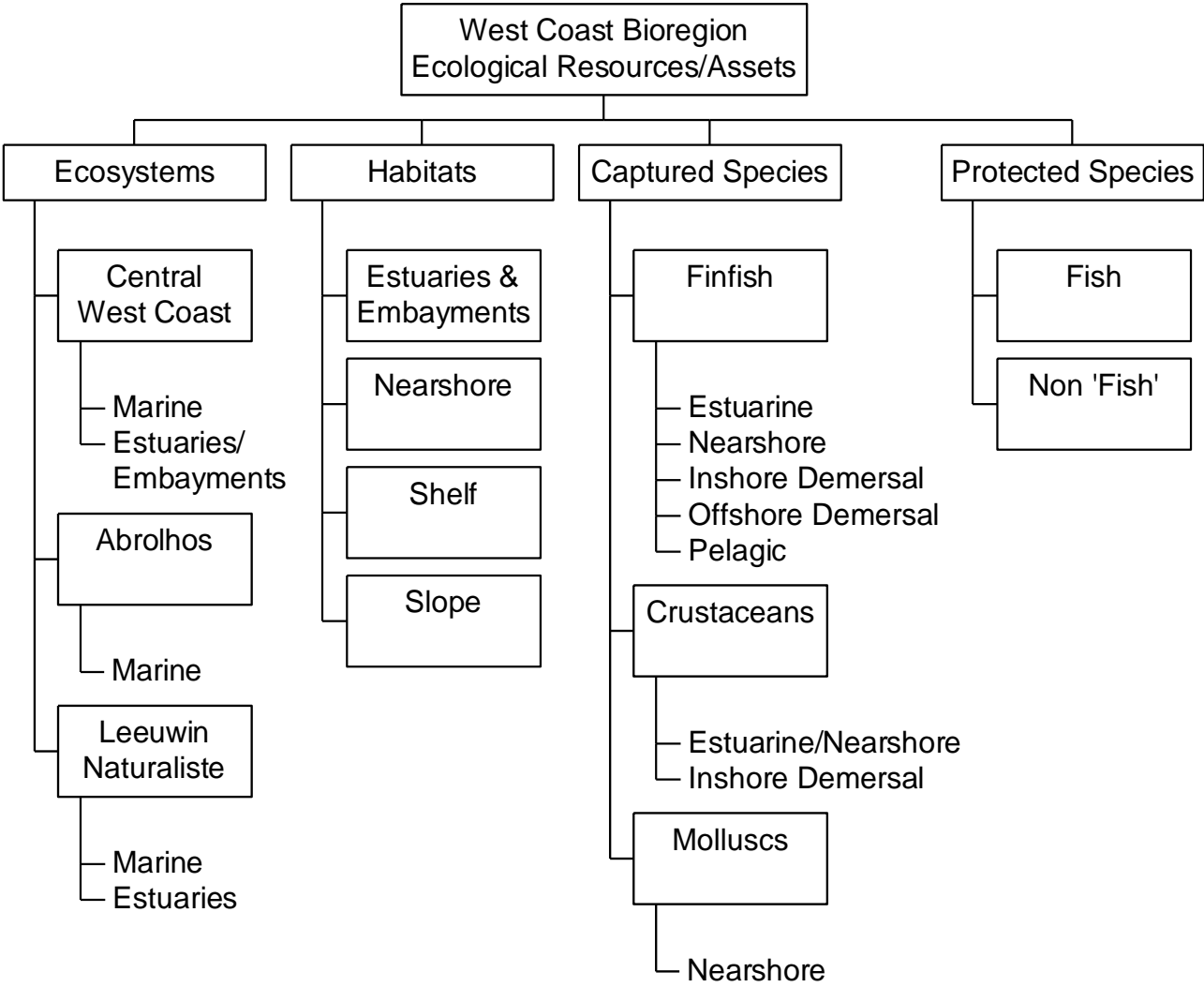
Map showing current and proposed formal marine protected areas in the west coast bioregion various areas of which are either consistent with IUCN categories I, II, III, IV or V.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 3

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

Note- This is based on Map 2 in IMCRA v4.0.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 4

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

INTRODUCED PESTS STATUS REPORT

Regional Monitoring and Research Update

The introduction and spread of marine pests in WA waters poses a serious threat to native biodiversity and can have widespread effects on both our economy and health. To this end the Marine Biosecurity Research group are actively involved in developing and implementing targeted marine pest monitoring and research programs in two ports in the West Coast bioregion. The aim is to detect the presence of introduced marine pests (IMPs) using a suite of tools. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. The Marine Biosecurity Research group previously completed a large-scale marine pest monitoring program in Fremantle Port in early 2011. This biennial program adhered to the Australian Marine Pest Monitoring Guidelines and was endorsed by the Commonwealth. To compliment this survey MBR has developed targeted supplementary monitoring designs to be completed in the intervening years. The survey for Fremantle Port was completed in early 2012.

In addition the Marine Biosecurity Research group, with financial and in-kind assistance from Fremantle Port Authority and the Defence Services Group is running an Early Warning System program using in-situ sampling equipment to potentially provide a mechanism for the early detection of marine pests in Fremantle Port and HMAS Stirling waters.

The Marine Biosecurity Research group has developed Commonwealth approved marine pest monitoring designs for

Geraldton Port and HMAS Stirling. Surveillance at these ports is expected to be undertaken in the foreseeable future.

Through this combined surveillance the species that have been detected in this region are reported in Introduced Pests Table 1.

The Marine Biosecurity Research group are currently conducting five main research projects in the West Coast bioregion (see below). While conducted in this bioregion the research outputs are designed to be applicable to biosecurity management across the state.

- Assessment of the likelihood of a marine pest being introduced into the ports of this bioregion;
- Determination of the efficacy of wrapping a recreational vessel hull to eliminate/kill biofouling on the wet areas of the hull;
- Quantification of the risk associated with recreational vessels for the introduction and translocation of marine pests along our coast;
- Evaluation of the efficacy of crab condos to sample for non-aggressive pest crab species; and
- Determination of the growth, physiology, reproductive strategies, response to stress and impacts of the invasive ascidian *Didemnum perlucidum*.

INTRODUCED PESTS TABLE 1

Introduced marine species detected in this bioregion.

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

FISHERIES

West Coast Rock Lobster Fishery Status Report

S. de Lestang, A. Thomson, M. Rossbach, J. Kennedy, G. Baudains and A. Steele

Main Features

Status		Current Landings (Season 2010/11)	
Stock level	Adequate	Commercial catch	5501 t
Fishing Level	Acceptable	Recreational catch	150 t

Fishery Description

Commercial

The West Coast Rock Lobster Managed Fishery (WCRLF) targets the western rock lobster, *Panulirus cygnus*, on the west coast of Western Australia between Shark Bay and Cape Leeuwin, using baited traps (pots). This fishery was one of the first limited entry fisheries in the world and utilised a sophisticated Individual Transferrable Effort based system for over 20 years. In 2009/10 catch limits and catch targets for each zone of the fishery were introduced. In 2010/11 individual catch limits based on a Total Allowable Commercial Catch (TACC) was set. It is planned that by 2013/14 the fishery will have moved to a full Individual Transferable Quota (ITQ) fishery. With annual production historically averaging about 11,000 t this has been Australia's most valuable single species wild capture fishery and was the first fishery in the world to achieve Marine Stewardship Certification (MSC). In early 2012 the fishery was re-certified by MSC for the third time.

Recreational

The recreational rock lobster fishery primarily targets western rock lobsters using baited pots and by diving.

Governing legislation/fishing authority

Commercial

West Coast Rock Lobster Management Plan 1993 and other subsidiary legislation

West Coast Rock Lobster Managed Fishery Licence

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

Recreational

Fish Resources Management Act 1994; *Fish Resources Management Regulations 1995* and other subsidiary legislation.

Recreational Rock Lobster Fishing Licence

Consultation processes

Commercial

The Department of Fisheries consults with the Western Rock Lobster Council (WRLC) on operational issues. Industry meetings are convened by the WRLC, while the West Australian Fishing Industry Council (WAFIC) is responsible

for statutory management plan consultation under a Service Level Agreement with the Department.

Recreational

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

Boundaries

Commercial

The fishery is situated along the west coast of Australia between Latitudes 21°44' to 34°24' S. The fishery is managed in 3 zones: south of latitude 30° S (C Zone), north of latitude 30° S (B Zone) and, within this northern area, a third offshore zone (A Zone) around the Abrolhos Islands.

Recreational

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

Management arrangements

Commercial

The West Coast Rock Lobster Managed Fishery (WCRLF) is divided into three zones. Historically, this has enabled effort to be distributed across the entire fishery (to prevent concentration of effort and exploitation in localised areas) and has also permitted the implementation of management controls which addressed zone-specific issues.

In 2010/11, management for the fishery continued to implement the processes designed to secure its long-term sustainability following a significant decline in puerulus settlement over a period of several years. Measures undertaken in 2010/11 to initiate transition to a full ITQ based framework included maintaining the TACC at 5,500 tonnes (roughly half the long-term average annual catch) and the introduction of a catch limit (or quota) on licences that varied in accordance with the number of units of entitlement on the licence and the zone to which the licence relates (as outlined below).

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Previously, the fishery was managed through a total allowable effort (TAE) system and associated input controls such as the number of pots fished per unit in the fishery, along with other restrictions such as; temporal closures including weekend and moon closures, and biological controls including size limits and protection of females in breeding condition; i.e. in tarspot, berried or setose condition. While many of these input controls remained in place for the 2010/11 season, the move to allocate a maximum catch limit per unit represents a significant step toward transitioning the Fishery to a full ITQ system, which is expected to be in place for the 2013/14 fishing season.

The management arrangements for the 2010/11 season were as follows:

- Total Allowable Commercial Catch (TACC) of 5,500 tonnes.
- Individual catch limits with the following number of kilograms per unit:
 - Zone A – 36kg from 15th November to 14th March (fishing in Zone B waters).
 - Zone A – 51kg from 15th March to end of season (fishing in Zone A waters).
 - Zone B – 81kg for entire season.
 - Zone C – 75kg for entire season.
- Fishing Prohibited weekends (rescinded in June of 2011).
- Big bank to remain closed.
- Season extended to 31st August.
- Zone C start date moved from 25th November to 15th November.
- 20 fathom line rule removed.
- Introduction of crate tags, catch and disposal records, authorised receivers, holding over books, and catch weighing procedures (including the use of landing areas) to monitor fishers' catch.
- Limited 'within season' transferability of licences and entitlement.

The change towards a TACC/ITQ framework required a great deal of adjustment and cooperation by both industry and the Department. The Department needed to design a new management and compliance strategy that was capable of accommodating the practicalities of quota monitoring in an industry where many fishers land their catch in remote locations.

The new management arrangements have provided western rock lobster fishers with increased flexibility in their fishing operations, as well as the opportunity to maximise the prices they receive for their product by fishing during periods where the market price of lobsters is high.

Recreational

The recreational component of the western rock lobster fishery is managed under fisheries regulations. A mixture of input and output controls is used which is designed to ensure that the recreational sector enjoys the amenity of its access to the rock lobster resource, while fishing to their 5% allocated share.

Recreational input controls include:

- Maximum of 2 pots per licence holder (no limit on total number of licences).
- Pots must meet specific size requirements and have gaps to allow under-size rock lobsters to escape.
- Divers can only catch by hand, snare or blunt crook to prevent lobster damage.
- Fishing for rock lobsters at the Abrolhos Islands is restricted to potting.
- The season runs from 15th November to 30th June each year on the coast, with a shorter season (15th March to 30th June) at the Abrolhos Islands.
- Night-time fishing for lobsters by either diving or potting is prohibited.
- Management regulations on minimum size limits, protection of breeding females and the maximum size of females that can be taken are the same as those for commercial fishers.

Output controls in 2010/11 were applied in the form of a bag limit of 6 lobsters per person per day, a boat limit of 12 lobsters and a possession limit of 24 lobsters.

There is also a requirement for recreationally-caught lobsters to be tail-clipped in order to stop these animals from being sold illegally as part of 'shamateur' activity. For the 2010/11 season, there was a change to the use of escape gaps within the recreational fishery between North-West Cape and Cape Leeuwin. Pots were required to have escape gaps with a minimum height of 55mm, and minimum width of 305mm.

During the 2010/11 season the recreational sector took 2.6% of the total catch of the West Coast Rock Lobster Fishery.

Integrated Fisheries Management

In March 2008, through the Integrated Fisheries Management process, the Minister determined that the allocated shares of the sectors of the West Coast Rock Lobster resource would be 95% to the commercial sector, 5% to the recreational sector and one tonne to customary fishers. The 2009/10 season was the first season where these shares were formally allocated to each sector.

Research summary

Research activities focus on assessing stock sustainability, forecasting future catch and breeding stock levels. This involves fishery-dependent and independent monitoring of breeding stock levels and puerulus settlement. Industry performance is monitored through compulsory catch and effort records from both fishers and processors, comprehensive data from the voluntary logbook scheme, and a commercial monitoring program, all of which are used for modelling and stock assessment.

An environmental management strategy was developed for use in the assessment of the broader ecosystem impacts of rock lobster fishing in the context of Ecological Sustainable Development (ESD) and MSC certification. This strategy includes research into the ecosystem effects of rock lobster fishing in deep water. A second Fisheries Research and Development Corporation (FRDC) funded project to examine the effects of western rock lobster fishing on the deep-water

ecosystem off the west coast of Western Australia was started in 2009, using a comparison between fished and unfished deep water areas.

A second project examining lobster populations in fished and unfished zones is ongoing at Rottne Island. This project consists of annual sampling using pots and underwater dive surveys at Armstrong Bay and Parker Point sanctuary zones. Results from the first five years after the no-take regions were implemented have shown a slight increase in lobster numbers within the protected areas. This study also aims to provide additional information on growth, natural mortality and size/sex-specific catchability.

Concern about the status of the breeding stock in the Big Bank region resulted in this area being closed to lobster fishing. Additional independent breeding stock survey sites have been sampled in this area since 2009 to generate baseline information to assess the effects of this closure.

A risk assessment workshop to examine the low puerulus settlement was held in April 2009. The workshop focused on examining the 'likelihood' of factors that could have caused the decline in puerulus settlement. The workshop concluded that the decline in settlement could have been caused by changes in environmental conditions and productivity in the eastern Indian Ocean, or a decline in the abundance of the rock lobster breeding stock, particularly in the northern region of the fishery, or a combination of these two factors. A report on this workshop can be found on the Departments website

(http://www.fish.wa.gov.au/Documents/occasional_publications/fop071.pdf).

A significant amount of research has been focused on the cause of these low settlement levels in recent years. Six projects have been developed and funded by the Fisheries Research and Development Corporation (FRDC):

Project 1. Identifying factors affecting the low western rock lobster puerulus settlement in recent years.

Project 2. Evaluating source-sink relationships of the Western Rock Lobster Fishery using oceanographic modelling.

Project 3. Evaluating the use of novel statistical techniques for determining harvest rates and efficiency increases in the Western Rock Lobster Fishery.

Project 4. Evaluation of population genetic structure in the western rock lobster.

Project 5. Assessing possible environmental causes behind the reduced colonization of puerulus collectors by a wide suite of species.

Project 6. A joint funded project between the FRDC and the Marine National Facility - RV Southern Surveyor. Biological Oceanography of the Western Rock Lobster – Winter / Spring Dynamics.

These projects have added to the current knowledge of western rock lobster larvae and settlement and the relationships these have with the environment. They have however not specifically identified the cause of the recent declines in settlement levels, and work in this area is ongoing.

To assess the economic performance of the fishery has been funded by the Seafood CRC. This project is examining maximum economic yield assessment, in light of the recent move towards a quota management system, and ways to

incorporate the economic assessment into the outputs generated by the stock assessment model.

For the recreational component of this fishery, an annual mail-based survey of participants has been used to estimate the annual catch and effort for the past 20 years. The trends generated by these data, together with data on puerulus settlement are used to predict the recreational catch and effort in following seasons. Since 2000/01, telephone diary surveys of recreational rock lobster fishers have also been undertaken in a number of years which have been used to generate a conversion factor to scale the estimates from the annual mail surveys.

Retained Species

Commercial landings (season 2010/11):

5501 tonnes

Lobsters: Trends in the annual catches from the West Coast Rock Lobster Managed Fishery are shown in West Coast Rock Lobster Figure 1. Due to the new management changes (TACC) introduced in response to the very poor puerulus settlement in 2008/09 and subsequent years, the catch landed by the WCRLF for 2010/11 (5501 t) was less than in 2009/10 (5899 t). In 2010/11 catches in A, B and C Zones were 950, 1875 and 2676 t, respectively, with A Zone 13.9% lower, B Zone 10.5% lower and C Zone 0.9% lower than the previous season.

Octopus: Octopus are also caught in rock lobster pots, generally in shallow water (<40 m), and a catch rate of 0.02 octopus per pot lift was recorded in 2010/11 from Catch and Disposal Records data. This was within the historical range of 0.02 – 0.045 per pot lift (1985/86 to 2009/10) based on logbook data.

This catch rate translates to an estimated 45,263 octopus caught in all regions of the fishery during 2010/11. Octopus catches were estimated for A, B and C Zones as 716; 29,095; and 15,460, respectively.

The catch rate of octopus (incidental landings) is an indicator for this fishery, and at 0.02 octopus per pot lift achieved the performance measure of being no more than 10% outside of the historical range $\pm 10\%$ (0.020–0.043 octopus per pot lift).

Recreational catch estimate (season 2010/11):

150 tonnes

Since the 1986/87 season, a mail survey has been used to estimate the total catch of the recreational sector. At the end of each fishing season, approximately 10% of people licensed to fish recreationally for rock lobster have been randomly sent a survey asking about their retained catch and level of effort for the season just completed. Typically, 40 – 60% of these surveys have been returned. It has been acknowledged that this survey method suffers from a recall bias (the inability of people to remember exact details of what fishing they may have completed as long as 7.5 months prior) and due to not all survey recipients returning the survey, a non-response bias (the possibility of non-respondents being

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

Historically a conversion factor of 0.53 was used to standardise the recreational mail survey catch estimate (this was based only on a two year comparison of the different surveys). Recently an additional five seasons of data has been collected and analysed, with a new conversion factor of 0.45 calculated (Thomson et al. submitted)². This new conversion factor has now been applied to all historical total catch estimates.

The recreational catch of western rock lobster for 2010/11 was estimated at 150 t based on the adjusted mail survey, with 98 t taken by potting and 52 t by diving. This represents close to 3% of the total catch of lobsters.

Comparative catch estimates for 2009/10 were 212 t, with 147 t by potting and 65 t by diving. The estimated recreational catch in 2010/11 was therefore 29% below the 2009/10 catch estimate. This decline was predicted (Figure 7).

Fishing effort/access level

Commercial

In 2010/11 the numbers of vessels fishing for lobster were 71 in A Zone, 70 in B Zone and 138 in C Zone. Thus, in comparison to the 297 active boats in 2009/10, a fleet of 279 vessels fished in 2010/11, which was a reduction of 6%.

Under the new management arrangements (TACC) pots allowed to be used to catch rock lobsters is based on 50% of a vessel's unit entitlement. In 2010/11 the fishery recorded 2,376,794 potlifts, which was a small increase on the previous season's potlifts of 2,204,126. The slight increase is due to the changing behaviour of fishers as they slowly adapt to the new management arrangements e.g. fishing in lower catch rate periods when the beach price is higher.

Recreational

A total of 37,882 licences were issued that permitted fishing for lobsters during some part of the 2010/11 season. This is a decline in the number of licences purchased in 2009/10 (43,787). The 2010/11 season represented the first season since 1993/94 where rock lobster specific licences were required, thus only people planning to fish for rock lobsters

would purchase a licence. In 2009/10 an umbrella licence that allowed for rock lobster fishing was available.

An estimated 21,400 (57%) licences were actually used to catch lobsters in 2010/11. This was very close to the forecasted number of 22,890. Sales of licences and associated usage figures are substantially higher in years of anticipated good recruitment into the fishery, which in turn results in those years producing a relatively higher overall recreational rock lobster catch due to a combination of increased lobster abundance and higher fishing effort. The number of licences used for rock lobster fishing in 2010/11 was 18% lower than those during the previous season, i.e. 2009/10 (26,260).

The average rates of usage by active pot and diving fishers (i.e. excluding all those who held a licence but failed to use it) were 26 and 10 days, respectively during the 2010/11 fishing season. These rates were similar in the 2009/10 fishing season.

Finally, the average diary-adjusted catch taken by active pot and diving fishers were 14 and 10 lobsters, respectively during the 2010/11 fishing season. In the 2009/10 season the average number of lobsters caught by pot and dive fishers was 16 and 9, respectively.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Level 5 - Size-structured population model

Breeding stock levels: Adequate

Targeted commercial catch next season

(2011/13): 6,938 tonnes TACC³

Projected recreational catch next season

(2011/12): 80 ± 40 tonnes

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

Indices of egg production are the main indicators for assessing the health of the lobster stock. Prior to 2008/09 these were empirically-based measures presented as the north and south coast fishery-dependent breeding stock indices based on commercial monitoring data and the fishery-independent breeding stock survey (IBSS) indices. Since 2008/09 the development of a fully integrated stock-assessment model that incorporates these data sources along with other information has enabled more robust and spatially comprehensive estimates of egg production to be generated. These model-based indices are now used for assessing the health of this stock and their continued use was a key recommendation from the recent stock assessment review of the fishery completed in May 2010.

The current focus for stock assessment is to determine what effects five years of low puerulus settlements will have on

¹ Baharthah, T. 2007. Comparison of three survey methods applied to the recreational rock lobster fishery of Western Australia. Master of Science Thesis. School of Engineering and Mathematics. Edith Cowan University, Western Australia.

² Thomson, A.W., Wise, B.S., and Baharthah, T. (In review). Correcting the recall, non-response and avidity bias in a mail survey of recreational western rock lobster fishers using phone-diary surveys. Canadian Journal of Fisheries and Aquatic Science.

³ Note this TACC covers a 15 month season and does not represent an increase compared to the 2011/12 season.

future catches and breeding stock levels and to assess the effects of different management measures in mitigating any negative impacts.

The proposed management arrangements, which have been updated from the changes implemented in 2005/06, 2008/09 and 2009/10, and which include reductions in the pot usage rate, reductions in maximum size limit for females and the closure of Big Bank, have ensured that the overall breeding stock projected five years into the future will remain above the threshold levels of the early to mid 1980s with a probability greater than 75% (West Coast Rock Lobster Figures 2, 3 and 4).

A performance measure for the fishery is that the egg production index for the three zones are projected to be above their respective threshold levels (that estimated to be the early-mid 1980s levels) five years into the future with a probability greater than 75%. The fishery has therefore met this performance measure.

Catch per Unit Effort (CPUE)

A second assessment measure in this fishery is the catch per unit of effort (CPUE) achieved annually by the fishery (West Coast Rock Lobster Figure 5). With the change in management from being effort controlled to TACC based on individual catch limits in 2010/11, commercial fishing behaviour has changed dramatically. Under effort controls, fishers were driven to utilise all available effort to maximise their catches. Under a TACC fishery, fishers are driven to maximise profits through catching the most valuable grades of lobsters during the most profitable periods of the season, while using as little effort as possible. This has resulted in an increase in pot soak times and a move to fishing more in lower catch rate periods when beach prices are generally at their highest. This impacts the relativity of commercial catch rates between the pre and post TACC phases of the fishery, therefore these two periods cannot be compared directly.

Commercial

The downward trend from the 1970s to the 1980s reflects increasing effort during this period (West Coast Rock Lobster Figure 1), which automatically led to a lower CPUE. This trend was reversed in the early 1990s through a substantial management-induced reduction in effort (i.e. pot usage was reduced to 82% of the unit holding).

Typically short-term fluctuations in abundance resulting from the cyclical nature of puerulus settlement were reflected in the legal-sized lobster abundance (CPUE) 3 to 4 years later. The increase in CPUE to 1.68 kg/pot lift (around 52% higher than the previous year) for the 2008/09 fishing season, however, relates more to the significant reduction in effort levels during that season. The low TACC set for the subsequent two fishing seasons (2009/10 and 2010/11) of about half the long term average annual landing of 11 000 t successfully maintained high levels of legal biomass and high catch rates in these two seasons. It should be noted that the catch rate does not directly reflect the overall abundance of lobsters, because legal catches do not include the large biomass of under-size animals and breeding females, which are both fully protected.

Recreational

The average recreational pot and diving diary-adjusted catch rates were 0.56 and 0.95 lobsters per person per fishing day in the 2010/11 fishing season. These catch rates are very similar to the 0.66 lobsters for potting and 0.97 lobsters for diving in the 2009/10 fishing.

Juvenile Recruitment and Catch Prediction

Post-larval (puerulus) recruitment to the fishery is monitored on a lunar monthly basis. Recruitment levels are affected by fluctuations in environmental conditions such as strength of the Leeuwin Current and the frequency and intensity of low-pressure systems generating westerly winds. Annual indices of puerulus settlement for 2010/11 were at low levels at nearly all sampling sites (West Coast Rock Lobster Figure 6). This settlement was below the long-term average at all sites, although it has shown a general improvement compared with the previous four seasons. The 2010/11 settlement will start to impact on catches during the 2013/14 fishing season.

Non-Retained Species

By-catch species impact:

Low

The bycatch of finfish and other species landed during normal rock lobster fishing operations must be recorded with details provided to the Department as part of the fishers statutory catch declaration. These data show that approximately 3.5 t of bycatch were landed during the 2010/11 fishing season.

Protected species interaction:

Low

Previously, the WCRLF interacted with the Australian sea lion, *Neophoca cinerea*, resulting in the accidental drowning of an estimated small number of sea lion pups in rock lobster pots, as the pups attempted to feed on the bait or rock lobsters contained in the pots. Such incidents were restricted to shallow waters (< 20 m) and to areas within 30 km of the mainland sea lion breeding colonies on the mid-west coast.

In order to eliminate these accidental drownings, from November 15, 2006 all pots fished in waters less than 20 m within approximately 30 km of the 3 breeding colonies, i.e. just north of Freshwater Point to just south of Wedge Island, were fitted with an approved Sea Lion Exclusion Device (SLED). SLEDs have also been required to be added to all pots fishing in areas less than 20 m in depth around the Easter and Pelsaert Groups in the Abrolhos Islands since 15 March 2011. Video trials have indicated that this device does stop sea lion pups from entering lobsters pots and drowning.

Approved SLED designs include an internal rigid structure, directly under the pot neck and an external design across the top of the pot, both of which ensure that the diagonal distance from the SLED to the neck of the pot is not greater than 132 mm. Further information on the SLED management package is available at <http://www.fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biodiversity/Pages/Protected-Species.aspx>.

Monitoring of commercial pots in the SLED zone in 2007/08 – 2008/09 showed that over 95% of pots checked had an approved SLED.

The performance measure for this fishery is that no increase in the rate of capture of sea lions occurs. During the 2010/11 western rock lobster season, no sea lion captures were reported, whereas the historical level is just over three sea lions per season. The fishery has therefore met this performance measure.

Turtle deaths as a direct result of interaction with the lobster fishery are very rare. Of the 6 turtle species that occur in the waters of the western rock lobster fishery, very few are reported to interact with western rock lobster fishing gear each year. The small number of interactions were concluded to be above a negligible risk, although still rated as a low risk. Given the significant reductions in effort and hence pot ropes in the water since this assessment was completed, the current risk is probably now even lower.

The performance measure for the fishery is that there is no increase in interactions with turtles. In 2010/11, no interactions with turtles were reported. This incident rate is below the historical range of between two and five entanglements per season over the preceding five seasons. The fishery has therefore met this performance measure.

There are occasional reports of a whale becoming entangled with pot ropes. The humpback whale is the predominant species that interacts with the WCRLF, during its northward migration to the North West Shelf breeding grounds in June to August. Owing to the fishery's historical closed season, there was a limited period for interaction; however, with the increasing population of whales and the extension of the fishing season into July and August, interactions are considered likely to occur in the future, although this increase might be offset by the recent marked reduction in effort levels.

Interactions are reported by industry to the Department of Environment and Conservation (DEC) and a specialist team is used to disentangle the animal, with a very high success rate. The western rock lobster fishing industry has developed a code of practice to minimise the interaction with whales in conjunction with DEC and SeaNet. The environmental management strategy adopted for the WCRLF requires monitoring of, and attempts to, minimise accidental interaction with these species wherever practicable.

The performance measure for the fishery is that there is no increase in the rate of interactions with whales and dolphins (entanglements). Over the recorded history (1989–2009), commercial lobster fishing has resulted in zero to four whale/dolphin interactions per season. Four whale entanglements with lobster gear were recorded during the 2010/11 lobster season. The fishery has therefore met this performance measure.

Ecosystem Effects

Food chain effects:

Moderate

Overall, the fishery is unlikely to cause significant trophic ('food web') cascade effects, as the protected sub-legal-sized lobsters and breeding stock components form a relatively constant significant proportion of the biomass which remains from year-to-year, and the catch, particularly in inshore areas, is less than the annual variability in biomass due to natural recruitment cycles. However, the rock lobster-specific ecological risk assessment completed in 2008 considered that, due to the lack of information, the removal of lobster in deep-water regions might be having some level of impact on the surrounding ecosystem. This forum subsequently classed this as a moderate risk. Consequently it has become a focus of research, with preliminary work, funded by FRDC now completed and a second WAMSI/FRDC project has been initiated to expand on these preliminary findings.

Habitat effects:

Low

The legislated design of rock lobster pots, the materials they are made from and the strict control of replacement pots prevent 'ghost fishing' problems arising. A study of human impacts on the marine environments of the Abrolhos Islands estimated that potting might impact on less than 0.3% of the surface area of fragile habitat (corals) at the Abrolhos, where fishing is only allowed for 3½ months of the year. Generally, throughout the coastal fishery, rock lobster fishing occurs on sand areas around robust limestone reef habitats, covered with coralline and macro-algae such as kelp (*Ecklonia* spp.). This type of high-energy coastal habitat is regularly subjected to swell and winter storms and so is considered highly resistant to damage from rock lobster potting. The significant recent reductions in fishing effort will have reduced these risks even further.

Social Effects

Commercial

The western rock lobster fishery is an important sector of Western Australia's economy, with the commercial catch from the current reporting season valued ex-vessel at \$194 million. Employment is seasonal, the fishing season covering nine and a half months from 15 November to 31 August.

A total of 279 vessels and approximately 780 people were engaged directly in fishing for rock lobsters in 2010/11. During the year, 6 main processing establishments, located in the Perth metropolitan area (3) and Geraldton (1), Ledge Point (1) and Cervantes (1) serviced practically every location where fishing occurred.

Recreational

With around 21,400 people taking about 300,000 individual lobsters in the last season alone, this fishery represents a major recreational activity and provides a significant social benefit to the Western Australian community.

Economic Effects

Estimated annual value (to fishers) for 2010/11:

Level 5 - > \$20 million (\$194 million)

The price that commercial fishers received for the western rock lobster in 2010/11 was an estimated average of \$35.20/kg in all zones of the fishery. This was 13.5% increase on the \$31.00/kg paid in 2009/10, with the increase due partly to fishers only landing catch when the advertised beach price was high. The overall value of the fishery increased marginally from the previous season's value of \$183 million as a result of high grading of the catch and higher price paid by overseas buyers.

The bulk of the product was exported to Japan, Taiwan, Hong Kong/China, United States and some into Europe.

Fishery Governance

Commercial

Current Fishing (or Effort) Level: Acceptable

Commercial catch target (11/13): 6931 tonnes

Between 1975/76 and 2010/11 commercial catches have averaged 10,443 and ranged from 5,501 t in 2010/11 to 14,523 t in 1999/2000. The variations in catches result primarily from varying levels of recruitment, which have been largely associated with the environmental conditions experienced by western rock lobster larvae and post-larvae, and levels of fishing effort. The record low puerulus settlement in 2008/09 and poor settlement in 2009/10 followed two previous years of low levels of settlement all of which has resulted in catch limits being imposed to generate a carry-over of legal biomass rather than continuing the historical strategy of catching a similar proportion of the available stock each year. These actions were designed to ensure a carryover of lobsters into what would have otherwise been low catch years (2010/11 – 2013/14). For the 2008/09 season this involved restricting the catch to below 7,800 t which required significant effort reductions for both the whites (reduced 35% compared to the previous whites) and reds (reduced by ca. 60% compared to the previous reds) portions of the season. A different strategy was adopted for the 2009/10 and 2010/11 seasons, with catch limits set at 5,500 t \pm 10 % and 5,500 t, respectively, being used to reduce catch rather than effort reductions. The 2011/13 season is a 15 month season therefore the catch target (TACC) has been increased in proportion to what previously would have been taken at the start of following season.

Recreational

Current Fishing (or Effort) Level Acceptable

Target recreational catch limit (11/12): 290 tonnes

Between 1986/87 and 2010/11 recreational catches have varied between 104 t in 1987/88 to 400 t in 2002/03. Variation of these catches results primarily from variable levels of recruitment, which are driven by the environmental conditions as described above. From 2008/09 onwards the commercial and recreational sectors have been managed under the principles of Integrated Fisheries management (IFM), which allocates the commercial and recreational

sectors 95% and 5% of the total catch, respectively. Under this arrangement the limit for the recreational catch for 2010/11 based on a commercial catch of 5501 t was 290 t.

The recreational catch estimate for the 2010/11 season was 150 \pm 25 t (95% confidence interval of the mean) which was well below their limit catch of 290 t.

New management initiatives (2011/12)

To move the Fishery to a full ITQ in 2013 and to accommodate the change in licensing period (proposed to commence in January 2013), the 2011/12 season will commence on November 2011 and extend through to January 2013, although fishing will not be permitted between 1st October 2012 and 14th November 2012 (note: the fishing season for Zone A [Abrolhos Islands] commences on 15 March 2012 and will finish on 30 September 2012). As a consequence the 2011/12 season will be referred to as the 2011/13 season.

The change to the licensing period from November/September to January/January is being made to allow fishers to commence their "quota season" during the higher value "reds" part of the season and finish fishing during the lower value, but highly catchable "whites" part of the season. To allow for the extended fishing season (and the inclusion of an extra "whites" period), the previously announced TACC of 5,500 tonnes will be increased to 6,938 tonnes for the 2011-13 season.

The management arrangements for the 2011/13 season will also provide increased flexibility by allowing permanent and temporary transfers of units of entitlement within the fishing season (not permitted during the 2010/11 season).

The use of the Department's Integrated Voice Recognition (IVR) catch monitoring system will be mandatory from the 15th November 2011. IVR will record pre fishing, pre landing and post landing (including the landed catch) nominations which will assist in maintaining the compliance integrity of the quota system. Fishers will need to use IVR to record their fishing activity as of the start of the 2011/13 season.

External Factors

The variations in western rock lobster catches both commercially and recreationally are largely a result of variable levels of puerulus settlement due to changes in the Southern Oscillation (El Niño or La Niña events in the Pacific Ocean) and their effect on the Leeuwin Current. A positive relationship exists between Leeuwin Current strength and levels of puerulus settlement. The southward-flowing Leeuwin Current also affects the spatial distribution of puerulus settlement along the coast. Catches are also dependent upon the environmental conditions at the time of fishing.

The 2010/11 settlement levels were a slight improvement on 2009/10 however this is still below the long-term average. The factors that may be contributing to this low settlement are being examined (see Research Summary).

Towards the end of 2010, evidence began to emerge of unusually warm waters flooding along the Western Australian coastline. By February 2011 it was clear that a significant warming event was taking place, with widespread

WEST COAST BIOREGION

reports of fish kills and tropical species being found further south than their normal range. Both large-scale satellite-derived sea-surface temperatures and local temperature logger measurements showed that temperatures were $>3^{\circ}\text{C}$ above the normal summer averages in some regions. The term “marine heat wave” was coined to describe the unprecedented nature of the spatially and temporally extensive event.

Increases in sea-water temperatures over the last 30-40 years, which may be related to climate change, appear to be affecting some of the biological parameters such as size at

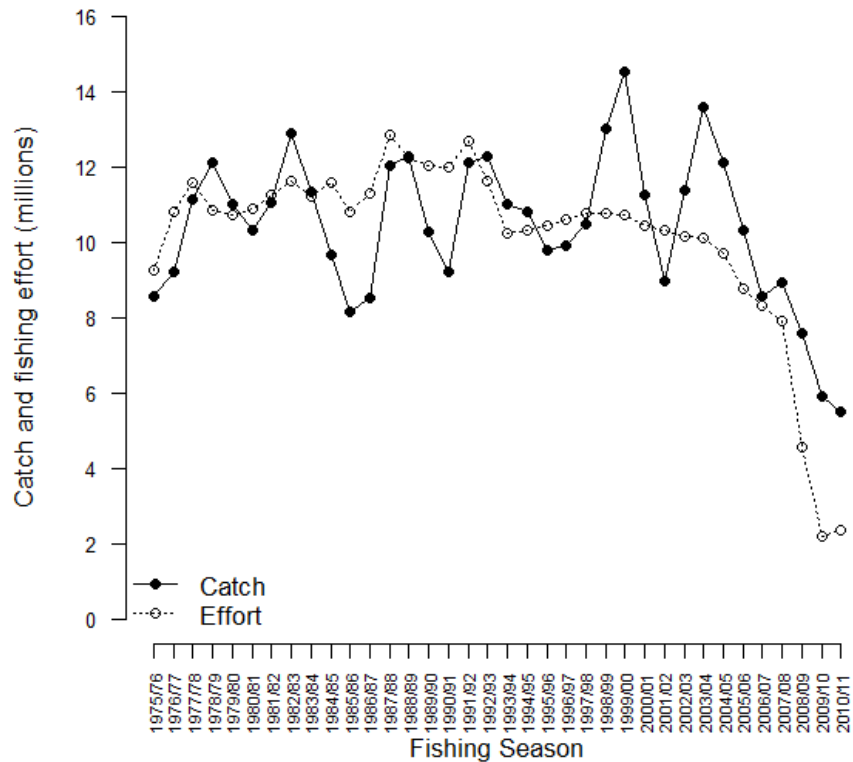
maturity and size of migrating lobsters. These changes are being taken into account in the stock assessment model and therefore in the future stock assessment of the fishery. An FRDC project examining climate change effects on fisheries will continue work in this area.

The economic performance of the fishery is being strongly affected by the value of the Australian dollar (affecting the price of lobsters), fuel and labour costs as well as the changes to the management of the fishery including the introduction of individual catch limits.

WEST COAST ROCK LOBSTER TABLE 1

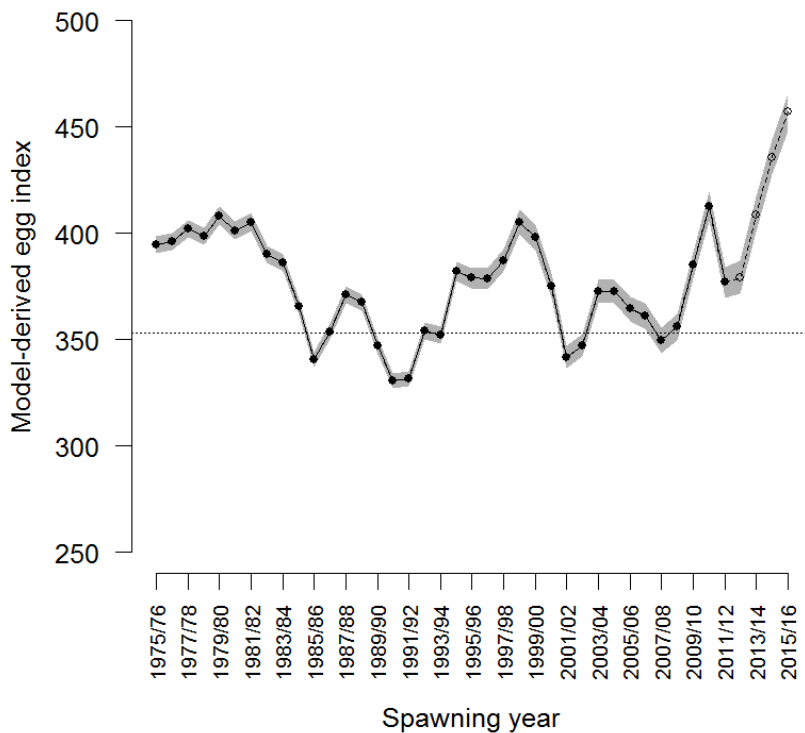
Landings (kg) of by-catch in lobster pots recorded in compulsory Catch and Effort monthly returns (CAES) during 2010/11.

Bycatch Species	Catch (kg)
Bugs	121.8
Cod	33.5
Cod, Breaksea	126.4
Cod, Chinaman	28.7
Crab, Champagne (Spiny)	99
Cuttlefish	225.3
Emperor, Spangled	6.5
Emperor, Sweetlip	29.5
Groper, Baldchin	1140.8
Groper, Blue	267.4
West Australian Dhufish	201.2
Leather Jacket	56
Other Fish Varieties	375
Parrot Fish	6
Rock Lobster, Southern	220.3
Shark, Wobbegong	16
Snapper, Pink	636.3
Snapper, Queen	2
Trevally, Other (Skippy)	0.7
Trout, Coral	4
Grand Total	3596.4



WEST COAST ROCK LOBSTER FIGURE 1

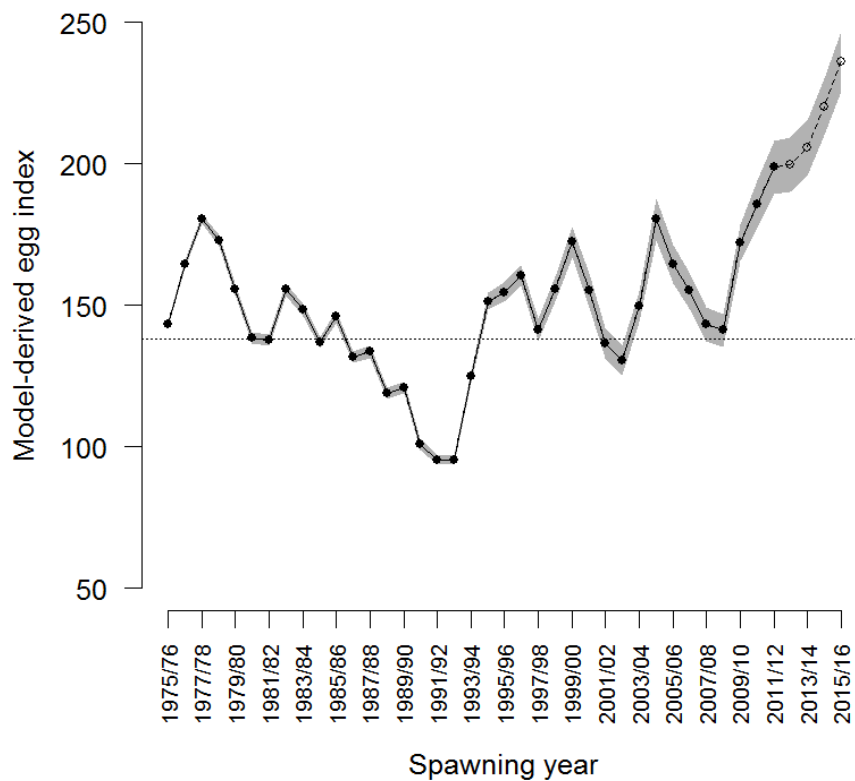
Annual catch (millions of kg) and nominal fishing effort (millions of pot lifts) from fishers' compulsory monthly returns for the West Coast Rock Lobster Managed Fishery from 1975/76 to 2010/11.



WEST COAST ROCK LOBSTER FIGURE 2

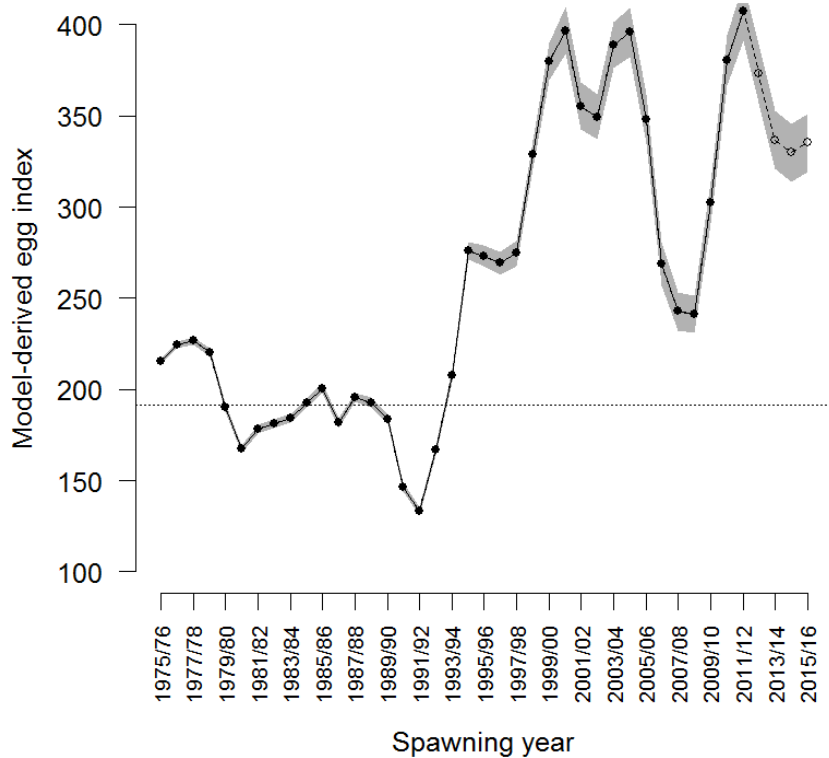
Mean (solid and dashed lines represent historic and future levels) and 50% confidence region (in grey) of model-derived egg production index for the Abrolhos zone of the fishery (A zone). The horizontal dotted line represents the 1980's threshold.

WEST COAST BIOREGION



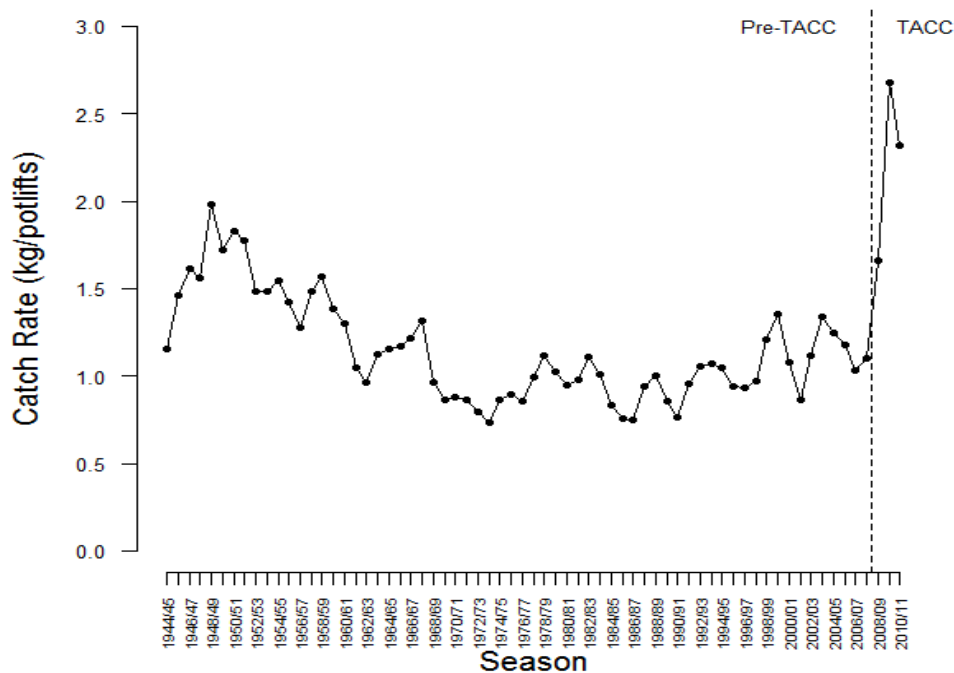
WEST COAST ROCK LOBSTER FIGURE 3

Mean (solid and dashed lines represent historic and future levels) and 50% confidence region (in grey) of model-derived egg production index for the northern coastal zone of the fishery (B zone). The horizontal dotted line represents the 1980's threshold.



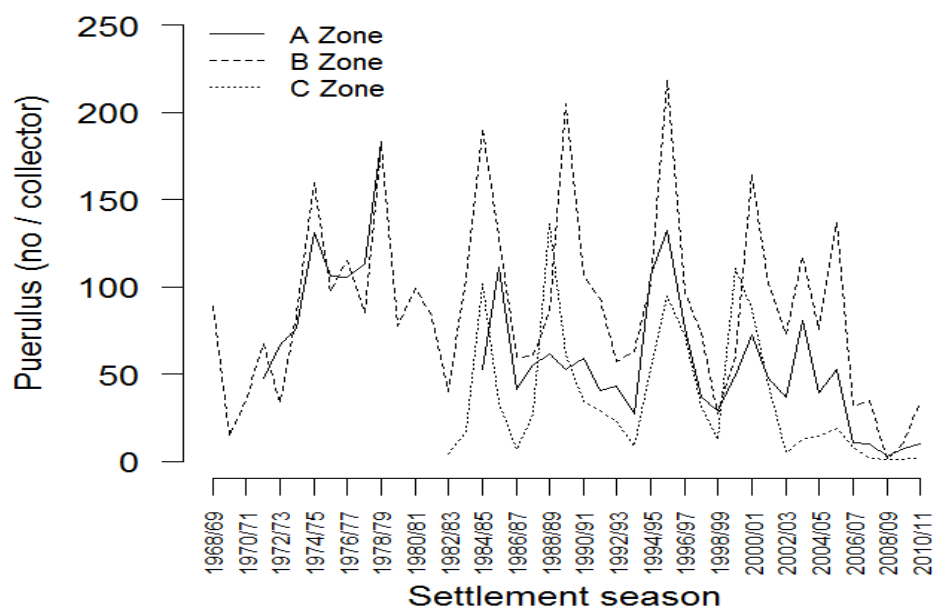
WEST COAST ROCK LOBSTER FIGURE 4

Mean (solid and dashed lines represent historic and future levels) and 50% confidence region (in grey) of model-derived egg production index for the southern coastal zone of the fishery (C zone). The horizontal dotted line represents the 1980's threshold.



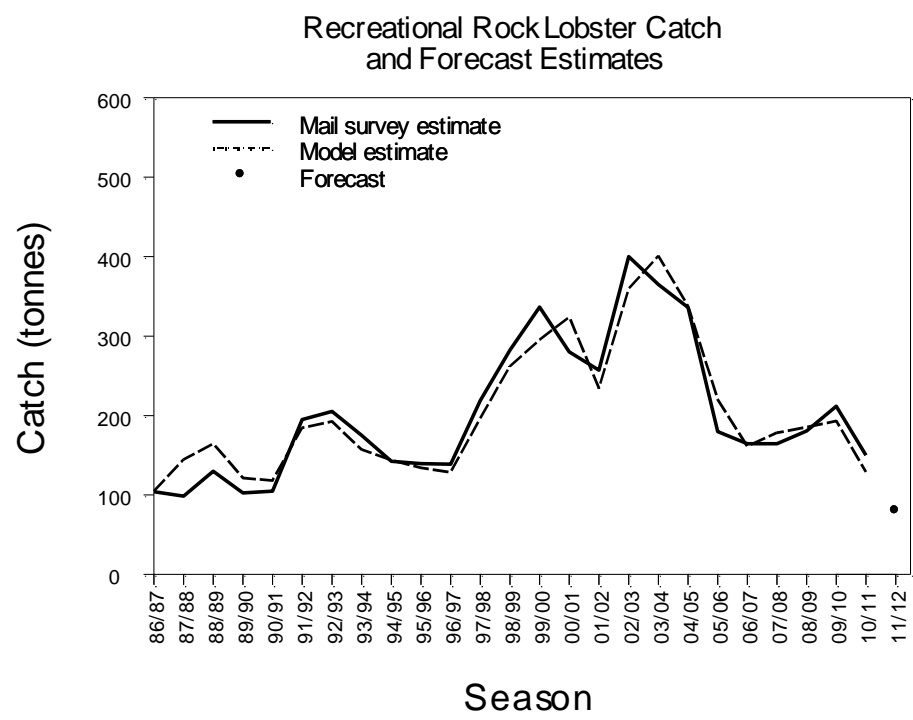
WEST COAST ROCK LOBSTER FIGURE 5

Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2010/11, showing the period prior to and after the implementation of Total Allowable Commercial Catches (TACC).



WEST COAST ROCK LOBSTER FIGURE 6

Annual indices of puerulus settlement from 1968/69 to 2010/11 for A (Abrolhos, solid line), B (Seven Mile Beach, dashed line) and C (Alkimos, dotted line) zones.



WEST COST ROCK LOBSTER FIGURE 7

Estimates of the recreational rock lobster catch since 1986/87 using adjusted mail survey results, and model estimates of catches in 2008/09 based on puerulus settlement 3 to 4 years earlier and expected licence usage.

Roe's Abalone Fishery Status Report

A. Hart, J. Brown, F. Fabris and A. Warnbrunn

Main Features			
Status		Current Landings	
Stock level	Adequate	Commercial Catch	
		West Coast	36 t
		Other	46 t
Fishing level	Acceptable	Recreational Catch	
		West Coast	22 t
		Other	14 t

Fishery Description

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

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

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

Governing legislation/fishing authority

Commercial

Abalone Management Plan 1992

Abalone Managed Fishery Licence

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

Recreational

Recreational Abalone Fishing Licence

Consultation process

Commercial

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

Recreational

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

Boundaries

Commercial

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

Recreational

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

Management arrangements

Commercial

The commercial Roe's abalone fishery is managed primarily through output controls in the form of total allowable commercial catches (TACCs), set annually for each area and allocated to license holders as individual transferable quotas (ITQs).

The overall TACC for 2011 was 92.8 t whole weight (note this small species is generally landed in the whole condition). This was 9 t lower than 2010 due to the closure of the Area 8 fishery as a result of catastrophic mortalities resulting from exceptionally high water temperatures in early 2011¹. The TACC is administered through 25,180 ITQ units, with a minimum unit holding of 800 units generally applying, although some Roe's abalone licences are permitted to operate below this minimum in recognition of historical fishing practices.

The licensing period (fishing year) runs from 1 April to 31 March of the following year.

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

WEST COAST BIOREGION

The legal minimum length for Roe's abalone is 60 mm shell length in most parts of the fishery. However, industry initiated commercial minimum length for Area 1 (WA/South Australia border to Point Culver) and Area 7 (Cape Bouvard to Moore River) of 70 mm are applied.

A comprehensive Ecologically Sustainable Development assessment of the commercial fishery has been undertaken to identify any potential sustainability risks requiring direct management under the Commonwealth's EPBC Act requirements for export fisheries. The only issue identified as requiring ongoing management to ensure acceptable performance was the breeding stock levels of Roe's abalone. Boxed text in this status report provides the annual assessment of performance for this issue.

Recreational

The recreational Roe's abalone fishery is managed under a mix of input and output controls. Recreational fishers must purchase a dedicated abalone recreational fishing licence. These licences are not restricted in number. The West Coast zone (Perth) of the recreational fishery is managed to an average total allowable recreational catch (TARC) of 40 t.

The fishing season in the Northern and Southern Zones extends from 1 October to 15 May. However, the Northern Zone was closed to fishing for 2011 due to large-scale stock mortalities resulting from exceptionally high water temperatures in early 2011¹. The West Coast Zone is only open for 5 Sundays annually, commencing on the first Sunday in November, followed by the first Sunday of each month until March. This was changed from the previous arrangement of 5 consecutive Sundays from the first Sunday in November. The daily allowed fishing time is 60 minutes (between 7.00 a.m. and 8.00 a.m.). Prior to 2006, daily fishing time was 90 minutes.

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

For Roe's abalone, the minimum legal size is 60 mm shell length, the daily bag limit is 20 per fisher, and the household possession limit (the maximum number that may be stored at a person's permanent place of residence) is 80.

Research summary

Commercial

Commercial abalone divers provide daily catch information on the total weight of abalone collected, the hours fished, the date and location of harvest and the name of the person(s) harvesting. These data are used to assist in research, compliance and management matters.

The main abundance index is an annual standardized catch per unit effort (CPUE) model that takes into account diver, sub-area and month of fishing, as well as technological improvements that aid fishing efficiency. The standardized

CPUE data are used in a decision-rule framework for quota setting for each area of the fishery.

Current research is focused on stock assessment using catch and effort statistics, fishery-independent surveys of Perth metropolitan stocks, and digital video imagery (DVI) surveys by industry divers, who survey selected sites with an underwater video camera. Size and density of Roe's abalone across the near-shore sub-tidal reef habitat is measured annually at 13 indicator sites between Mindarie Keys and Penguin Island. Eleven of these are fished while the other 2 are the Waterman's Reserve Marine Protected Area (MPA), and the Cottesloe Fish Habitat Protection Area (FHPA).

Research translocation trials with funding assistance from the Seafood CRC are underway to see whether they can assist the recovery of abalone stocks in the Kalbarri region affected by the marine heatwave in 2011.

Recreational

Current annual recreational catch and effort estimates are derived from an annual field survey (West Coast Zone / Perth metropolitan fishery), and occasional telephone diary surveys covering all licence holders in the state (last completed in 2007).

The field survey estimates the catch and effort from each distinct Roe's abalone stock within the Perth fishery, and estimates are based on average catch (weight and numbers), catch rates (derived from 800 interviews in 2011), and fisher counts conducted by Fisheries Volunteers and research personnel from shoreline vantage points and aerial surveys. This method provides a comprehensive assessment, but is too resource-intensive to be applied routinely outside of the Perth metropolitan area.

The telephone diary survey estimates the catch of all 3 species on a state-wide basis. In 2007, around 500 licence holders were randomly selected from the licensing database, with selection stratified by licence type (abalone or umbrella-which was available at that time) and respondent location (country or Perth metropolitan area). The licence holders were sent a diary to record their fishing activity and were contacted every 3 months by telephone for the duration of the abalone season, or at the end of the season for those only involved in the Perth abalone season.

Research is progressing on an in-season catch prediction model based on environmental conditions, for the Perth metropolitan fishery. This model will assist the Department in managing a summer season for the fishery should this option be adopted in the future.

Retained Species

Commercial production

Season 2011: 82 tonnes whole weight

Metro only: 36 tonnes whole weight

The TACC for the 2011 quota year was 92.8 t whole weight for Roe's abalone. The 2011 catch of 81.6 t whole weight (Roe's Abalone Table 1) was 10 tonnes lower than 2010 and about 90% of the TACC. The overall TACC was not caught because Area 1 and Area 8 of the fishery (Roe's Abalone Figure 1) were not fished in 2011, and catches in Area 5 were below the TACC (75% of TACC caught) due to unfavourable weather.

¹ Pearce et al., (2011). The marine heatwave off Western Australia during the summer of 2010/11. *Fisheries Research Report No. 222. Department of Fisheries, Western Australia.* 40pp.

Recreational catch**Season 2011:** Roe's Metro Fishery 22 tonnes**(Season 2007):** Roe's rest of state 14 tonnes
(31% of total catch)

The recreational catch for Roe's abalone from the Perth metropolitan area in 2011 was 22.4 t (Roe's Abalone Table 2). This was a decrease of about 50% from 2010, and occurred as a result of poor weather conditions, small average weight of the abalone, and low legal-size densities (Roe's abalone Table 4).

Based on the Perth recreational fishery for 2011 (22 t), and using the 2007 phone diary estimate for the rest of the state (14 t), recreational fishing represented about 31% of the total (commercial and recreational) Roe's abalone catch (118 t) across the state in 2011.

Fishing effort/access level**Commercial**

Total effort for dedicated Roe's abalone divers in 2011 was 426 diver days, lower than last year's effort of 567 diver days (Roe's Abalone Table 1). The low effort in 2011 resulted from a combination of lower quota being set, closures to the Area 8 fishery (which traditionally required between 100 and 150 days) and improved fishing efficiency. For example, the use of Internet weather prediction services to plan the fishing schedule has resulted in fishing efficiency increases of between 10 and 17%.¹

Recreational

For the 2011 season, 17,300 licences were issued allowing abalone fishing (Roe's Abalone Figure 3). This was the first year in which only abalone specific licenses were available to those wishing to fish for abalone. Umbrella recreational licenses, which allow for the catch of multiple species, have been phased out (Roe's Abalone Figure 3).

Effort in the Perth fishery for 2011 was 11,396 hours, a 40 % reduction from 2010 effort of 18,010 hours (Roe's Abalone Table 2) and the lowest in over 10 years. This was primarily due to poor weather conditions and unfamiliarity with the new summer season for 2011. The new summer season was part of ongoing adjustments in management as part of the IFM process. Since 2006, daily season length has been shortened from 1.5 hours to 1 hour, and number of fishing days from 6 to 5. The new monthly Sunday fishing day coincided with high tide on most Sundays this year which contributed to the lower catch rate and effort.

Effort estimates for recreational abalone fishing from the 2007 telephone diary survey were 13,400 days (10,500 – 16,200 days) in the Perth metropolitan area, 6,300 days (3,800 – 8,800 days) on the west coast (excluding the Perth metropolitan area), and 4,900 days (1,700 – 8,000 days) on the south coast (Roe's Abalone Table 3).

Stock Assessment**Assessment complete:** Yes**Assessment level and method:****Level 4 - Catch Rates / Direct Survey****Breeding stock levels:** Adequate

CPUE and TACC assessment: The standardised CPUE (SCPUE) for the Roe's abalone fishery is the main performance indicator for the abundance of legal-sized abalone. This indicator replaces the raw CPUE data used historically, however the raw CPUE data has been provided for comparative purposes.

The SCPUE for dedicated Roe's abalone divers in 2011 was 30.7 kg/hr, which was slightly higher than the 2010 catch rate (Roe's Abalone Table 1). This suggests that, overall, stocks are slightly above average levels. The exception is Area 8 commercial (Northern Region for recreational), which has been closed to all fishing to promote stock recovery following an environmentally induced mass mortality².

The catch rate of recreational fishers in the Perth metropolitan fishery of 23 abalone/hour in 2011 was lower than the 2010 catch rate of 26 abalone per hour (Roe's Abalone Table 2).

Stock surveys: Densities of sub-legal animals (less than 60mm in size) on the platform habitat of the fished stocks in 2012 were 49 abalone m⁻², similar to 2011 (Roe's Abalone Table 4). Sub-legal animals are at high levels compared to the historical average of 44 m⁻². Within the subtidal habitat, densities of sub-legal animals were similar between 2011 and 2012, and are also at their highest density since 1997.

Densities of legal-sized animals (60+ mm) on the platform habitat were significantly lower in 2012 (9 m⁻²), compared to 11 m⁻² in 2011 (Roe's Abalone Table 4), and are at their lowest levels since 1997. With the significant decline in recreational catch in 2011, legal-size densities were expected to recover towards historical levels, however there has also been a sharp decline in legal size densities in the Marine Protected Area, which were at their lowest levels in over 15 years (Roe's Abalone Table 4). This suggests there may have been environmentally related mortalities in this habitat.

In the subtidal habitat, legal-sized densities were 10 abalone m⁻² in 2010, which is close to their long-term average (Roe's Abalone Table 4).

Densities of legal-sized Roe's abalone in the MPA are about 60% higher on the platform habitat, compared with the fished stocks (Roe's Abalone Table 4). For sub-legal animals, densities are only about 12% higher in the MPA stocks (Roe's Abalone Table 4). Declines in legal size densities have however, occurred in both the MPA (55%) and fished stocks (44%) since 2009 (Roe's abalone Table 4). This is indicative of environmentally related mortality, possibly the "marine heatwave" experienced in over the 2010/11 summer.

¹ Hart AM, Fabris F, Caputi N (2009). Performance indicators, biological reference points and decision rules for Western Australian abalone fisheries (*Haliotis* sp.): (1) Standardised catch per unit effort. Fisheries Research Report No. 185. Department of Fisheries, Western Australia. 32p.

² See 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. for full details.

WEST COAST BIOREGION

Breeding stocks: Size at sexual maturity (50% of animals mature) of Roe's abalone in the Perth metropolitan area is approximately 40 mm (2 to 3 years of age). Preliminary growth data for these same metropolitan Roe's abalone indicate that they have a minimum of 1 year's spawning before reaching 60 mm – the minimum legal size at which Roe's abalone are harvested anywhere in Western Australia.

This is considered to provide adequate protection for the breeding stock under normal environmental conditions, especially since the commercial fishery's legal minimum size in Area 7 (the Perth metropolitan area) is 70 mm – which is 10 mm larger than that used by the recreational sector. In Area 1, the commercial fishery's legal minimum length is 75 mm.

The main performance measure for the fishery relates to the maintenance of adequate breeding stocks in each area of the fishery.

This is assessed using a combination of the level of quota achieved and the effort required to achieve the quota, both of which reflect stock abundance. In 2011, catch and standardised CPUE were within the agreed ranges in most areas fished, indicating that overall breeding stock levels were adequate (Roe's Abalone Table 5). Adverse weather conditions limited the fishing in the remote Area 1 and, to a lesser extent, in Area 5 (75% of TAC caught). In Area 8 the fishery has been closed due to environmentally related mortality.

Non-Retained Species

Bycatch species impact: Negligible

Divers have the ability to target abalone of choice (species, sizes and quality of abalone) and do not inadvertently harvest bycatch in their normal fishing activities.

Protected species interaction: Negligible

The only potential protected species interaction in this fishery would be with the white shark (*Carcharodon carcharias*) while fishing in some of the more open-water locations. Some Roe's abalone divers are adopting the 'shark shield' technology generally used by greenlip/brownlip divers for their personal protection.

Ecosystem Effects

Food chain effects: Negligible

Commercial abalone diving occurs over a small proportion of the total abalone habitat of the Western Australian coastline. In view of the relatively low exploitation rates and consequent maintenance of a high proportion of the natural biomass of abalone, it is considered unlikely that the fishery has any significant effect on the food chain in the region.

Habitat effects: Negligible

The fishing activity makes minimal contact with the habitat, which typically consists of hard rock surfaces in a high wave energy environment. As abalone feed on drift algae, their

removal is unlikely to result in any changes to the algal growth cover in areas fished.

Social Effects

There are 26 vessels commercially fishing for Roe's abalone, employing approximately 50 people across WA. The dispersed nature of the Roe's abalone fishery means that small coastal towns from Kalbarri to Eucla receive income from the activity of divers.

The recreational fishery provides a major social benefit to those sectors of the community that appreciate the abalone as a delicacy, and 17,300 licenses were issued that would have allowed fishers to participate in the recreational abalone fishery (Roe's Abalone Figure 3).

Economic Effects

Estimated annual value (to fishers) for 2011:

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

The estimated average price for Roe's abalone in 2011 was \$26.00/kg. This value was similar to the value of \$25/kg in 2010. On the basis of the average price, the fishery was worth approximately \$2.1 million. Overall, the price of Roe's abalone has dropped by over 50% since 2000, when it was \$55/kg whole weight. This is due to the value of the Australian dollar, which increased from \$US0.6 in 2000 to >US\$1.00 in 2011. The other factor in the decline in prices is competition from abalone produced by aquaculture.

Fishery Governance

**Commercial
Target SCPUE range:**

28 – 33 kg per hour (all areas combined)

Target effort range: **530 – 640 diver days**

To assess whether the catch quota set is appropriate (sustainable) relative to the stock available, Roe's abalone catches should be taken within the range of SCPUE recorded over the 1999 – 2006 fishing years (28 – 33 kg per hour; Roes Abalone Table 1). This range reflects the acceptable variation in catch rates due to weather and recruitment cycles. Roes Abalone Table 5 shows performance measures of each individual area.

The effort value of 426 diver days in 2011 (Roes Abalone Table 1) falls below the expected effort range. This was due primarily to the closing of Area 8, which generally required about 100-150 days fishing, and lowered effort in Area 5 and Area 1 because of weather conditions.

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

5 year moving average - 40 ± 2 tonnes

The governance range is based on the 5 year moving average of catch in the West Coast Fishery. This range takes in the permitted maximum variations of ± 2t around the TARC (Total Allowable Recreational Catch) of 40 t.

The 5-year (2007-2011) moving average for 2011 was 38.7 t. This was within the governance range.

New management initiatives (2011/12)

The first trial of a summer season for the West Coast Zone of the recreational fishery was undertaken for the 2011/12 summer. The season began on the first Sunday of November 2011 and extended till the first Sunday of March 2012, with fishing taking place between 7 and 8 am on the first Sunday of each month. The trial will continue for another 2 years.

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

External Factors

During the summer of 2010/2011, the West Coast experienced a marine heatwave with sea surface temperatures of up to 3 degrees above average¹. This was widespread with fish kills being recorded across many fish species, however the Area 8 Roe's abalone fishery, particularly in the area around Kalbarri, were the most severely impacted. Mortalities on roe's abalone were estimate at 99.9%+ and a complete closure of the commercial and recreational fisheries was implemented. Research translocation trials are underway to see whether they can assist the recovery.

Apart from that the main external factor influencing the Roe's commercial abalone fishery has been the decline in beach price and overall economic value over the last decade. The small size of Roe's abalone means that, as a fishery product, it is in direct competition with small hatchery-produced greenlip abalone. In the recreational fishery, weather conditions have a significant effect on catch rates and total catch of recreational fishers.

WEST COAST BIOREGION

ROE'S ABALONE TABLE 1

Roe's abalone catch and effort¹ by quota period with raw and standardised catch per unit effort (SCPUE)

Quota period ²	Roe's TACC kg whole weight ³	Roe's caught kg whole weight	Diver days ⁴ (Roe's divers only)	Raw CPUE (roei divers) kg per day)	SCPUE (kg per hour)
1990	105,000	116,447	936	112	
1991	101,000	109,489	832	118	
1992	105,000	111,341	735	134	27.3
1993	128,000	115,281	832	123	29.4
1994	125,960	117,835	908	113	27.7
1995	125,960	114,501	1,047	98	25.5
1996	125,960	118,715	1,004	106	28.8
1997	126,790	118,738	855	120	30.2
1998	93,960 ⁵	86,425	695	108	27.9
1999 ⁶	119,900	112,949	659	149	29.5
2000	115,900	107,735	647	144	28.7
2001	107,900	99,174	685	126	30.0
2002	107,900	100,471	700	125	28.6
2003	110,900	96,005	723	118	29.0
2004	110,900	107,593	736	126	28.0
2005	112,700	96,496	672	131	31.3
2006	112,700	98,370	625	136	33.2
2007	109,700	90,750	585	132	28.5
2008	106,700	93,197	580	133	28.6
2009	101,800	92,838	554	140	29.0
2010	101,800	91,418	567	134	29.5
2011	92,800	81,607	426	157	30.7

Notes

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

ROE'S ABALONE TABLE 2

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

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

ROE'S ABALONE TABLE 3

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

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

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

ROE'S ABALONE TABLE 4

Mean densities (abalone/m²) of sub-legal (<60 mm shell length) and legal-sized Roe's abalone (60 mm and over) from 11 monitoring sites (fished stocks) and the Marine Protected Area (MPA) in the Perth fishery. The platform habitat is primarily the recreational fishery, while the sub-tidal habitat is primarily the commercial fishery. Data has been standardised by a GLM (Generalized Linear Models) analysis, as the sites are not the same for all years.

Year	Platform habitat				Sub-tidal habitat			
	Fished stocks		Waterman's Reserve (MPA)		Fished stocks		Waterman's Reserve (MPA)	
	<60	60+	<60	60+	<60	60+	<60	60+
1997	40	29	44	26	4.9	14.0	9.2	21
1998	49	28	51	37	5.3	11.3	13.5	37
1999	55	29	52	26	4.3	6.9	12.0	27
2000	52	25	29	35	2.9	9.9	8.6	31
2001	51	26	38	34	4.2	10.1	7.8	28
2002	42	29	42	39	3.5	9.8	6.9	31
2003	33	27	34	41	5.0	11.2	4.1	25
2004	34	21	33	53	3.9	9.0	4.5	20
2005	35	19	43	40	5.2	8.7	8.7	22
2006	36	19	49	38	6.8	9.5	5.7	20
2007	39	17	42	35	5.3	11.0	6.7	19
2008	42	18	69	37	6.7	12.3	7.3	19
2009	51	16	67	38	8.7	12.0	10.8	24
2010	53	14	77	32	11.8	13.3	8.4	23
2011	51	11	66	26	9.8	12.2	6.4	22
2012	49	9	62	17	10.2	10.3	8.8	23

ROE'S ABALONE TABLE 5

Assessment against agreed performance measures for 2011.

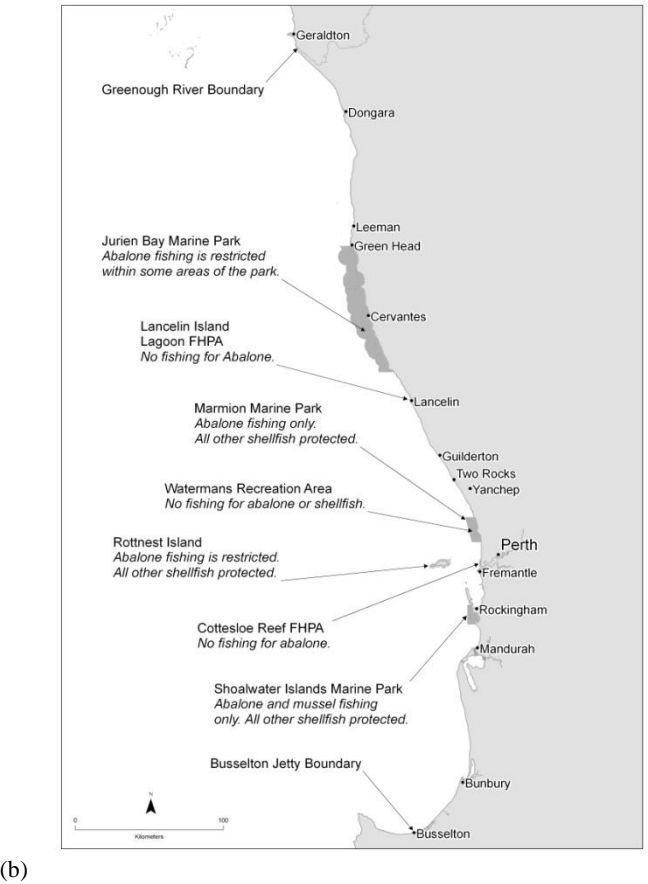
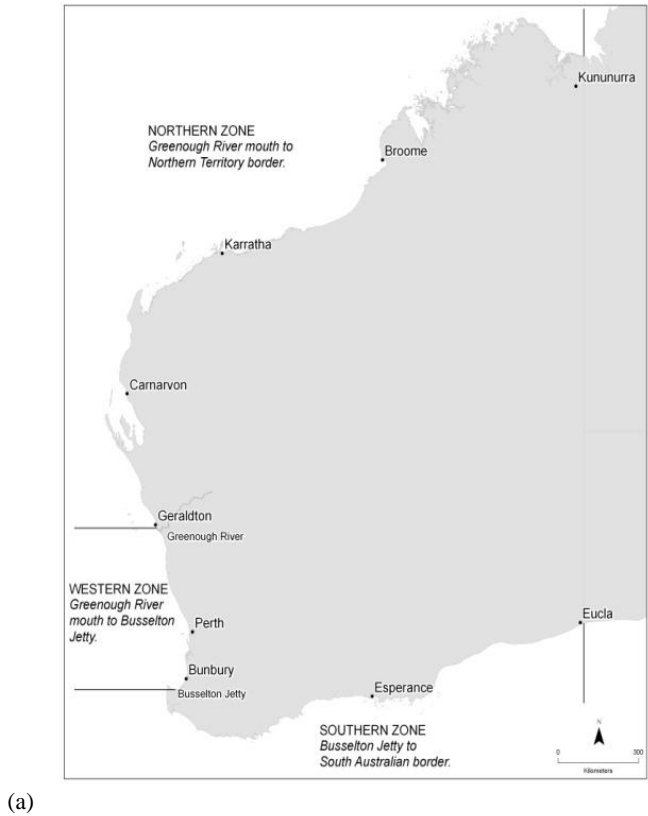
Performance Indicator	Performance Measure ¹	2011 Values	Assessment/Comments
<i>Area 1</i>			
Total catch (TACC)	5,000 kg	0	Exploratory quota – no fishing in 2011.
Effort range (Diver days)	14 – 43	0	See above.
<i>Area 2</i>			
Total catch (TACC)	19,800 kg	19,092	Met – 97% of quota caught.
Standardised CPUE	20 – 31	27	Met – within agreed ranges.
<i>Area 5</i>			
Total catch (TACC)	20,000kg	14,785	Not Met – 75% of quota caught.
Standardised CPUE	18 – 27	25	Met – within agreed ranges.
<i>Area 6</i>			
Total catch (TACC)	12,000 kg	12,005	Met – 100% of quota caught.
Standardised CPUE	18 – 26	24	Met – within agreed ranges.
<i>Area 7</i>			
Total catch (TACC)	36,000 kg	35,726	Met – 100% of quota caught.
Standardised CPUE	28 – 42	37	Met – within agreed ranges.
<i>Area 8</i>			
Total catch (TACC)	9,000 kg		Not assessed – fishery closed.
Standardised CPUE	16 – 24		Not assessed – fishery closed.

1. With the exception of Area 1, the standardised CPUE (SCPUE) performance measure replaces the effort ranges (in diver days) used in previous state of the fisheries reports. The range in SCPUE represents the Target (upper) and Limit (lower) biological reference points as developed in the following document. Hart A, Fabris F, Caputi N (2009). Performance indicators, biological reference points and decision rules for Western Australian abalone fisheries (*Haliotis* sp.): (1) Standardised catch per unit effort. Fisheries Research Report No. 185. Department of Fisheries, Western Australia. 32p.



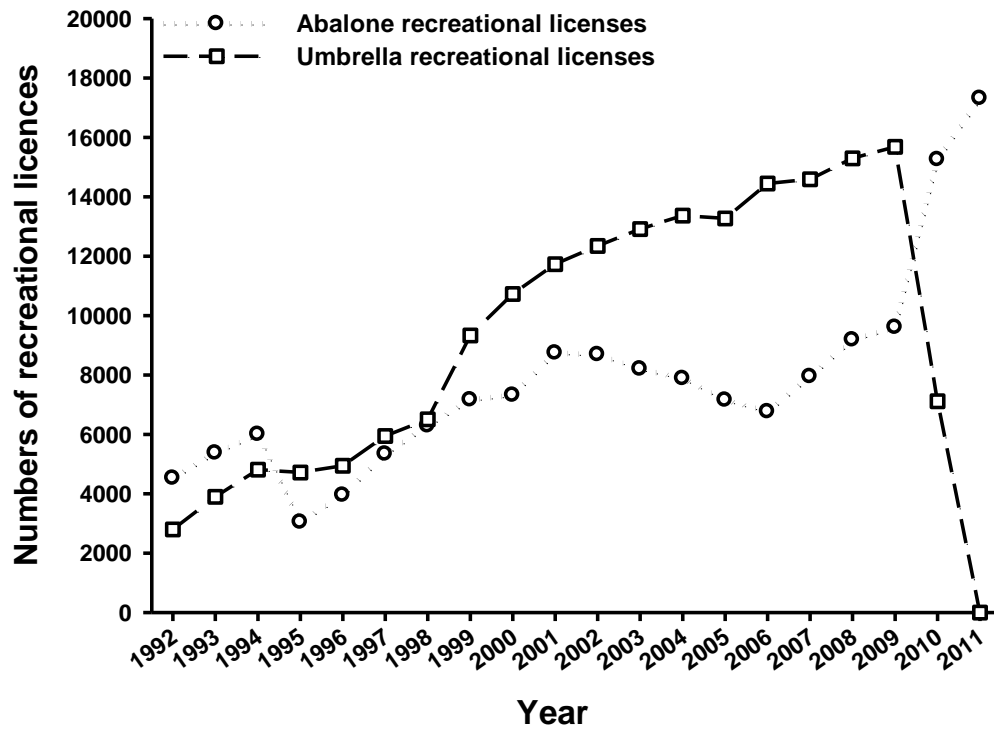
ROE'S ABALONE FIGURE 1

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



ROE'S ABALONE FIGURE 2

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



ROE'S ABALONE FIGURE 3

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

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

E. Sporer, M. Kangas, S. Brown, L. Pickles

Main Features

Status		Current Landings	
Stock level	Adequate	AIMWTMF:	Scallops 2203 t (whole weight)
		SWTMF:	Scallops 82 t (whole weight)
Fishing level	Acceptable		Prawns 13 t
		SCTF:	Scallops 176 t (whole weight)

Fishery Description

The Abrolhos Islands and Mid West Trawl Managed Fishery (AIMWTMF) is based on the take of saucer scallops (*Amusium balloti*), with a small component targeting the western king prawn (*Penaeus latisulcatus*) in the Port Gregory area.

The South West Trawl Managed Fishery (SWTMF) includes two of the State's smaller scallop fishing grounds – Fremantle and north of Geographe Bay. It is a multi-species fishery.

The South Coast Trawl Fishery (SCTF) principally targets scallops (*A. balloti*) and associated by-products, although in years of low scallop catches licensees may use other trawl gear to target fin-fish species. Scallop landings for the fishery have varied dramatically over the years, depending primarily on the strength of recruitment. While the boundaries of the fishery covers a large section of the south coast, the operations of the fleet are effectively restricted to very small areas of higher scallop abundance.

Each of these fisheries operates using low opening otter trawl systems.

Governing legislation/ fishing authority

Abrolhos Islands and Mid West Trawl Management Plan 1993

Abrolhos Islands and Mid West Trawl Managed Fishery Licence

South West Trawl Management Plan 1989

South West Trawl Managed Fishery Licence

Trawling Prohibition (Whole of State) Notice 1992 (Order)

Surface Trawl Net Fishery (South Coast) Notice 1992

Trawling for Scallops (South Coast) Notice 1992

Condition 73 and/or 79 on Fishing Boat Licences

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

Consultation process

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

Boundaries

AIMWTMF

'all the waters of the Indian Ocean adjacent to Western Australia between 27°51' south latitude and 29°03' south latitude on the landward side of the 200 m isobath'.

SWTMF

'all the waters of the Indian Ocean adjacent to Western Australia between 31°43.38'27" south latitude and 115°08.08' east longitude where it intersects the high water mark at Cape Leeuwin, and on the landward side of the 200 m isobath'.

The area is further divided into four management zones, with a limited number of operators (indicated in brackets) permitted access to fish within each zone as follows:

Zone A	from 31°43'27" S to 32°16' S	(3 MFL's)
Zone B	from 32°16' S to 115°08' E	(12 MFL's)
Zone C	north-east of Cape Naturaliste	(0 MFL's Closed to trawling)
Zone D	Comet Bay off Mandurah	(3 MFL's)

SCTF: Condition 73 provides for the use of demersal otter trawl nets off the south coast of Western Australia in waters east of 115° E longitude. Condition 79 provides for the use of demersal otter trawl nets for taking scallops within the Recherche Archipelago. The four fishing boat licences have both conditions.

Management arrangements

AIMWTMF

The AIMWTMF operates under an input control and constant escapement based management system. There was initially a maximum total net headrope capacity restriction of 336.5m (184 fathoms), specified net mesh size, along with seasonal closures and significant spatial closures protecting all near-shore waters and sensitive reef areas. Bycatch reduction devices (grids) to release large species are fully implemented in the AIMWTMF as a licence condition. The fishery operates to a catch rate threshold level of 250kg meat weight per 24 hours trawling to cease fishing.

In 2009 one boat was removed from the fishery through a Voluntary Fisheries Adjustment Scheme (VFAS) together with the headrope net entitlement of 21.9 m (12 fathoms). In December 2010, a second VFAS for the AIMWTMF was approved for five licences and removed a total of 91.4 m (50 fathoms) headrope entitlement from the fishery.

The two restructures the fishery have removed 113.4 m (62 fathoms) of headrope, reducing the current permitted overall net headrope capacity to 223.1 m (122 fathoms) with 10 licences. However, the total net headrope used by the 10 boats that remain in the fishery when fishing with two 12.8 m (7 fathom) nets is 256 m (140 fathoms), which is 33 m (18 fathom) in excess of the allowed capacity remaining after the VFAS. An exemption has been approved and there is an amendment sought to remove the current headrope unitisation from the Management Plan and establish standardisation of nets in the AIMWTMF. The same boats fish the AIMWTMF and the Shark Bay Scallop Managed Fishery and use the same nets (two 12.8 m nets) in the Shark Bay scallop fishery and therefore these sized nets will also be the standard net for the AIMWTMF. This will make fishing more cost effective for licensees.

In 2011, the scallop season opened on 25 March and closed on 1 August. Actual fishing commenced 25 March and ceased on 17 June. There was, however, a hiatus from fishing in the AIMWTMF when boats moved to the Shark Bay scallop fishery between 6 and 23 April. The Port Gregory prawn trawl area of the fishery also opened and closed in conjunction with the Abrolhos scallop season.

Because the AIMWTMF area is fished by the rock lobster and the scallop fishing sectors of the fishing industry, the fishery is spatially separated for the scallop sector into two parts: the traditional parts of the fishery which, are divided into nine fish grounds, and non-traditional areas. The traditional parts of the fishery contain known scallop grounds and these are the grounds historically fished by the scallop fleet. The non-traditional areas, comprise parts of the fishery where scallops are not commonly found and have not been traditionally fished by the scallop fleet. Trawl fishing can be undertaken in this area but there are guidelines for exploratory fishing before any commercial trawl fishing can be undertaken.

SWTMF

The SWTMF is a gear based managed fishery that operates under an input control system that limits boat numbers, gear sizes and fishing areas. There is a total of 14 MFLs operating in this fishery, some in more than one zone. The fishing season operates between 1 January and 15 November in Zones A and B. Access to Zone C ceased in 2002. The management plan also includes large closures to protect

sensitive coastal habitats (including seagrass beds) and nursery areas such as Cockburn Sound, Warnbro Sound and inshore Geopraphe Bay.

SCTF

The SCTF is managed primarily by limited entry with only four licences permitted to operate in the fishery. There are also seasonal closures in specified parts of the fishery under the Trawling for Scallops (South Coast) Notice 1992.

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

The Commonwealth Government's Department of Sustainability Environment Water Populations and Communities (SEWPaC), has assessed the AIMWTMF under the provisions of the Environment Protection and Biodiversity Conservation Act 1999. The SEWPaC Minister granted a five year export approval for the fishery until 2013. The comprehensive ESD assessment of this fishery identified that maintaining an acceptable breeding stock level of the target scallop species was the key performance indicator for the fishery. Boxed text in this status report provides the annual assessment of performance against this indicator.

Research summary

Research monitoring of the scallop stocks for all fisheries is undertaken using daily logbooks validated by processor returns. Advice on the status of stocks and appropriate season opening and closing dates is provided to industry and management. In the AIMWTMF there is also an annual pre-season survey that provides the information required for assessing the fishery. This preseason survey is undertaken in the traditional fish grounds and provides scallop abundance information for each fish ground and an overall catch prediction for the fishery.

Monitoring of the scallop stocks in the SWTMF and the SCTF is through mandatory daily logbooks.

Retained Species

Commercial landings (season 2011)

AIMWTMF: Scallops 2203 tonnes whole weight

SWTMF: Scallops 82 tonnes whole weight

Prawns 13 tonnes

SCTF: Scallops 176 tonnes whole weight

AIMWTMF

The total landings for the 2011 season were 2203 t whole weight (441 t meat weight) of scallops (West and South Coast Scallop Figure 1). Based on the 2010 annual survey, the catch prediction for 2011 was 2785 t whole weight (557 t meat weight) with a range between 2230 and 3345 t whole weight (446 to 669 t meat weight). The total landings were slightly below the predicted catch range. There were two contributing factors for the lower landings; firstly one of the areas where a high abundance of scallops was evident in the survey (the Wallabi area) only provided small sizes and poor quality scallop meat at the time of fishing, therefore, the area was not fished to its potential catch. The other factor was

WEST COAST BIOREGION

ceasing fishing at a catch rate level (250 kg/24 hrs) to provide carry over of stock for spawning, which has been a protocol in this fishery since 2004.

SWTMF

The recorded landings in the SWTMF for the season comprised 13 t of western king prawns and 82 t whole weight of scallops (West and South Coast Scallop Figure 2). Since 2004 annual king prawn landings have been low, in the range of 3 to 19 t. In 2011 the scallop landings were low compared to the high catch in 2010, similar to the decline observed between the very high catch of 1990 and 1991 with similar catches. Being a multi-species fishery other product retained include 13 t of mixed whiting spp., 3 t of blue swimmer crabs (*Portunus armatus*) and 2 t of squid. All other landings were recorded as 1 t or less for each species.

SCTF

The scallop catch was 176 t (whole weight) which was slightly higher than last years catch of 112 t. There is generally low effort expended in the fishery and variable recruitment (West and South Coast Scallop Figure 3). Byproduct species landings were negligible.

Recreational catch: Nil

Fishing effort/access level

AIMWTMF

In 2011, eight of the ten Licensed Fishing Boats fished with twin 12.8 m nets (as in Shark Bay). The boats used a total of 204.8 m of net, slightly less than the permitted 223.1 m net headrope capacity. This has removed the inefficient practise of changing nets because of different size net headropes in each fishery, when these boats move between these two fisheries. A total of 3240 nominal trawl hours (3240 hours standardised effort due to all boats now using standard nets) were recorded for the 2011 season which was higher than the standardised effort for 2010 of 2269 hours. Since 1998, the aim has been to reduce ineffective fishing effort by providing annual survey catch abundance and location reports to fishers to reduce search time and enable fishing effort to be applied where scallop abundance is higher. Scallop fishing ceases at a threshold catch rate level to provide adequate spawning stock and all boats leave the fishery together rather than individual fishers continuing to fish to low catch rate levels.

SWTMF

A total of 242 days were fished in the SWTMF a slight increase compared to 2010 (203 days). This is low compared to the effort levels (between 1990 and 2003) of generally over 400 days because of the focus to value add scallops by providing Rottnest Island fresh scallops to eastern states markets and providing scallops and prawns to the local restaurant trade. Effort (fishing days) in 2010 and 2011 however, represents an increase compared to the previous four years (125-153 days). Low effort also reflects the availability of boats to fish in this fishery, inclement weather conditions restricting fishing time and the rising cost of fishing. There is, however, potential for effort to increase markedly because of latent effort in this fishery.

SCTF

For the 2011 season three boats fished for scallops between April and December recording a total of 130 boat days. This

was similar to the 2010 fishing season (129 days). The annual effort expended in the SCTF is mostly affected by scallop recruitment levels. As a consequence, the level of effort utilised each year closely follows stock abundance and catch levels.

Stock Assessment

Assessment complete:

AIMWTMF: Yes

SWTMF and SCTF: Not assessed

Assessment level and method:

AIMWTMF: Level 4 - Direct survey, catch rate

Breeding stock levels:

AIMWTMF: Adequate

SWTMF and SCTF: Not assessed

Projected catch range next season (2012)

AIMWTMF: Scallops nil tonnes

The annual fishing season arrangements in the AIMWTMF are set so that the majority of the mature scallops are able to spawn before fishing occurs. Breeding stocks are therefore protected to ensure that recruitment is dependent only on environmental conditions each year. This fishery is highly variable, being dependent on sporadic recruitment, which appears to be strongly influenced by environmental conditions, e.g. the Leeuwin Current. A pre-season survey is undertaken annually. The survey index for 2011 was the lowest index since 1997. It is expected that the landings would be less than the target range (95-1830 t) in 2012 and therefore the fishery was not opened.

The main performance measure for the fishery relates to maintaining breeding stocks of scallops. This is done in two ways; by setting the season fishing period according to the catch prediction and by closing the fishery at a threshold catch rate level.

The 2011 fishing season was set at approximately 4 months, consistent with the yield predicted from the survey in November 2011. Also, fishing ceased at the catch rate threshold level of 250 kg/24 hrs. Hence the breeding stock indicator was met.

Non-Retained Species

Bycatch species impact: Low

The AIMWTMF trawl fleet operates over a small portion of the licensed fishing area, focusing on scallop aggregations in several different areas or fish grounds and fishing activity is dependent on how widespread settlement is each season. Scallops settle on relatively bare sand habitats. The overall extent of the fishery is 3808 square nautical miles and of that the permitted trawl area is 2420 square nautical miles, 64% of the extent of the fishery. The area actually fished in the 2011 season was 124 square nautical miles (5.1%). Owing to the focused nature of this fishery, protocols set out when fishing and the confined area fished in 2011 and the large mesh size (100 mm), little bycatch was taken during the fishing season.

In the SWTMF trawling for scallops is focused on a few small offshore areas, while the prawn catch is mainly taken from Comet Bay.

The large-mesh (100 mm) trawl gear used in the SCTF takes minimal bycatch. The areas trawled by the boats for scallops (primarily in waters near Bremer Bay, the Recherche Archipelago and Israelite Bay) represents a very small percentage of the fishing area within the SCTF waters, therefore bycatch species impact is considered to be minimal.

Protected species interaction: Low

While turtles do occur in the Abrolhos Islands, these species are towards the southern extent of their range, and do not breed in the Abrolhos Islands area because water temperatures are too low. Consequently, interactions with turtles were always minimal and now that grids are compulsory in the fishery, their capture should be negligible. No turtles were reported as being caught in the AIMWTMF in 2011. Aside from migrating humpback whales that usually avoid trawl boats, and occasional white sharks few other protected, endangered or threatened species, are sighted in this area. For the SWTMF and SCTF whilst some protected, endangered and threatened species frequent these waters they do not occur regularly in the fishing areas. There were two turtles recorded as caught and returned to the sea alive in the SCTF in 2011.

Ecosystem Effects

Food chain effects: Low

The total biomass taken by these fisheries is generally very small. Moreover, due to the high natural variability of scallop stock abundance it is unlikely that any predators are highly dependent on this species.

Habitat effects: Low

The fishers generally operate over a very small proportion of the licensed area and therefore the total area impacted by trawling is small. Trawling is not extensive and confined to trawl grounds where fishable scallop abundance is significant.

The areas associated with scallops are sandy habitats and trawling activity does not impact these significantly.

Social Effects

The estimated employment of crew for the year 2011 was 90 in the AIMWTMF, not including factory staff based in Perth, 10 in the SWTMF and 10 in the SCTF.

Economic Effects

Estimated annual value (to fishers) for year 2011:

AIMWTMF Level 4 - \$10 - 20 million (\$11 million)

SWTMF: Level 1 - < \$1 million

SCTF: Level 1 - < \$1 million

The estimated value of the AIMWTMF is based on the Shark Bay scallop beach price, which was 5.00/kg whole weight. For the SWTMF and the SCTF the estimated value of the scallop catch is based on wholesale price per kilogram (beach price) obtained from these fisheries, which is \$4.20/kg whole weight. King prawn price was about \$15.00/kg.

Fishery Governance

Target catch range:

AIMWTMF: 95 – 1,830 tonnes whole weight

Current fishing level: Acceptable

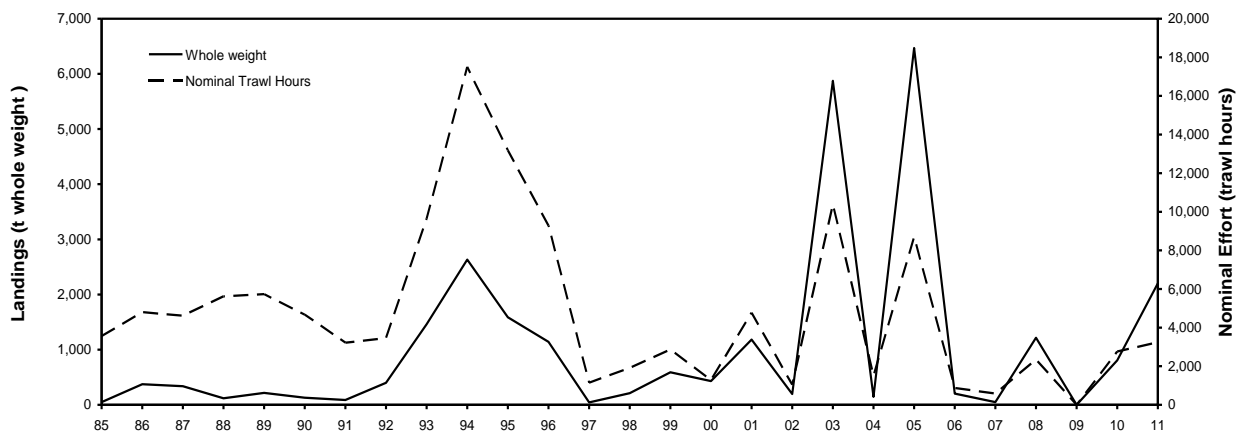
Except for a small number of years (see External Factors for details) the historic catch range for this fishery is 95 – 1,830 tonnes whole weight. The landings in 2011 were slightly below the predicted catch range (see catch section above for reasons) but above target catch range.

New management initiatives (2012) none

External Factors

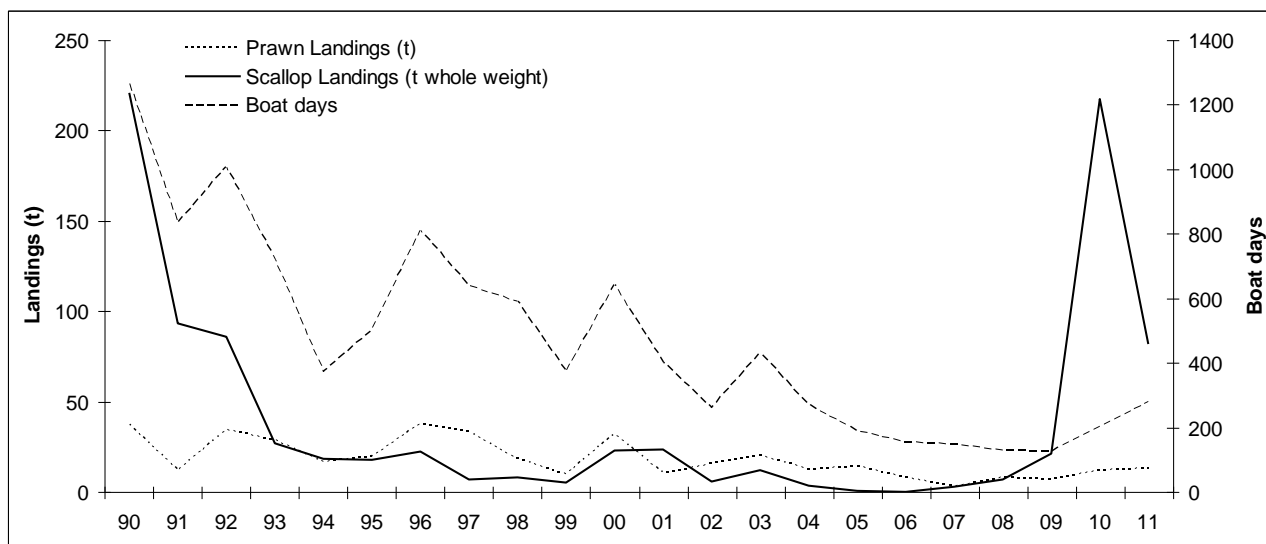
High variability in the level of recruitment highlights the dependence of recruitment success upon environmental conditions, such as the Leeuwin Current, rather than spawning stock levels. The relationship between environmental factors and recruitment success is being evaluated for all these regions. This high variability in recruitment results in a variable level of fishing activity and quantity of catch. Additionally, the high cost of fishing in recent times has affected fishing levels. Meat quality and size (for marketing purposes) are also important in the current economic climate and are factors in determining the amount of effort expended in addition to stock abundance levels.

WEST COAST BIOREGION



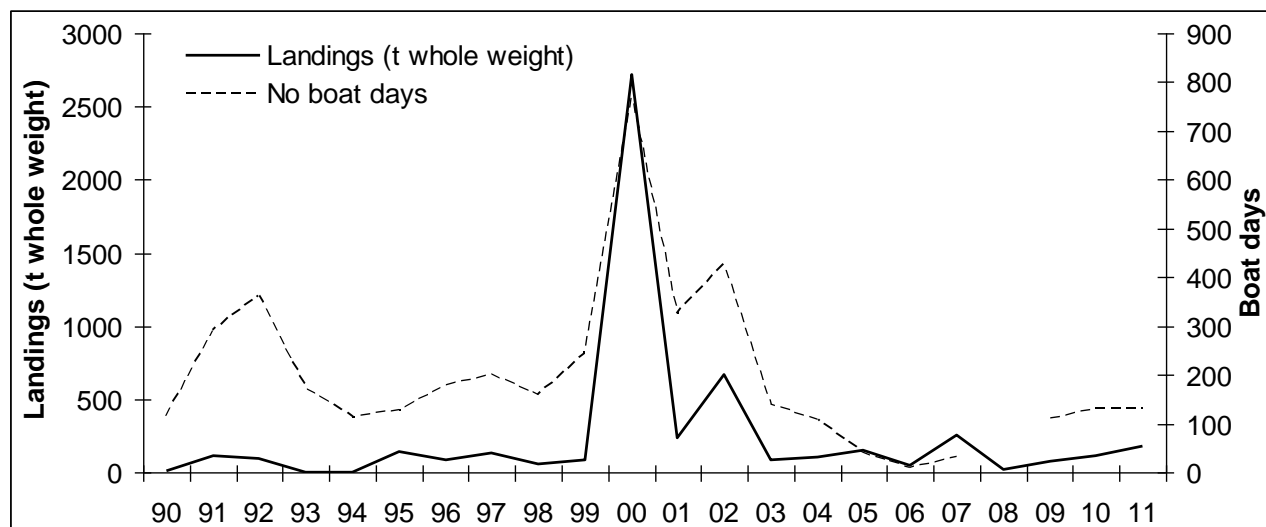
WEST AND SOUTH COAST SCALLOP FIGURE 1

Annual Scallop Landings and Nominal Effort for the Abrolhos Islands and Mid West Trawl Managed Fishery, 1985 – 2011.



WEST AND SOUTH COAST SCALLOP FIGURE 2

Annual Scallop and Prawn Landings and number of boat days for South West Trawl Fishery, 1990 – 2011.



WEST AND SOUTH COAST SCALLOP FIGURE 3

Annual Scallop Landings and number of boat days for South Coast Fishery, 1990 – 2011.



WEST AND SOUTH COAST SCALLOP FIGURE 4

Boundaries of the Abrolhos Islands and Mid West Trawl Managed Fishery, extent of fishery, Port Gregory area, Kidney patch and reef observation area's in 2011.

West Coast Blue Swimmer Crab Fishery Status Report

D. Johnston, D. Harris, J. Fissioli and K. Walshe

Main Features			
Status		Current Landings	
Stock level		Total Commercial catch (2010/11)	161 t
Cockburn Sound	Adequate	Cockburn Sound	53 t
Peel-Harvey Estuary	Adequate	Peel-Harvey Estuary	62 t
		Catch by other commercial fisheries	46 t
Fishing Level			
Cockburn Sound	N/A	Recreational catch	Approximately 60 - 70% of total catch
Peel-Harvey	Acceptable	Peel-Harvey Estuary (Nov 07 - Oct 08)	107-193 t

Fishery Description

The blue swimmer crab (*Portunus armatus*) is found along the entire Western Australian coast, in a wide range of inshore and continental shelf areas, from the inter-tidal zone to at least 50 metres in depth. However, the majority of the commercially and recreationally fished stock is concentrated in the coastal embayments between Geographe Bay (in the south) and Port Hedland (in the north).

The commercial blue swimmer crab fisheries within the West Coast bioregion are the Cockburn Sound Crab Managed Fishery, the Warnbro Sound Crab Managed Fishery, Area I (the Swan and Canning Rivers) and Area II (the Peel-Harvey Estuary) of the West Coast Estuarine Managed Fishery and Area I (Comet Bay) and Area II (Mandurah to Bunbury) of the Mandurah to Bunbury Developing Crab Fishery. Originally, commercial crab fishers in WA used set (gill) nets or drop nets, but most have now converted to purpose-designed crab traps. Blue swimmer crabs are also retained as by-product by trawlers operating in Comet Bay (Area D of the South West Trawl Managed Fishery), and occasionally by trawlers operating in the waters from Fremantle to Cape Naturaliste (Area B of the South West Trawl Managed Fishery).

Recreational crabbing in the West Coast bioregion is centred largely on the estuaries and coastal embayments from Geographe Bay north to the Swan River and Cockburn Sound. Blue swimmer crabs represent the most important recreationally fished inshore species in the southwest of WA in terms of participation rate. While the majority of recreational fishers use either drop nets or scoop nets, diving for crabs is becoming increasingly popular.

There are separate reports for crab fisheries in the Gascoyne and North Coast bioregions.

Governing legislation/fishing authority

Commercial

West Coast Estuarine Fishery (Interim) Management Plan 2003

West Coast Estuarine Interim Managed Fishery Permit

Cockburn Sound (Crab) Management Plan 1995

Cockburn Sound Crab Managed Fishery Licence

Warnbro Sound (Crab) Management Plan 1995

South West Trawl Management Plan 1989

South West Trawl Managed Fishery Licence

Exceptions to the *Fish Traps Prohibition Notice 1990* and *Fish Traps Restrictions Notice 1994*

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

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation.

Consultation process

Commercial

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

Recreational

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

Boundaries

The Cockburn Sound (Crab) Managed Fishery encompasses the inner waters of Cockburn Sound, from South Mole at Fremantle to Stragglers Rocks, through Mewstone to Carnac Island and Garden Island, along the eastern shore of Garden Island, and back to John Point on the mainland.

The Warnbro Sound (Crab) Managed Fishery includes Warnbro Sound itself and adjacent waters, extending from Becher Point to John Point.

The West Coast Estuarine Fishery encompasses the waters of the Swan and Canning Rivers and the waters of the Peel Inlet and Harvey Estuary, together with the Murray, Serpentine, Harvey and Dandalup Rivers.

The Mandurah to Bunbury Developing Crab Fishery covers the waters south of the Shoalwater Islands Marine Park (32°22'40" S) to Point McKenna near Bunbury (33°18' S), and offshore to 115°30' E. The fishery is further divided into two zones. A single northern zone (Area 1) 80-pot exemption authorises crab fishing in a specified area of Comet Bay between 32°22'40" S and 32°30' S. A single southern zone (Area 2) 120-pot exemption authorises crab fishing in the waters between Cape Bouvard and the southern boundary of the fishery. The area separating the 2 zones (waters between 32°30' S and Cape Bouvard) is closed to commercial crab fishing.

The Geographe Bay fishery was officially closed on 21 January 2005 to reduce conflict between the recreational and commercial fishing sectors and commercial fishing in the Leschenault Estuary at Australind ceased in 2000.

Management arrangements

Commercial access to blue swimmer crab stocks in WA is governed by a series of separate management arrangements provided for under the legislative framework of the Fish Resources Management Act 1994. Individual fisheries are managed under an input control system, primarily through the regulation of vessel and trap numbers. Supplementary controls cover retainable species and associated minimum size limits, gear specifications and seasonal and daily time restrictions.

The principal management tool employed to ensure adequate breeding stock in the commercial crab fisheries involves maintaining minimum size limits well above the size at sexual maturity. Except for male crabs in Shark Bay, which mature at 115 mm carapace width, blue swimmer crabs become sexually mature below 100 mm carapace width. The legal minimum size range varies between 127 – 135 mm carapace width in the fisheries of the West Coast bioregion – well above the size at sexual maturity (86-98 mm carapace width).

Recreational fishing for blue swimmer crabs in Western Australia is managed through a series of input and output controls. As with commercial fishing, the principal management tool employed to sustain an adequate breeding stock involves maintaining minimum size limits well above the size at sexual maturity. A minimum legal size limit of 127 mm carapace width applies in State waters, along with a bag limit of 10 crabs per person or 20 crabs per boat. A Recreational Fishing from Boat Licence was introduced in March 2010 that restricts catch to 20 crabs per powered boat when there are two or more people on-board holding Recreational Fishing from Boat Licences and 10 crabs if there is only one person on-board holding a Recreational Fishing from Boat Licence regardless of the number of fishers aboard.

Restrictions also govern gear types that can be used to take blue swimmer crabs, along with localised spatial and temporal closures. Management measures were introduced in August 2007 to include a seasonal closure to both commercial and recreational fishers in the Peel-Harvey

Estuary for the months of September and October to protect pre-spawning female crabs.

In 2006, the Cockburn Sound crab fishery was closed to protect crab stocks that were significantly depleted due to fishing pressures and environmental conditions that resulted in poor recruitment. Commercial fishers were prohibited from taking crabs in all waters of the Cockburn Sound Managed Crab Fishery, while recreational fishers were prohibited from taking crabs south of a line from Woodman Point across to Garden Island. The closure remained in place for the 2006/07, 2007/08 and 2008/09 season.

Following a rebuilding of the Cockburn Sound crab stock, the fishery was re-opened on 15 December 2009. A precautionary management approach was adopted under the following management controls:

- a 20% reduction in commercial pot numbers;
- an increased commercial size limit of 140 mm;
- a recreational size limit of 127mm; and
- a limited commercial and recreational season from 15 December 2009 to 31 March 2010.

A precautionary management approach was again adopted for the 2010/11 season, under the following management controls:

- a 20% reduction in commercial pot numbers;
- a commercial size limit of 135 mm;
- a recreational size limit of 127 mm;
- a limited commercial season from 15 December 2010 to 31 March 2011; and
- a limited recreational season from 15 December 2010 to 30 April 2011.

A voluntary Fisheries Adjustment Scheme resulted in the number of licenses in the Swan/Canning River (Area 1 of the West Coast Estuarine Fishery) being reduced from 4 to 2 in July 2005. A further licence was removed from the fishery in early 2008.

Research summary

Data for the assessment of blue swimmer crab stocks in the West Coast bioregion are obtained from a variety of sources. Commercial catch and effort is assessed using fishers' compulsory monthly catch and effort returns, voluntary daily log books from fishers in the Mandurah to Bunbury Developing Crab Fishery, and data from on-board catch monitoring conducted by the Department of Fisheries' research staff in each of the West Coast bioregion's commercial crab fisheries.

In addition, direct surveys generating recruit, residual and breeding stock indices, along with data on the general crab population, have been conducted in Cockburn Sound for 10 years and in the Peel-Harvey for four years.

A stock-recruitment-environment model has been developed for Cockburn Sound, which correlates water temperature in the pre-spawning months of August and September, and the size of the breeding stock, with the following season's commercial catch.

Following the closure of the Cockburn Sound crab fishery in December 2006, research funding (from the Development

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and Better Interest Fund) was granted to assess the reasons for the stock collapse and monitor the recovery of the fishery. The causes of the collapse and description of the recovery have been described in the scientific paper, Decline of a blue swimmer crab (*Portunus pelagicus*) fishery in Western Australia—History, contributing factors and future management strategy (Johnston et al., 2011)¹. The stock status of the Cockburn Sound crab fishery, a description of the stock-recruitment-environment relationship for the Cockburn Sound crab stock, and a summary of the crab fisheries in Warnbro Sound and the Swan River have been presented in the Fisheries Research Report Status of the Cockburn Sound Crab Fishery FRR219 (Johnston et al., 2011)². Reports on the population status of the Peel-Harvey Estuary crab stock, and the 2007/08 recreational crabbing survey in the Peel-Harvey Estuary, are currently being written.

Retained Species

Commercial landings (season 2010/11):

	Total 161 tonnes
Cockburn Sound	53 tonnes
Peel-Harvey Estuary	62 tonnes
Other West Coast commercial fisheries	46 tonnes

The total commercial catch from the West Coast bioregion in 2010/11 was 161 t, a 14% decrease on the 184 t taken in 2009/10. This reduction was primarily due to slight declines in catch from the Cockburn Sound crab fishery and from the Peel-Harvey Estuary and no fishing in Area II of the Mandurah to Bunbury trap fishery. This catch accounted for 15% of the state commercial blue swimmer crab catch of 1087 t for 2010/11 (West Coast Blue Swimmer Crab Figure 1).

The commercial catch from the Cockburn Sound Crab Managed Fishery for 2010/11 was 53 t, a 5% decrease from the 56 t caught during the 2009/10 season (West Coast Blue Swimmer Crab Figure 2).

The commercial catch from the Peel-Harvey Estuary (Area II of the West Coast Estuarine Managed Fishery) for 2010/11 was 62 t. This represents a 5% decrease on the 65 t in 2009/10 (West Coast Blue Swimmer Crab Figure 4).

The Mandurah to Bunbury Developing Crab Fishery reported an annual catch for 2010/11 of 11 t, representing a 61% decrease on the 28 t reported for the 2009/10 financial year (West Coast Blue Swimmer Crab Figure 5). This significant decrease was primarily due to the fisher that operates along

the coast between Mandurah and Bunbury not crabbing during the 2010/11 financial year.

Recreational catch estimate:

Peel-Harvey Estuary (Nov 2007 - Oct 2008)

107-193 tonnes

Recreational catch for West Coast Bioregion:

approximately 60-70% of total catch

Most of the recreational blue swimmer crab fishing in Western Australia occurs in the West Coast bioregion. Departmental surveys have estimated that the recreational sector accounts for 60-70% of the total blue swimmer crab catch in this bioregion.

A 12-month recreational catch and effort survey in the Peel-Harvey Estuary was completed in October 2008. This survey covered fishing from boats, shore, canals, and houseboats. Recreational catch for the Peel-Harvey Estuary from November 2007 to October 2008 was estimated to be between 107-193 t, which represents a significant decline in recreational catch estimate of 251-377 t from the last survey undertaken in 1998/99. Boating has become the dominant fishing method, with a decline in the amount of scoop netting undertaken. The majority of fishers are now also Mandurah locals, rather than people from the metropolitan area.

Within Cockburn Sound, recreational crabbing surveys in 1996/97 and 2001/02, and in the 2002, 2003 and 2004 calendar years, produced relatively consistent recreational catch estimates of 24 t, 25 t, 18 t, 23 t and 18 t respectively. However, the recreational catch for the 2005/06 financial year was estimated to be just 4 t. It should be noted that these figures are likely to under-estimate the total recreational blue swimmer crab catch in each of these years, as the surveys commenced at various times between 7am and 9am and finished between 4pm and 8pm so missed any crabbing activity that potentially occurred before or after the survey began or finished.

The Minister for Fisheries closed the Cockburn Sound crab fishery to recreational fishing in December 2006, south of a line between Woodman Point and the northern end of Garden Island. The closure remained in effect until November 2009.

The whole of Cockburn Sound was re-opened to recreational crabbing for the 2009/10 season from December 15th 2009 to March 31st 2010, at which point the area south of Woodman Point was again closed to continue rebuilding crab stocks in this area. A survey quantifying recreational catch and effort in the West Coast bioregion was conducted over a two-year period between July 2008 and June 2010. The survey provided a recreational catch estimate for the 3½ months of the 2009/10 season of 15.4 t (S.E.±3.3 t) of blue swimmer crabs, for an area covering Cockburn Sound (south of latitude 32°05'S), Shoalwater Bay and the northern half of Warnbro Sound (north of latitude 32°20'S). However, the survey covered only the period during the day between 9am and 5pm. As there is a significant level of early morning recreational crabbing in Cockburn and Warnbro Sounds, an additional survey was conducted between 5.30 am and 9am during the 2009/10 crabbing season. This survey provided an additional recreational catch estimate for this area of 18.8 t (S.E.±5.5 t) of blue swimmer crabs for the 3½ months of the 2009/10 season.

¹ Johnston, D., Harris, D., Caputi, N. and Thomson, A. 2011. Decline of a blue swimmer crab (*Portunus pelagicus*) fishery in Western Australia—History, contributing factors and future management strategy. Fish. Res. **109**(1), 119-130 doi:10.1016/j.fishres.2011.01.027

² Johnston, D., Harris, D., Caputi, N., de Lestang, S. and Thomson, A. 2011. Status of the Cockburn Sound Crab Fishery. Fisheries Research Report No. 219. Department of Fisheries, Western Australia. 104pp.

All of Cockburn Sound was again re-opened to recreational crabbing for the 2010/11 season from December 15th 2010 to April 30th 2011, after which the area south of Woodman Point was closed.

A 12-month survey of recreational fishing in the Swan/Canning Estuary Basin between August 1998 and July 1999 estimated the total recreational blue swimmer crab catch to be 7.3 t. This compares with a commercial catch during the 1998/99 financial year of 24 t. In subsequent years, commercial catches have ranged between 10 t and 20 t, but no further recreational surveys have been undertaken specifically in the Swan-Canning Estuary.

Both the Leschenault Inlet and Geographe Bay are now exclusively for recreational use. Previous surveys have found the annual recreational blue swimmer crab catch from Geographe Bay to be between 7 – 11 t per year.

A statewide survey of boat-based recreational fishing was conducted during 2011/12 and was a collaboration between the Department of Fisheries, Edith Cowan University and Recfishwest. Approximately 3,000 fishers from the “Recreational Fishing from Boat” licence database participated in a 12 month phone-diary survey in conjunction with boat ramp surveys of boat-based fishers. Estimates of catch and effort will be available in late 2012.

Fishing effort/access level

After three years of closure due to declining crab stocks, the Cockburn Sound (Crab) Managed Fishery partially re-opened for the 2009/10 and 2010/11 fishing season. Commercial fishers in Cockburn Sound reported a total of 55,294 trap lifts for the 2010/11 season, a 6% decrease on the 58,747 trap lifts reported during the 2009/10 season (West Coast Blue Swimmer Crab Figure 2).

Commercial fishers in the Peel-Harvey Estuary reported 58,119 trap lifts during the 2010/11 season – a 4% increase on the 55,595 trap lifts reported the previous year (West Coast Blue Swimmer Crab Figure 4).

Commercial effort in the Mandurah to Bunbury Developing Crab Fishery also fell in 2010/11, with a total of 13,186 trap lifts reported compared to 22,520 trap lifts the previous year (West Coast Blue Swimmer Crab Figure 5), primarily because the Mandurah to Bunbury fisher did not operate during this period.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Cockburn Sound Level 4 - Direct survey

Peel-Harvey Level 2 - Catch rate

Other West Coast fisheries Level 2 - Catch rate

Breeding stock levels:

Cockburn Sound Adequate

Peel-Harvey Adequate

Other West Coast fisheries Adequate

Catch rates from fisheries within the West Coast bioregion generally provide an index of abundance that can be used to assess individual fishery performance from year-to-year. In addition, direct surveys generating recruit, residual and breeding stock indices, along with data on the general crab population, have been conducted in Cockburn Sound for 10 years and in the Peel-Harvey for four years.

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

Following the second highest annual catch on record in 2000 (340 t) the catch declined over the next few years to the point where the low stock abundance required closure of the fishery (in December 2006).

Adequate protection of the breeding stock of blue swimmer crabs in Cockburn Sound had been assumed to occur if the minimum legal size was set well above the size at sexual maturity, which would allow female crabs to spawn at least once before entering the fishery. While this is a common strategy for this species, a combination of biological, environmental and fishery-dependent factors contributed to the collapse and include: 1) vulnerability to environmental fluctuations as this species is at the southern extreme of its temperature tolerance, 2) a life cycle contained within an embayment and is self-recruiting, 3) a change in fishing method from gill nets to traps which increased fishing pressure on pre-spawning females in winter and reduced egg production to one age class, 4) four consecutive years of cooler water temperatures resulting in poor recruitment and 5) continued high fishing pressure during years of low recruitment resulting in low breeding stock.

Despite an absence of fishing pressure, the recovery of the breeding stock and subsequent recruitment has been slow. While catch estimates reflected a slow improvement in the stocks, they were well below the historic catch range of the fishery. Consequently, the closure was extended to November 2009.

Fishery-independent trawl and commercial monitoring surveys conducted during 2009 suggested the strength of both recruitment and breeding stock in Cockburn Sound had improved sufficiently to re-open the crab fishery for the 2009/10 fishing season. However, it was considered prudent to adopt a precautionary approach to the management of the fishery (see Management arrangements above).

Given the relatively low commercial catch in 2009/10, and lower than expected 2010 breeding stock and recruitment indices, it was again considered prudent to maintain a precautionary approach to fishing for the 2010/11 season in Cockburn Sound.

Despite the reduction in the minimum size, the commercial catch in 2010/11 of 53 t (from 55,000 pot lifts) was marginally lower than the previous year's catch and effort. This low outcome was partly due to a large cohort of unusually small-sized juveniles recruiting into the fishery during 2010. These juveniles were on average 78 mm CW during July 2010, the smallest carapace width since data was first collected in 2005. These small-sized crabs did not moult

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to legal size until late in the fishing season, as evidenced by the largest catch occurring in March 2011 when January is typically the peak catch month.

Breeding stock (egg production) levels during 2011, based on the relationship between egg production and recruitment (0.63), were above the acceptable breeding stock index that is currently set at a precautionary level (0.4) (West Coast Blue Swimmer Crab Figure 3). The strength of recruitment of juvenile crabs within Cockburn Sound improved significantly during 2011, with an increased juvenile (0+) index from research trawls of 3.1 compared with 1.4 in 2010. In addition, the average size of recruits in July 2011 of 82 mm CW was larger than in 2010 (78 mm CW). The good abundance of residual crabs (1+) seen in 2010 (7.9) was maintained in 2011 (8.8), as this residual cohort did not contribute significantly to the 2010/11 season with the fishery stopping in March.

Peel Harvey: The mean annual catch rate for 2010/11 in the Peel-Harvey Estuary was 1.07 kg/trap lift, marginally lower than the 2009/10 catch rate of 1.17 kg/trap lift (West Coast Blue Swimmer Crab Figure 4). This catch rate, however, remains acceptable for this fishery.

A recreational survey conducted in the Peel-Harvey Estuary during 2007/08 estimated that the recreational take accounted for approximately 60 % of the total catch. Consequently, it is recognized that commercial catch data alone may not provide an accurate indication of the status of crab stocks in this estuary.

Mandurah to Bunbury: Mean annual trap catch rates in the Mandurah to Bunbury Developing Crab Fishery have increased steadily since the commencement of exploratory fishing along the coast south of Mandurah to Bunbury in 2002. This increase reflects more efficient fishing of the region as the commercial operators' knowledge of the spatial and temporal distribution of resident stocks and localized environmental influences increased over time. The mean catch rate for 2010/11 in the Mandurah to Bunbury fishery was 0.81 kg/trap lift – a 36% decrease on the 2009/10 catch rate of 1.26 kg/trap lift (West Coast Blue Swimmer Crab Figure 5). The reduction in catch rate in this fishery was primarily because the fisher that operates along the coast between Mandurah and Bunbury did not fish during the 2010/11 financial year. The catch rate for Area 1 of the Mandurah to Bunbury Developing Crab Fishery actually increased from 0.71 kg/traplift in 2009/10 to 0.81 kg/traplift in 2010/11.

Monthly monitoring surveys conducted aboard commercial vessels in the Mandurah to Bunbury fishery have indicated a high percentage of female crabs in the catch from this fishery, especially during the peak period of commercial fishing from April to August, and this will need to be closely monitored to avoid overfishing the breeding stock.

Non-Retained Species

Bycatch species impact: Negligible

The shift from using set nets to traps in most blue swimmer crab fisheries has resulted in a substantial reduction in bycatch from dedicated crab fishing. Pots are purpose-designed to minimise the capture of non-target species and are therefore an inefficient way to capture fish, the majority

of which are able to escape through the entrance gaps when the pot is soaking or being hauled.

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

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

Protected species interaction: Negligible

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

Ecosystem Effects

Food chain effects: Low

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

Habitat effects: Negligible

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

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

Social Effects

During 2010/11, approximately 28 people were employed as skippers and crew on vessels targeting blue swimmer crabs in the West Coast bioregion.

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

Economic Effects

Estimated annual value (to fishers) for 2010/11:

Level 2 - \$1 - 5 million (\$1.15 million)

The commercial blue swimmer crab catch in the West Coast bioregion for 2010/11 was valued at around \$1.15 million, down 10% on the \$1.21 million generated in 2009/10. Most

of the catch from the West Coast bioregion was sold through local markets.

The economic value of commercial blue swimmer crab fishing to the State of Western Australia for the 2010/11 financial year was estimated to be \$6.35 million – a 15% increase on the estimated \$5.37 million generated in 2009/10.

Fishery Governance

Current fishing level

Cockburn Sound: Under review

Peel Harvey: 40 - 90 tonnes

Other West Coast fisheries: Under review

The new catch range for Cockburn Sound crabs will need to be developed once the spawning stock and recruitment levels return to normal levels and the management arrangements are stabilised. The acceptable catch range for Peel Harvey is now determined to be within the last 10 years of catch values. The other west coast crab fisheries are yet to develop a sufficiently stable catch history or set of management arrangements to develop a definitive catch range.

New management initiatives (2011/12)

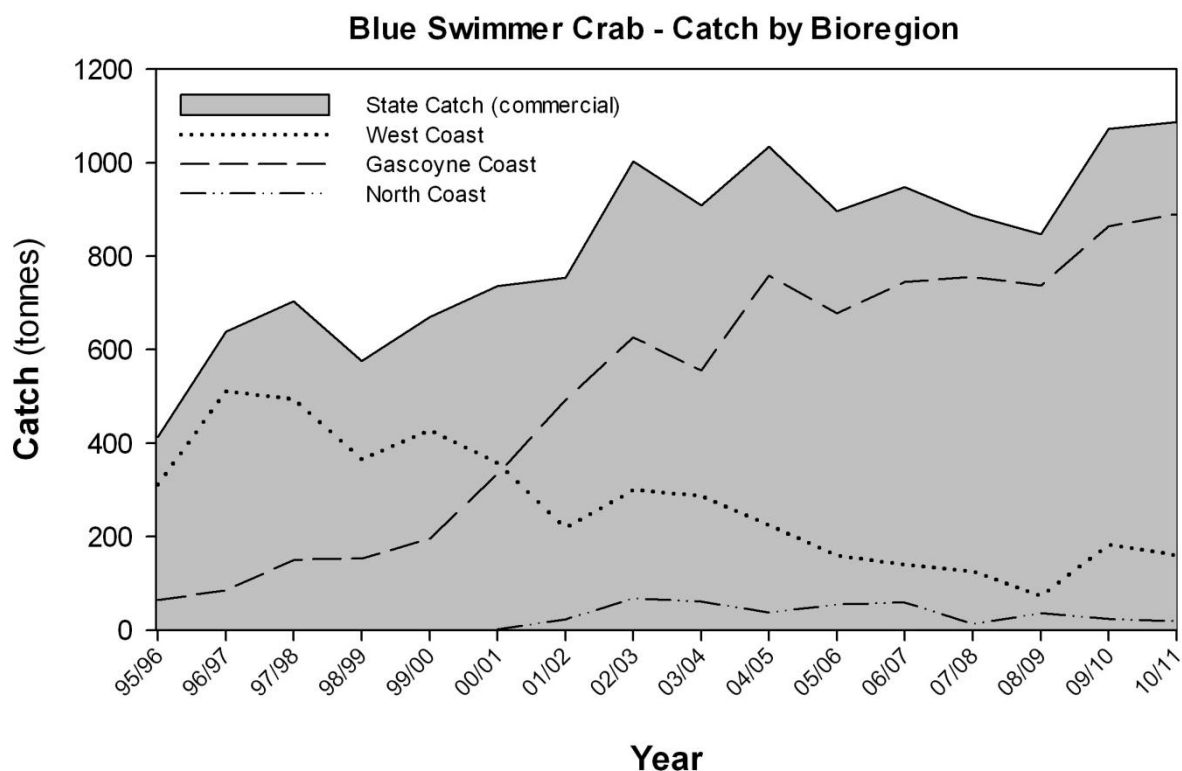
As an outcome of the review into the management arrangements for Cockburn Sound the following changes were implemented in December 2011 for this fishery.

- Extension of the commercial fishing season from 15 Dec to 15 June
- Extension of the recreational fishing season from 15 Dec to 30 July
- A decrease in commercial size limit for male blue swimmer crabs from 135 to 130 mm CW
- Retention of the commercial size limit for female blue swimmer crabs at 135 mm CW
- Maintenance of the current 20% pot reduction in the commercial fishery

The Mandurah to Bunbury Developing Fishery underwent its final review by the Developing Fisheries Assessment Committee (DFAC) in mid-2007 as part of the 'Developing New Fisheries' process. The Department of Fisheries is considering the recommendations of the DFAC.

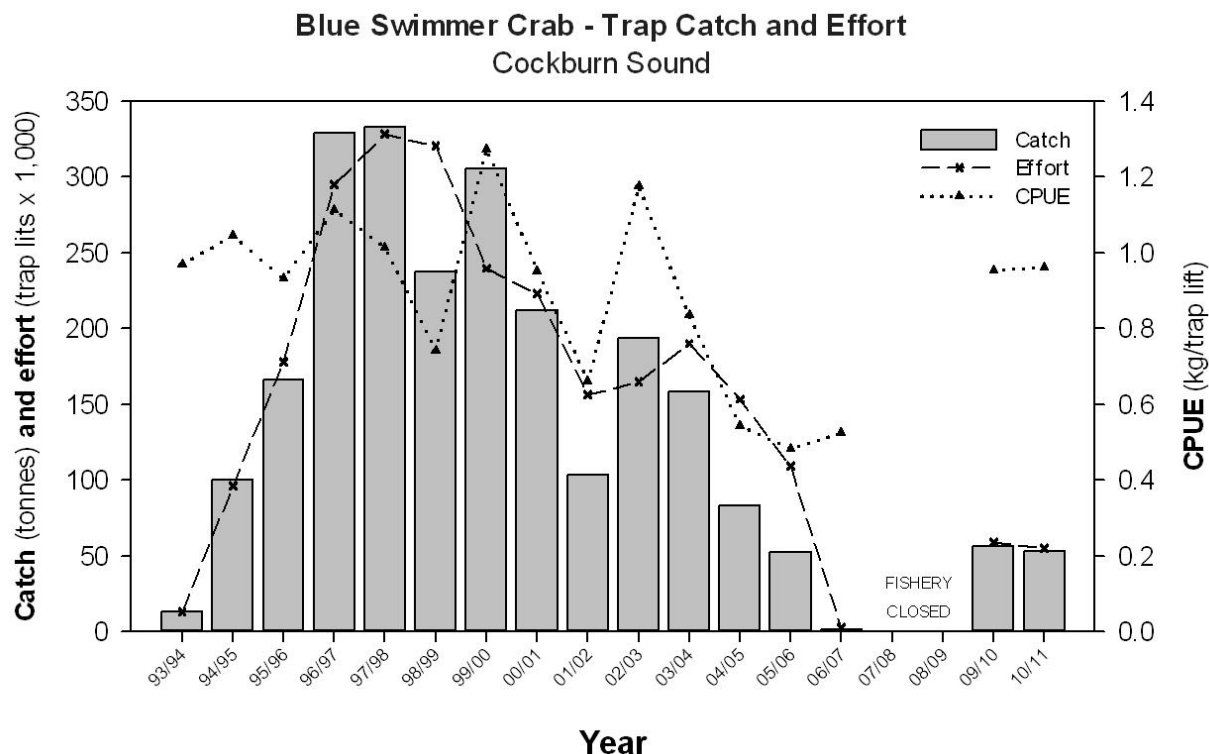
External Factors

Levels of recruitment to many of the crab fisheries fluctuate considerably. While the causes of these variations are not fully understood, it is considered most likely due to environmental influences (e.g. water temperature) both on spawning success and larval survival through to recruitment. The relationship between environmental factors, recruitment and catch is being further evaluated as data becomes available.

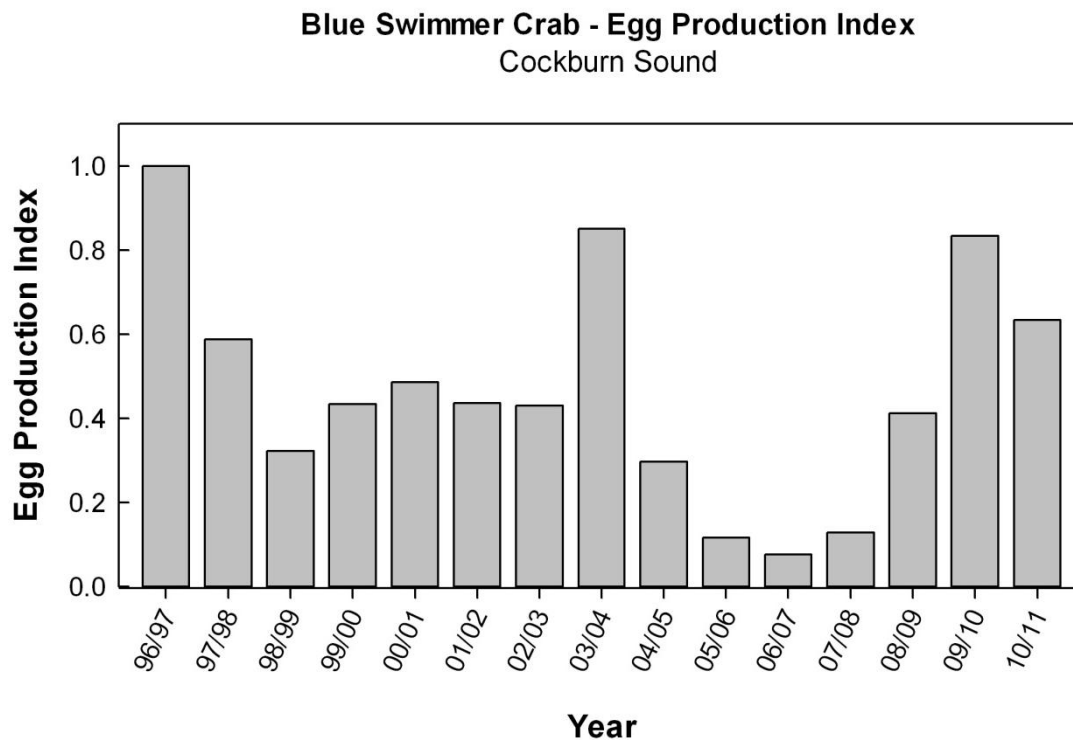


WEST COAST BLUE SWIMMER CRAB FIGURE 1

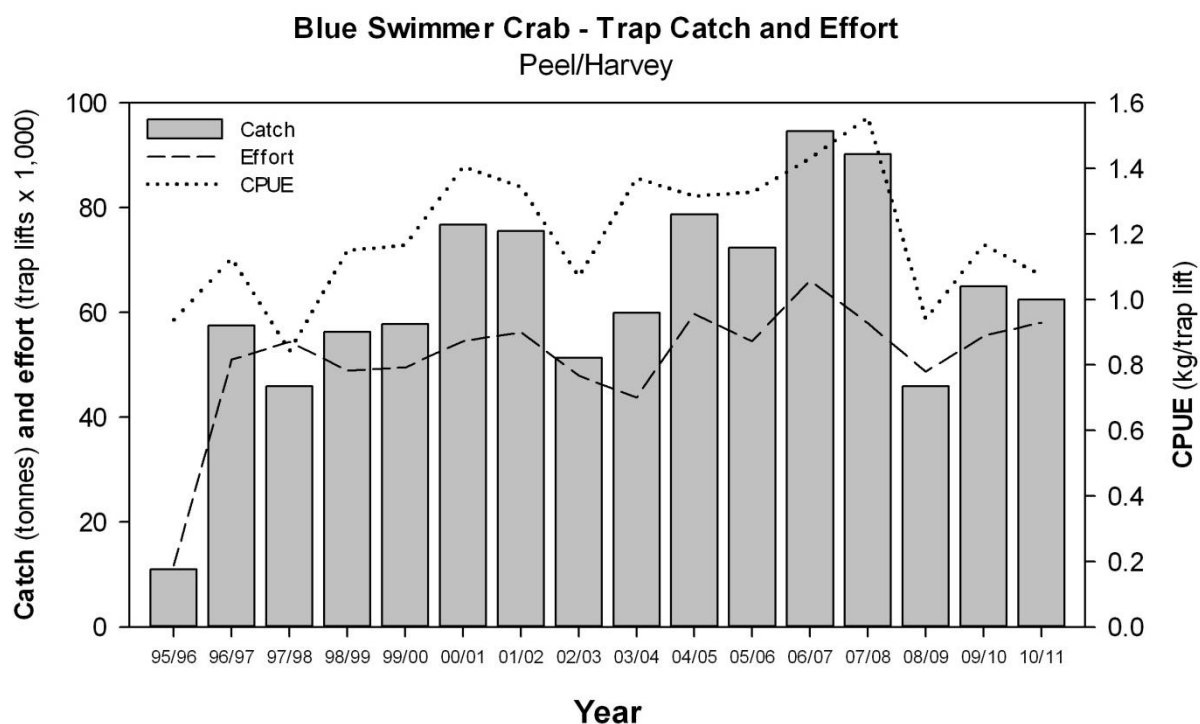
State and bioregion commercial catch history for the blue swimmer crab in Western Australia since 1995/96.

**WEST COAST BLUE SWIMMER CRAB FIGURE 2**

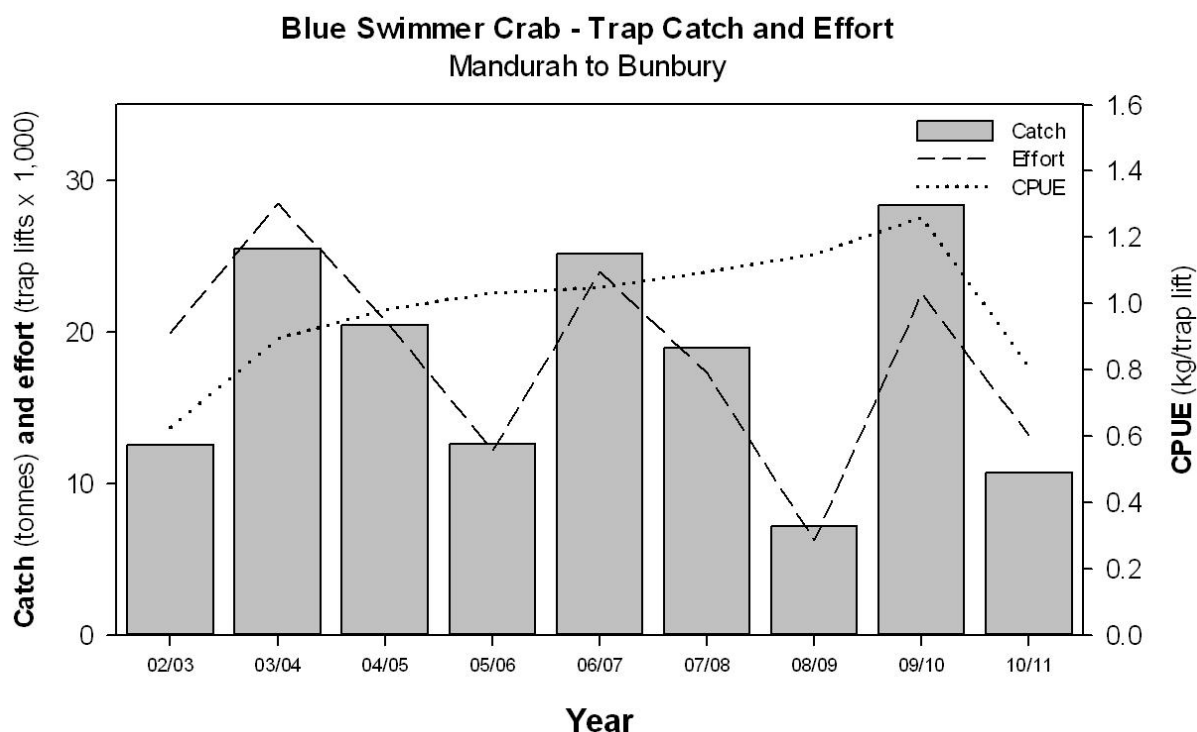
Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in the Cockburn Sound Crab Fishery using traps since 1993/94.

**WEST COAST BLUE SWIMMER CRAB FIGURE 3**

Annual standardized egg production index based on numbers and carapace widths of sexually mature female blue swimmer crabs captured during all juvenile trawl surveys between 1996 and 2011, all trawl surveys aboard the Fisheries Research trawlers *RV Flinders* (1999–2001) and *RV Naturaliste* (2001–2011), and all catch monitoring surveys aboard commercial crab vessels in Cockburn Sound (1999–2011).

**WEST COAST BLUE SWIMMER CRAB FIGURE 4**

Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in Area 2 of the West Coast Estuarine Fishery (the Peel-Harvey Estuary) using traps since 1995/96.

**WEST COAST BLUE SWIMMER CRAB FIGURE 5**

Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in the Mandurah to Bunbury Developing Crab Fishery since 2002/03.

West Coast Deep Sea Crab (Interim) Managed Fishery Status Report

J. How and K. Nardi

Main Features

Status

Stock level	Adequate
Fishing Level	Acceptable

Current Landings

Crystal Crabs	140 t
Champagne Crabs	5.4 t

Fishery Description

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

Governing legislation/fishing authority

West Coast Deep Sea Crustacean Fishery (Interim) Management Plan 2007

West Coast Deep Sea Crustacean Interim Managed Fishery Permit

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation).

Consultation process

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

Boundaries

The boundaries of this fishery include all the waters lying north of latitude 34° 24' S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150m isobath out to the extent of the Australian Fishing Zone.

Management arrangements

The West Coast Deep Sea Crustacean (Interim) Managed Fishery is a quota based 'pot' fishery. The fishery mostly operates in depths of 500-800 metres, with the only allowable method for capture being baited pots ('traps'). These are operated in 'long-lines', which have between 50 and 150 pots attached to a main line marked by a float at each end.

The Department of Fisheries has minimum size limit regulations to protect breeding females. A minimum carapace length of 120 mm applies for the principal target

species Crystal Crab, and 92 and 140 mm carapace minimum lengths applying respectively for the lesser targeted species-Champagne and Giant crabs.

The interim management plan came into effect on 1 January 2008. This plan introduced a number of key management changes such as the removal of management zones in the fishery, removing part-time permits and initiating a quota management system, with individual transferable quota for each existing permit holder. There are currently seven permits operating in the fishery. Each permit has a 2 tonne limit for Giant and Champagne crabs combined (annual combined quota of 14 tonnes), while the TAC for crystal crabs (across all permits with Crystal Crab entitlement) totals 140 tonnes.

Research summary

Research for this fishery has involved assessing the current status of the west coast deep sea crab stocks based on commercial catch returns, log book information and at-sea research monitoring of the catch. The annual total Crystal crab catch from 2000 to 2008 have been historically used to monitor this fishery for ecologically sustainable development assessment. However, since the quota system has come into operation in 2008, performance measures based on whether the quota is achieved and the catch rate and effort required to achieve the catch will now need to be established.

Retained Species

Commercial landings (season 2011):

Crystal crab	140 tonnes
Champagne crab	5.4 tonnes

The catch of 140 tonnes of Crystal crab in 2011 was similar to the previous three years where catches have been just below the 140 tonne quota which was introduced in 2008 (Deep Sea Crab Figure 1). The catch of 5.4 t of Champagne crab taken in 2011 was similar to the last two seasons where catches were between 5 and 6.3 tonnes. The catch records are based on mandatory monthly catch and effort returns prior to 2008, with the more accurate trip catch disposal records from 2008 onwards. No Giant crab was landed in 2011.

Recreational catch estimate (season 2011) Nil

Fishing effort/access level

Commercial nominal effort decreased by 12 % from an estimated 66,003 pot lifts in the 2010 season to 58,356 pot lifts in the 2011 season. The catch of the fishery (see above) is divided by the average logbook catch rates to provide an estimate of nominal effort for the fishery.

Stock Assessment

Assessment complete Yes

Assessment level and method:

Level 2 - Catch rate

Breeding stock levels Adequate

Catch rates increased by 20% in 2011 with a standardised catch rate of 1.88 kg/pot compared with 1.56 kg/pot in 2010 (Deep Sea Crab Figure 2). The standardised catch rate for 2010 differs from that reported last year, of 1.34 kg/pot. This is due to errors found during further data validation associated with the conversion of landed baskets to weights. The 2011 standardised catch rate represents the highest standardised catch rate in a decade (Deep Sea Crab Figure 2).

Crystal crabs are known to be very slow growing as are most other deep-water species. Preliminary estimates suggest that the males attain maturity at around 12 years and reach legal minimum size at about 14 years. Ageing estimates are not available for females, but size at maturity information shows that they mature well below the legal size limit and probably moult once after reaching maturity, which means that their contribution to the fished biomass is small and that egg production in the fishery is well protected by the legal size limit provided that there are sufficient males. After a drop in the standardised catch rate of ovigerous females in 2008, presumably due to a shift in effort with the removal of zone restrictions, it has remained steady from 2008 to 2011.

The original performance measure is whether the catch remains within the range 100-250 t which was met. Given that the fishery has moved to catch quota, the performance measure needs to be revised to include whether the quota has been achieved and if the effort required to achieve the quota is acceptable.

Non-Retained Species

Bycatch species impact Low

The gear used in this fishery generates minimal bycatch and the design of the pots is such that they do not 'ghost fish' if lost.

Protected species interaction Negligible

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

Ecosystem Effects

Food chain effects Negligible

Total landings of the 3 species of deep sea crabs represent a very small biomass, and any impact of fishing on the general food chain is expected to be minimal. Most of the commercial Crystal crab catch is taken in depths between 500 to 800 metres. An estimate of the amount of ground between 500–1,000 m over the distributional range of Crystal crabs is about 50,600 km². Assuming that all the ground is equally productive, at catch levels experienced in the past seasons about 3 kilograms of crabs are being removed each year per square kilometre of ground.

Habitat effects Low

Crab potting is considered to have a low impact on the largely soft mud habitat over which the fishery operates.

Social Effects

This fishery is based on mobile vessels that employ a skipper and two or three crew. The product is landed live at ports between Carnarvon and Fremantle, generating some additional economic activity and benefits. There were four vessels operating in 2011.

Economic Effects

Estimated annual value (to fishers) for 2011

Level 2 - \$1 - 5 million (\$2.9 million)

The beach value of the fishery was about \$2.9 million in 2011 with the majority of the catch exported live to SE Asia.

Fishery Governance

Target catch range 100-140 tonnes

Revised Effort range 50-80,000 pot lifts

Current fishing (or effort) level Acceptable

The TAC for the fishery has been set well below landings of recent years and is at the lower end of the target catch range for the WTO assessments. A preliminary effort range to achieve the TAC had been generated as 70,000–100,000 pot lifts but with the current nominal effort (2009-11) of 76,370-58,356 pot lifts all below this level, a revised effort range of 50,000-80,000 pot lifts will be used until more data become available from this fishery whilst under quota management.

New management initiatives for 2012

The West Coast Deep Sea Crustacean Fishery (Interim) Management Plan (2007) was amended in 2011 to facilitate the full unitisation of the Fishery, with seven permit holders permitted to take a share of the TAC depending upon the number of units conferred on their permit.

There are separate units for Crystal Crabs (A Units) and Champagne and Giant crabs (B Units) with all units intended to be fully transferable between permit holders. This provides flexibility to trade and/or amalgamate units to optimise

WEST COAST BIOREGION

economic and operational efficiencies in the Fishery. The two tonnes combined quota for champagne and giant crabs is now transferable in its own right. This will allow better access to the fishery and enable the continued expansion of the giant and champagne crab fishery which is spatially separate from the crystal crab fishery as it occurs in different depth ranges.

Other Management Initiatives introduced for the 2012 fishing season and beyond included:

- The use of wood batten traps to target champagne crabs;
 - The use of experimental traps to target crystal crabs at a rate no greater than two traps per 100-trap line;
 - The use of bait as defined in the West Coast Rock Lobster Managed Fishery Plan; and
- The inclusion of Hamelin Bay and Augusta as additional ports for fishers to land deep sea crustaceans at the southern boundary of the Fishery.

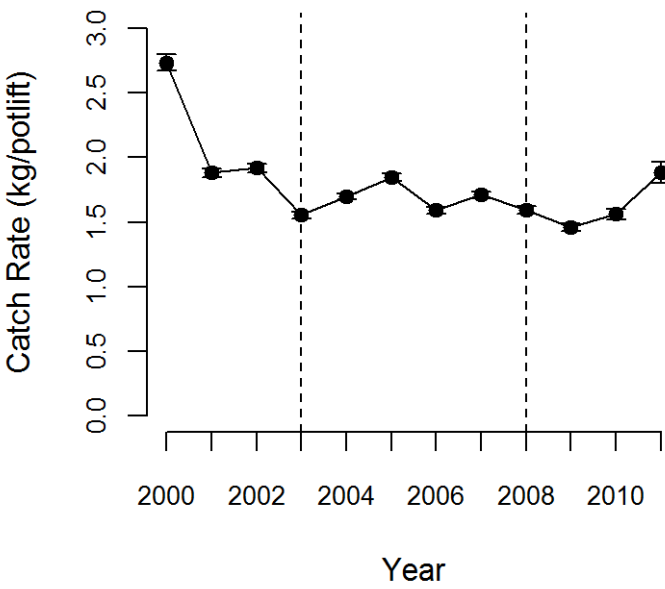
External Factors

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



WEST COAST DEEP SEA CRAB FIGURE 1

Annual catches of Crystal (grey) and Champagne (dashed) crabs since 1989. Annual giant crab catches have always been small, and they have therefore been excluded.



WEST COAST DEEP SEA CRAB FIGURE 2

Standardised catch per unit (\pm SE) effort since 2000 for crystal crabs. Area between vertical dashed lines indicate period when management required fishing in all zones.

West Coast Nearshore and Estuarine Finfish Resources Status Report

K. Smith, J. Brown, A. Howard, K. Walshe and J. Fissioli

Main Features			
Status		Current Landings (2011)	
Stock level:		Commercial total	215 t (finfish only)
Australian herring	Uncertain	South West Coast Salmon Fishery	6 t (salmon only)
Tailor	Acceptable	West Coast Beach Bait & South West Beach Seine Fisheries	
Southern garfish	Acceptable		35 t (whitebait only)
Sea mullet	Acceptable	West Coast Estuarine Fishery	74 t (finfish only)
Whitebait	Acceptable		
Black bream (Swan-Canning)	Acceptable	Recreational	not available for current year
Cobbler (Peel-Harvey)	Acceptable	Most recent survey 2000/01	940 t (key species only)
Fishing level:			
Australian herring	Under assessment		
Other stocks	Acceptable		

Fishery Description

Commercial - Nearshore

Commercial fishers target a large number of finfish species in nearshore and estuarine waters of the West Coast Bioregion using a combination of gill nets and beach seine nets.

The Cockburn Sound (Fish Net) Managed Fishery uses gill nets in Cockburn Sound. The main target species are southern garfish (formerly southern sea garfish) (*Hyporhamphus melanochir*) and Australian herring (*Arripis georgianus*).

The South West Coast Salmon Managed Fishery operates on various beaches south of the metropolitan area. This fishery uses seine nets, to take western Australian salmon (*Arripis truttaceus*).

The West Coast Beach Bait Managed Fishery operates on various beaches from Moore River (north of Perth) to Tim's Thicket (south of Mandurah). The South West Beach Seine Fishery operates on various beaches from Tim's Thicket southwards to Port Geographe Bay Marina. These seine net fisheries both target whitebait (*Hyperlophus vittatus*), but blue sprat (*Spratelloides robustus*), sea mullet (*Mugil cephalus*), yellowfin whiting (*Sillago schomburgkii*), southern garfish and yelloweye mullet (*Aldrichetta forsteri*) are also taken in small quantities.

A number of commercial beach net fishers currently operate outside the metropolitan area under an Exemption that allows them to fish in the waters of the West Coast Demersal Scalefish (Interim) Managed Fishery. These fishers mainly use beach seine nets to target sea mullet, mulloway (*Argyrosomus hololepidotus*), Australian herring, yellowfin whiting and southern garfish.

Commercial - Estuarine

West Coast Estuarine (Interim) Managed Fishery (WCEF) operates in the Swan/Canning and Peel/Harvey estuaries. It is a multi-species fishery targeting blue swimmer crabs (*Portunus pelagicus*) and numerous finfish species. The blue swimmer crab component of the fishery is reported in the West Coast Blue Swimmer Crab Fishery status report. The finfish component is described in this report. The methods used by commercial fishers to target finfish in West Coast Bioregion estuaries are gill nets and seine nets.

A small number of operators have a condition on their Fishing Boat Licence to operate in other West Coast Bioregion estuaries (Hardy Inlet: 1 operator; Vasse/Wonnerup and Toby Inlet: 5 operators). The latter estuary system is only occasionally fished, yielding small quantities of sea mullet. These estuaries are not included in the WCEF interim management plan.

Recreational

Most finfish caught recreationally in West Coast Bioregion estuaries and nearshore waters are taken by shore or boat-based line fishing. The most commonly targeted recreational species include Australian herring, tailor (*Pomatomus saltatrix*), whiting (various species) (Sillaginidae), southern garfish, silver trevally (*Pseudocaranx* sp.) and black bream (*Acanthopagrus butcheri*) (estuaries only).

A relatively small amount of recreational net fishing occurs in the West Coast Bioregion, mainly to target sea mullet.

Governing legislation/fishing authority

Commercial

West Coast Estuarine Fishery (Interim) Management Plan 2003

West Coast Estuarine (Interim) Managed Fishery Permit

Cockburn Sound (Fish Net) Management Plan 1995

Cockburn Sound Fish Net Managed Fishery Licence

Cockburn Sound (Line and Pot) Management Plan 1995

West Coast Demersal Scalefish Fishery (Interim) Management Plan 2007

West Coast Demersal Scalefish (Interim) Managed Fishery Permit

West Coast (Beach Bait Fish Net) Management Plan 1995

West Coast (Beach Bait Fish Net) Managed Fishery Licence

South-West Coast Salmon Fishery Management Plan 1982

South-West Coast Salmon Managed Fishery Licence

Proclaimed Fishing Zone Notice (South-West Coast) 1975

Salmon Block Net Prohibition Notice 1996

Closed waters and Permitted Gear Orders under Section 43 of the Fish Resources Management Act 1994

Condition 19 on a Fishing Boat Licence

Condition 65 and 66 on a Fishing Boat Licence

Condition 68 on a Fishing Boat Licence

Condition 84 on a Fishing Boat Licence

Condition 17 on a Commercial Fishing Licence

Salmon and Snapper Purse Seining Prohibition Notice 1987

Directions to Licensing Officers

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation

Recreational Net Fishing Licence

Consultation processes

Commercial

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

Recreational

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

Boundaries

Commercial - Estuarine

WCEF: The management plan encompasses all estuaries in the West Coast Bioregion between 27° S and 33°11' S.

Complex closures exist for both the Swan/Canning and Peel/Harvey commercial fisheries (refer to management plans, related legislation and regulations).

Leschenault Estuary is closed to commercial fishing. The waters of the Vasse/Wonnerup Estuary and Toby's Inlet and all estuaries and canals located in between are open to commercial fishing.

Waters of Hardy Inlet and the Blackwood River are open to commercial fishing upstream from a line connecting Point Irwin to the Irwin Street boat ramp to a line drawn across the river from the eastern boundary of Sussex Location 133 (approximately Great North Road).

Commercial - Nearshore

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

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

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

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

Recreational

Recreational line fishing is permitted in most areas within estuaries and nearshore waters of the West Coast Bioregion. Some spatial closures exist, including closures in marine reserves and around industrial structures.

A small number of areas within estuaries and nearshore waters of the West Coast Bioregion are open to recreational netting. Recreational net fishers must hold a licence. Recreational net fishing regulations are complex – please refer to the 'Recreational Net Fishing Guide' for details.

Management arrangements

Commercial

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

Recreational

Recreational fishers in West Coast Bioregion nearshore and estuarine waters take a diverse array of finfish species. Size and possession limits apply to these species when caught recreationally in the West Coast Bioregion. Refer to the 'Recreational Fishing Guide - West Coast Bioregion' for details. A State-wide Recreational Fishing from Boat Licence (RFBL) was introduced on 2 March 2010. A RFBL is required to undertake any general fishing activity (including crabbing) conducted with the use of a powered boat anywhere in the State.

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

Indicator species

The Department of Fisheries has selected several key species as indicators for monitoring and assessing the status of the

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finfish resources in the West Coast Bioregion (DoF 2011¹). Australian herring, tailor, southern garfish and whiting species are indicators for this Bioregion's nearshore finfish suite and black bream, Perth herring (*Nematalosa vlaminghi*) and cobbler (*Cnidogobius macrocephalus*) are indicators for the estuarine finfish suite. Although not an indicator, the status of sea mullet (*Mugil cephalus*) is also reported here because it is a significant component of nearshore fishery landings in this Bioregion.

Tailor, black bream and King George whiting (*Sillaginodes punctata*) are currently assigned to the 'medium risk' category (individual species daily bag limits of 8, 4 and 8, respectively, apply to recreational fishers). Australian herring, southern garfish, sea mullet, southern school whiting (*Sillago bassensis*) and Perth herring are assigned to the 'low risk' category (mixed species daily bag limit of 30 fish). Cobbler (*Cnidogobius macrocephalus*) is assigned to the 'medium risk' category (daily bag limit of 4), except in the Swan-Canning Estuary, where a total fishing ban is in effect until 2017.

Research summary

Monitoring of fisheries and fish stocks in West Coast Bioregion nearshore and estuarine waters is based on commercial catch and effort statistics (CAES) from compulsory monthly returns, recreational catch and effort data from voluntary recreational fisher log books (Research Angler Program) and recreational fishing surveys, fishery-independent surveys using beach seine nets to monitor annual juvenile recruitment by various fish species (including Australian herring, whiting and mullet) and research angling to monitor annual juvenile tailor recruitment. Rates of fishing mortality (F) will be used to monitor the status of Australian herring, commencing in 2012.

While commercial catch levels are determined annually from data reported in compulsory monthly commercial returns, recreational catch levels are estimated only occasionally when recreational fishing surveys are conducted.

A state-funded NRM research project designed to provide more rigorous monitoring and assessment of the status of West Coast Bioregion nearshore indicator species (Australian herring, tailor, whiting species and southern garfish) commenced in mid-2009 and is due to be completed in late 2012. Volunteer anglers and commercial fishers provided samples of these species to enable researchers to determine the age structure of recreational and commercial catches in the West Coast Bioregion. This information will enable development of methods to monitor levels of fishing mortality for Australian herring.

The NRM-funded project is also examining aspects of stock structure, including sources of recruitment to the West Coast Bioregion Australian herring and tailor stocks. The majority of West Coast Bioregion tailor landings are taken by recreational fishers in the metropolitan area. Monitoring of juvenile tailor recruitment since the mid-1990s has identified

two significant 'pulses' of 0+ recruits that arrive each year. Limited data suggests that these pulses are products of both local and remote (i.e. outside Perth metropolitan waters) spawning events. Research is currently underway to examine source(s) of recruitment to the metropolitan tailor fishery, which may also assist in explaining the highly variable annual recruitment to this fishery. The proportions of Australian herring in the West Coast Bioregion fishery that originate from nursery sites in the West Coast and South Coast Bioregions is also being examined.

As an extension of the NRM-funded project, a tagging study of Australian herring commenced in 2012. Recaptures of tagged fish will be provide detailed information about movement within the WCB to aid interpretation of other data and ensure effective future management for herring. Tagging and recaptures over successive years will also provide an independent estimate of mortality for comparison with estimates obtained from the analysis of age structure. This will provide an alternative estimate of F.

Retained Species

Total commercial finfish landings (2011):

132 tonnes in nearshore waters

89 tonnes in estuarine waters

Commercial landings by fishery (2011):

South West Coast Salmon: 6 tonnes (salmon)

WC Beach Bait + SW Beach Seine:

35 tonnes (whitebait)

West Coast Estuarine: 74 tonnes (finfish)

Commercial catches (West Coast Nearshore and Estuarine Table 1) are taken by estuarine fisheries and beach-based fisheries using gill nets, haul nets and beach seines. Minor quantities of the same species that are taken by other methods (e.g. purse seine, demersal gill nets and long-lines) are generally not included this report, although catches by all methods and all fisheries are included in the total catches reported for key species and are taken into account in stock assessments.

In 2011, the total commercial catch of finfish by estuarine and beach-based fisheries in the West Coast Bioregion included approximately 25 species. The majority of the catch consisted of sea mullet (28% by weight), Australian herring (16%), whitebait (16%) and southern garfish (9%).

Key finfish species:

Commercial nearshore species

Australian herring: Australian herring comprise a single stock across southern Australian waters. This species is targeted commercially in Western Australia (WA) and South Australia (SA). Negligible quantities are also taken commercially in Victoria. The proportion of total commercial landings taken in South Australia was relatively constant, typically 20-30% per year, from the early 1970s until 2007. However, in the past 3 years (2008-2011), SA landings comprised 43% of the national catch.

¹ Department of Fisheries (DoF). 2011. Resource Assessment Framework (RAF) for Finfish Resources in Western Australia. Fisheries Occasional Publication No. 85. Department of Fisheries, Perth.

In WA, 83% of total commercial landings of Australian herring since 2000 were taken in the South Coast Bioregion, with the remaining 17% taken in the West Coast Bioregion. Within the South Coast Bioregion, 90% of landings since 2000 were taken by the ocean beach-based herring trap net fishery (see South Coast Nearshore and Estuarine Finfish Resources Report), 6% taken in estuaries and the remainder taken by other fishers in nearshore waters. All trap net fishery landings were taken in the Albany area. Within the West Coast Bioregion, 60% of landings since 2000 were taken in the Geographe Bay/Bunbury area, 23% taken in Cockburn Sound and 9% taken in the Peel-Harvey Estuary.

Nationally, commercial landings of Australian herring peaked at approximately 1800 t per year in the late 1980s and early 1990s and steadily declined thereafter (West Coast Nearshore and Estuarine Figure 1). National landings were approximately 265 t in 2011, the lowest level since the start of reliable catch records in 1950. Commercial landings within WA and in SA each followed this trend. In WA, landings peaked at 1,537 t in 1991 and reached an historical low of 147 t in 2011. In SA, landings peaked at 498 t in 1987/88 and reached an historical low of 105 t in 2006/07. In 2010/11, 118 t of herring was landed in SA¹.

In the South Coast Bioregion of WA, the total annual commercial catch reached an historical peak of 1,427 t and then steadily declined to an historical low of 110 t in 2011. Recent low catches in the South Coast Bioregion reflects declining catches by the trap net fishery. The decline is believed to be due a combination of factors – reduced availability of fish due to multiple recent years of low recruitment and lack of targeting by the trap net fishery in response to low market demand.

In the West Coast Bioregion, the total annual commercial catch of Australian herring reached an historical peak of 211 t in 1988 and attained a similar level of 191 t in 1992. Annual landings then steadily declined to reach an historical low of 31 t in 2010. In 2011, the catch remained low at 37 t. The downward trend in the West Coast Bioregion mainly reflected declining catches in the Geographe Bay/Bunbury area. Landings of Australian herring in Cockburn Sound declined only slightly. Declines in the Geographe Bay/Bunbury area were partly due to a substantial decline in fishing effort (i.e. decline in targeting) after 2005. Prior to 2005, annual effort was stable/increasing and the decline in catch was mainly attributable to the reduced availability of fish.

Tailor: In WA, tailor is found in coastal waters from Onslow to Esperance and is likely to constitute a single stock over this range. Incomplete records prior to 1976 suggest the total WA annual commercial catch of tailor probably peaked in 1965 at approximately 90 t. Since 1976, annual landings have fluctuated between 19 and 59 t and the overall trend was stable (non-directional) (West Coast Nearshore and Estuarine Figure 2). In 2011, the total WA catch of tailor was 25 t,

which was mostly caught in the Gascoyne Coast Bioregion. Since 2000, 84% of total WA commercial landings of tailor have been taken in the Gascoyne Coast Bioregion, 15% in the West Coast Bioregion and 1% in the South Coast Bioregion.

In the Gascoyne Coast Bioregion, total landings of tailor were typically 20-30 t per year during the period 1976-1990. Annual landings were markedly higher (>30 t per year) during the period 1990-2000, including an historical peak of 49 t in 1999. Elevated catches in this period probably reflect a higher availability of fish due to strong recruitment. After 2000, annual landings returned to levels similar to those reported prior to 1990. In 2011, the Gascoyne catch was 18 t, virtually all of which was taken in Shark Bay.

In the West Coast Bioregion, total landings of tailor declined from 28 t in 1976 to reach an historical minimum of 2 t in 2008. Subsequent landings have increased slightly, reaching 6 t in 2011. Since 2000, the majority (55%) of West Coast landings were taken in the Peel-Harvey Estuary.

Whiting: From 2000 to 2011, 67% of total commercial landings of whiting (all species) in WA were taken in the Gascoyne Coast Bioregion, 23% were taken in the West Coast Bioregion, 7% in the South Coast Bioregion and 3% in the North Coast Bioregion. Since 2000, the Hardy Inlet and the Peel-Harvey Estuary each contributed about 25% of total commercial whiting landings in the West Coast Bioregion.

Within the West Coast Bioregion, total landings over this period were reported to be mainly yellowfin whiting (86%) and King George whiting (9%). However, with the exception of King George whiting, there may be misidentification of some commercial landings of whiting. At least five species of *Sillago* are known to be taken commercially in the West Coast Bioregion. The species composition of whiting landings (commercial and recreational) is currently being investigated by the Department.

The total annual commercial catch of whiting in the West Coast Bioregion was 27 t in 2011. The whiting catch has been gradually declining due to an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of various fishery adjustment schemes (licence buy-backs) operating since 1990.

Southern garfish: There are possibly five species of garfish landed in WA waters. However, the vast majority of commercial garfish landings are believed to be southern garfish (*Hyporhamphus melanochir*) with small quantities of river garfish (*H. regularis*) and robust garfish (*H. robustus*) also landed. Since 2000, 54% of total commercial landings of garfish in WA have been taken in the West Coast Bioregion, with 31% from the South Coast, 13% from the Gascoyne Coast and 1% from the North Coast Bioregions.

In the West Coast Bioregion, total annual garfish landings peaked at 44 t in 1999. Subsequently, annual landings were quite variable but the overall trend was downward until 2007, when 11 t was taken. The decline was partly due to a reduction in commercial effort. Since 2007, West Coast Bioregion total annual garfish landings have been increasing gradually. In 2011, 19 t of garfish was taken in the West Coast Bioregion.

Since 1995, 82% of total commercial landings of garfish in the West Coast Bioregion have been taken in Cockburn Sound. The historical peak in annual landings within Cockburn Sound was 37 t in 1999. Since 2000, annual

¹ Knight MA and Tsoilos A. 2012. South Australian Wild Fisheries Information and Statistics Report 2010/11. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2008/000804-4. SARDI Research Report Series No. 612. 57pp.

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landings of garfish in Cockburn Sound have been relatively stable, ranging between 10 and 20 t.

Whitebait: In WA, whitebait occurs from Kalbarri southwards but is relatively rare along the south coast. All commercial landings of whitebait in WA are taken in the West Coast Bioregion, between Perth and Busselton. Fishing occurs in two areas: Area 1 (Tim's Thicket to Busselton) is fished by the West Coast Beach Bait Managed Fishery and Area 2 (Perth to Tim's Thicket) is fished by the South West Beach Seine Managed Fishery. Total landings have declined since the 1990s when historic peaks of about 330 t occurred in 1990 and 1997 (West Coast Nearshore and Estuarine Figure 3). The decline partly reflects declines in landings in Area 1 following effort reductions in this area. Annual landings in Area 2 have been relatively stable (with the exception of 2011) and virtually all (97%) landings since 2004 have been in this area. In 2011, the total commercial catch of whitebait was 35 t, all of which was landed by the South West Beach Seine Fishery. This was the lowest catch since the commencement of the fishery in the early 1970s. It coincided with very unusual oceanographic conditions associated with a 'heatwave' event along the west coast (Pearce et al. 2011¹). Substantial variations in whitebait landings appear to occur in response to environmental factors including El Niño-Southern Oscillation (ENSO) and Leeuwin Current fluctuations.

Sea mullet: Sea mullet occurs in coastal waters in all WA Bioregions. There is likely to be connectivity between Bioregions due to adult migration and larval dispersal, which could result in a shared sea mullet stock across some/all Bioregions. There may also be connectivity between sea mullet along the south coast of WA and in SA. The total WA annual catch of sea mullet peaked at 694 t in 1988 and then gradually declined (West Coast Nearshore and Estuarine Figure 4). The decline was mainly due to widespread reductions in commercial fishing effort in nearshore and estuarine waters. In 2011, the WA total catch was 213 t.

Historically, annual landings of sea mullet were higher in the WCB than in the GCB but, since 2000, GCB landings have been slightly higher each year. From 2000 to 2011, 45% of total commercial landings of sea mullet in WA were taken in the Gascoyne Coast Bioregion, with 43% from the West Coast, 11% from the South Coast and <1% from the North Coast Bioregions.

In the West Coast Bioregion, commercial landings of sea mullet were highest during the 1970 and 1980s, including an historical peak of 429 t in 1988. Between 1988 and 2004, the total annual catch in the West Coast Bioregion steadily declined. The decline was partly due to an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of various Voluntary Fisheries Adjustment Schemes (VFAS) (licence buy-backs) operating since 1990. From 2004 to 2011, total landings were stable at 100-120 t per year. In 2011, landings declined to 62 t. Since 2000, 49% of total commercial landings of sea mullet in the West Coast

Bioregion were taken in the Peel-Harvey Estuary and 16% from ocean waters near Jurien Bay (latitude 30-31°S).

In the South Coast Bioregion, commercial landings of sea mullet have been stable (non-directional) over a long period. Since 1976 the annual catch has averaged 36 t (range 11-94 t per year). In 2011, the catch was 31 t. Historically, the vast majority (>90%) of annual landings of sea mullet in the South Coast Bioregion have been from estuaries. Since 2000, 30% of total commercial landings of sea mullet in the South Coast Bioregion have been taken in Wilson Inlet, 18% in Oyster Harbour, 17% in Beaufort Inlet, and 14% in Gordon Inlet. Minor sea mullet landings were reported in all other estuaries open to commercial fishing over this period.

In the Gascoyne Coast Bioregion, commercial landings of sea mullet peaked at 266 t in 1982, and have since gradually declined. Since 2000, the annual commercial catch has fluctuated between 64 and 165 t. Virtually all landings were taken in Shark Bay. In 2011, 100 t of sea mullet was caught commercially in the Gascoyne Coast Bioregion.

Commercial estuarine species

Perth herring: Perth herring is endemic to the West Coast Bioregion of WA and constitutes a single stock over this range. 'Perth herring' previously reported from the Gascoyne Coast Bioregion are now believed to be a different species. Historically, the majority of landings of this species were caught in the Swan-Canning Estuary. Commercial targeting of Perth herring in this estuary ceased in 2007. The minor quantities taken in subsequent years were predominantly from the Peel-Harvey Estuary. Since 2000, <3 t of Perth herring per year has been reported from the Peel-Harvey Estuary.

Recent landings of Perth herring are very low compared to historical landings. From 1963 to 1988, annual commercial catches of Perth herring in the Swan-Canning Estuary were consistently >40 t, including a historical peak of 178 t in 1968. Total West Coast Bioregion landings peaked at 239 t in 1978. Declining landings are partly due to an ongoing reduction in commercial effort in estuarine and nearshore waters as a result of VFAS (licence buy-backs) operating since 1990. However, decreasing stock abundance as a result of deteriorating environmental conditions in West Coast Bioregion estuaries and historical overfishing are believed to be the main factors contributing to the current low stock level.

Cobbler: In WA, commercial targeting of cobbler is essentially restricted to estuaries. Each estuary hosts a discrete stock of cobbler, which is genetically distinct to other estuarine populations and also distinct to cobbler populations in adjacent ocean waters. Since 2000, 95% of commercial landings of cobbler have been caught in estuaries of the South Coast Bioregion, with the remaining 5% in estuaries of the West Coast Bioregion. Virtually all West Coast landings over this period were in the Peel-Harvey Estuary.

Historically, commercial catches of cobbler in West Coast Bioregion estuaries were much higher. Landings peaked at 298 t in 1961 in the Peel-Harvey Estuary, at 158 t in 1958 in Leschenault Estuary and at 56 t in 1960 in the Swan-Canning Estuary. Landings in the Hardy Inlet have always been relatively low.

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.

In the Peel-Harvey Estuary, cobbler landings during the 1950s, 1960s and 1970s were frequently >100 t. Landings in the 1970s (1970-79) averaged 127 t per year. However, annual landings fell dramatically from 233 t to 49 t between 1980 and 1982. From 1983 to 1996, annual landings ranged from 3 to 74 t. Since 1996, annual landings have ranged from <1 t to 10 t. In 2011, 7 t of cobbler was reported in this estuary.

In the Swan-Canning Estuary, annual cobbler landings during the 1960s and 1970s were frequently >20 t (average catch 31 t per year for period 1959-1977). However, landings fell dramatically from 76 t to 7 t between 1976 and 1978. From 1978 to 1996, annual landings ranged from 1 to 10 t. After 1997, annual catches in the Swan-Canning Estuary were <800 kg. A prohibition to catch cobbler in the Swan-Canning Estuary was introduced on 6 July 2007 in order to protect the stock.

In the Leschenault Estuary, a period of relatively high cobbler landings occurred from 1955 to 1965 (average 45 t per year, 1955-65). Landings declined from 17 t in 1978 to 2 t in 1979. From 1979 until the closure of the commercial fishery in 2000/01, annual catches of cobbler ranged from <1 t to 6 t.

Declining landings are partly due to an ongoing reduction in commercial effort in estuaries since 1990. However, decreasing stock abundance as a result deteriorating environmental conditions in West Coast Bioregion estuaries and historical overfishing are believed to be the main factors contributing to the current low stock levels.

Black bream: Black bream is a true estuarine species, spending its entire life cycle in these waters. Each estuary hosts a discrete stock of black bream, which is genetically distinct to other estuarine populations. Most estuaries and coastal lagoons in south-western WA host a black bream population. Since 2000, 93% of commercial landings of black bream have been in the South Coast Bioregion, with the remaining 7% from the West Coast Bioregion.

In the West Coast Bioregion, commercial landings of black bream have always been relatively low compared to landings of other estuarine target species. Historically, the Swan-Canning Estuary and Hardy Inlet contributed the vast majority of commercial black bream landings. Landings peaked at 8 t in 1996 in the Swan-Canning Estuary and peaked at 4 t in 1983 in Hardy Inlet. Occasional landings were taken in the Leschenault Estuary (<2 t per year), prior to the closure of that fishery. Annual landings of bream in the Peel-Harvey Estuary have always been negligible. Commercial targeting of black bream in the Swan-Canning Estuary has been negligible since 2007, resulting in the Hardy Inlet now being the only (albeit minor) commercial bream fishery in the West Coast Bioregion.

Since 2000, total West Coast Bioregion commercial landings of black bream have ranged from <1 to 5 t per year.

Recreational catch estimate (2011): N/A

Most recent catch estimate (2000/01):
940 tonnes (key species only)

The recreational catch levels of finfish in nearshore and estuarine waters of the West Coast Bioregion were not estimated for 2011. The most recent estimates are from the

National Recreational and Indigenous Fishing Survey conducted in 2000/01 (West Coast Nearshore and Estuarine Table 2). The exception is Hardy Inlet, where a creel survey was conducted in 2005/06¹. While the dominant species in the nearshore catch are probably similar to those caught in 2000/01, the current catch and effort levels by nearshore recreational fishers may have changed substantially since this survey. Therefore, current total catch level cannot be estimated.

Overall, the most abundant species in the retained catch (nearshore and estuarine combined) in 2000/01 were Australian herring (48% by number), whiting (various species, excluding King George) (24%), tailor (9%), southern garfish (3%), King George whiting (2%) and trevally (*Pseudocaranx* spp.).

The regions of highest catches were southern metropolitan, Mandurah and Geographe Bay/Bunbury, each of which contributed about 20% of all retained fish. In nearshore waters, 61% of retained fish were taken by shore fishers.

Surveys of boat-based recreational fishing in the West Coast Bioregion estimated catches of key nearshore species in 1996/97 and 2005/06 (West Coast Nearshore and Estuarine Table 3). Boat-based landings of many nearshore species typically declined between these surveys. This trend could indicate a decline in abundance of nearshore species. However, since landings of demersal species typically increased between surveys, it may also reflect a shift in effort by boat-based fishers towards targeting of demersal species instead of nearshore species.

Additional West Coast Bioregion boat-based surveys were conducted in 2008/9 and 2009/10. A comprehensive Statewide Recreational Boat Fishing Survey was conducted in 2011/12, with results due in late 2012 (Department of Fisheries, unpub. data).

Total landings of nearshore and estuarine species cannot be estimated from the results of these boat-based surveys because shore-based fishers, who are believed to take the majority of the recreational nearshore and estuarine finfish catch, were not surveyed.

The Department of Fisheries recently conducted a pilot study of shore-based fishers in the Perth Metropolitan area from April to June 2010 in an attempt to determine the best method to quantify recreational fishing catch and effort from this sector (Smallwood et al. 2011²). During this three-month pilot study, the most frequently retained species were Australian herring, southern garfish and whiting (combined species).

¹ Prior SP and Beckley LE. 2006. Creel survey of the Blackwood Estuary, 2005-06. Final report to South West Catchments Council (Project C3-01).

² Smallwood CB, Pollock KH, Wise BS, Hall NG and Gaughan DJ. 2011. Quantifying recreational fishing catch and effort: a pilot study of shore-based fishers in the Perth Metropolitan area. Fisheries Research Report 216. Department of Fisheries, Perth.

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Recreational catch share

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

Fishing effort/access level

Commercial

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

Fishing effort in nearshore and estuarine fisheries is sometimes reported as the number of units of access (vessels, licensees, teams, etc). These measures of effort provide a general indication of effort changes over time and are often the only types of effort data available throughout the history of each fishery. Where possible, effort is also calculated as the number of days fished by each method. It is considered that 'method days fished' generally provides a more accurate measure of the effort undertaken in each fishery.

Licence holders in the West Coast Bioregion estuaries that are open to commercial fishing are endorsed to fish a single estuary system only.

Peel-Harvey Estuary: A substantial proportion of fishing effort in this estuary is directed towards the capture of blue swimmer crabs (50-60% of method days per year since 2000). The vast majority of crabs are taken by crab pots, whereas finfish are taken by gill and haul nets. Since 2000, the effort spent targeting finfish in this estuary (i.e. days spent gill and haul netting) has been stable, fluctuating between 600 and 1200 method days per year. Since 2000, the mean number of active fishing units per month has been about 8. There are currently 11 licences in the fishery.

Swan-Canning Estuary: The mean number of active fishing units per month declined from about 25 in the mid-1970s to 1 in 2009 and subsequent years. The majority of total commercial effort in 2011 and other recent years was spent targeting blue swimmer crabs.

Hardy Inlet: The mean monthly number of fishing units declined from 3 in the 1970s to 1 in 2000 and subsequent years, including 2011. Virtually all commercial effort in recent years was spent targeting a limited number of finfish species.

Cockburn Sound (Fish Net) fishery: Since the early 1990s, there has been a progressive decline in the number of commercial licences operating in Cockburn Sound as a result of VFAS. In the Cockburn Sound (Fish Net) fishery, the number of licences fell from six in the early 1990s to one in 2003 and subsequent years. All effort by this fishery is spent targeting finfish.

Moore River to Kalbarri: The total number of method days fished in this region by shore-based net fishers (gill nets, haul nets and beach seines only) in 2011 was 318. In 2011, 6 licensees reported finfish landings by netting methods in this region.

South West Coast Salmon Fishery: From 1997 to 2005, 15 teams were licenced to capture western Australian salmon in the West Coast Bioregion. This number was

reduced via VFAS to 12 teams in 2006 and then to 8 teams in 2010 and subsequent years. Only 3 of the 8 teams reported salmon catches in 2011.

West Coast Beach Bait and South West Beach Seine Fisheries: In 2011, 5 licensees reported landings of whitebait.

Recreational

Twelve month surveys of boat-based fishing in the West Coast Bioregion were conducted in 1996/7, 2005/6, 2008/9 and 2009/10. The 2011/12 Statewide Recreational Boat Fishing Survey will provide recreational boat fishing effort data for the West Coast Bioregion in 2012. These surveys estimated the total effort expended by boat-based recreational fishers in the West Coast Bioregion, including effort expended on all species. However, the proportion of boat-based effort spent targeting nearshore finfish during these surveys is unknown.

Recent estimates of effort by shore-based recreational fishers, who are believed to capture the majority of nearshore and estuarine finfish in the West Coast Bioregion, are unavailable. Effort data from the recently conducted pilot study of shore-based fishers (Smallwood *et al.* 2011¹) is not included here as this study's aim was to examine the relative benefits of different survey techniques and only investigated 3 months of metropolitan recreational fishing.

The 2000/01 National Recreational and Indigenous Fishing Survey, which included all methods and Bioregions, provided the most recent comprehensive information on recreational fishing effort in the West Coast Bioregion. About 95% of the nearshore and estuarine 'fishing events' that were targeting finfish during the survey used line fishing (bait or lure). About 75% of line fishing events in both nearshore and estuarine waters were shore-based. In nearshore waters, the estimated line fishing effort (either bait or lure) in 2000/01 comprised 946,841 shore-based and 308,673 boat-based fishing events during the 12-month survey period.

Stock Assessment

Assessment complete: Not all

Assessment level and method:

Level 2 - Catch rates

Breeding stock levels:

Australian herring	Uncertain
Tailor	Adequate
Southern garfish (Cockburn Sound)	Adequate
Whiting species	Not assessed
Sea mullet	Adequate
Whitebait	Adequate
Black bream (Swan-Canning)	Adequate

¹ Smallwood CB, Pollock KH, Wise BS, Hall NG and Gaughan DJ. 2011. Quantifying recreational fishing catch and effort: a pilot study of shore-based fishers in the Perth Metropolitan area. Fisheries Research Report 216. Department of Fisheries, Perth.

Black bream (other estuaries)	Not assessed
Cobbler (Peel-Harvey)	Adequate
Cobbler (other estuaries)	Not assessed
Perth herring	Not assessed

Indicator species - nearshore

Australian Herring (Uncertain): Australian herring form a single, genetically homogeneous breeding stock across southern Australia. Spawning occurs mainly in the lower West Coast Bioregion (Perth to Augusta) in WA during May-June. Eggs and larvae are dispersed by the Leeuwin Current to coastal nurseries distributed from the West Coast Bioregion to Victoria. A strong Leeuwin Current associated with a *La Niña* event can result in high annual recruitment outside the West Coast Bioregion due to greater larval dispersal. Australian herring caught by the trap net commercial fishery in the South Coast Bioregion are mainly pre-spawning fish undergoing a westward migration to the West Coast Bioregion to spawn. These fish originate from juvenile nurseries in the South Coast Bioregion, SA and (to a lesser extent) Victoria. Australian herring caught in the West Coast Bioregion are a combination of these fish, plus fish originating from local juvenile nurseries in the West Coast Bioregion. There is no reverse migration after spawning – all adult fish remain in the West Coast Bioregion after spawning. Adult fish (the spawning stock) are primarily targeted by the West Coast Bioregion recreational fishery.

Declining commercial catch and catch rates suggest declining availability of Australian herring since 2000 in the South Coast Bioregion and in southern parts of the West Coast Bioregion (Capes, Geographe Bay and Bunbury regions) (Figure 1 and 5) but stable availability in Perth and in areas north of Perth. The catch rates of voluntary recreational logbook fishers also suggest a relatively stable trend in the availability of Australian herring in Perth from 2006 to 2011, albeit with a slight decline in 2011 (West Coast Nearshore and Estuarine Figure 6). Declining catches in southern areas reflect a reduced availability of fish, probably due to low recruitment in these areas since 2000 (West Coast Nearshore and Estuarine Figure 7). Stable Perth catch rates possibly reflect more stable levels of annual recruitment in this area. Alternatively, catchability could have been maintained in this area due to the aggregation of spawning fish, despite a decline in overall stock abundance.

The cause of low recruitment in recent years appears to be partly due to environmental factors including the strength of the Leeuwin Current (weak south coast recruitment tends to occur in years of weak current). Very low recruitment was observed in 2011 during extremely unusual oceanographic conditions along the west coast, including summer temperatures $>3^{\circ}\text{C}$ above average in some areas (a 'heatwave' event, Pearce *et al.* 2011¹) (West Coast Nearshore and Estuarine Figure 7).

An extensive analysis of Australian herring sampled from

commercial and recreational landings since the 1970s was completed in 2011/12. The analyses of these data are currently undergoing external review which is expected to be completed by the end of 2012.

Tailor (Acceptable): Catch rates from a volunteer fishing program in the Swan-Canning Estuary provide an indicator of the strength of annual recruitment by juvenile (age 0) tailor to the West Coast Bioregion. Since this recruitment index began in 1996 there have been highly variable levels of annual recruitment (West Coast Nearshore and Estuarine Figure 8). Recruitment has followed an increasing trend since 2003. Anecdotal reports by West Coast recreational fishers of increasing catch rates of adult tailor over the past 3 years are consistent with the increases in the recruitment index over this period. Catch and catch rates of tailor in the main commercial fishery, the Shark Bay Beach Seine and Mesh Net Fishery, are within the historical range and are considered acceptable.

Southern garfish (Acceptable): Southern garfish are distributed across southern Australia from Kalbarri (WA) to Eden (NSW), and Tasmania. Southern garfish populations on the west and south coasts of WA are genetically distinct (Donnellan *et al.* 2002²) and are managed as separate stocks. Population structuring at finer scales has not been examined in WA, but evidence from elsewhere indicate that garfish populations are comprised of numerous sub-populations which are separated by small (<60 km) distances (Steer *et al.* 2009³, 2010⁴). On this evidence, garfish caught in Cockburn Sound are assumed to belong to a distinct sub-population and treated as a discrete management unit.

Cockburn Sound provides the majority of commercial landings of southern garfish. Recreational landings in this area are also believed to be substantial, although the total recreational catch is unknown due to lack of information about the shore-based component of the catch. Southern garfish are dependent on seagrass and other marine vegetation for reproduction and feeding. Seagrass area in Cockburn Sound has declined by around 80% since the 1950s and continues to be under threat due to ongoing development (e.g. dredging) (Cockburn Sound Management Council 2005⁵). For these reasons, the sustainability of garfish in

² Donnellan S, Haigh L, Elphinstone M, McGlennan D & Ye Q. 2002. Genetic discrimination between southern sea garfish (*Hyporhamphus melanochir*) stocks of Western Australia South Australia, Victoria and Tasmania. In Fisheries Biology and Habitat Ecology of Southern Sea Garfish (*Hyporhamphus Melanochir*) in Southern Australia (Jones GK, Ye Q, Ayvazian S & Coutin P, eds), pp. 9-34. FRDC Project 97/133. Canberra: Fisheries Research and Development Corporation.

³ Steer M, Fowler AJ and Gillanders BM. 2009. Age-related movement patterns and population structuring in southern garfish, *Hyporhamphus melanochir*, inferred from otolith chemistry. Fisheries Management and Ecology. 16:265–278.

⁴ Steer M, Halverson GP, Fowler AJ and Gillanders BM. 2010. Stock discrimination of Southern Garfish (*Hyporhamphus melanochir*) by stable isotope ratio analysis of otolith aragonite. Environmental Biology of Fish 89:369–381.

⁵ Cockburn Sound Management Council. 2005. Environmental Management Plan for Cockburn Sound and its Catchment. Department of Environment, Perth.

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.

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Cockburn Sound is at higher risk than other populations in WA.

Commercial catch rates suggest the abundance of garfish in Cockburn Sound varies annually although the overall trend suggests long term stability in abundance since 1996 (West Coast Nearshore and Estuarine Figure 9).

Sea mullet (Acceptable): A single breeding stock of sea mullet is believed to occur in each Bioregion. It is not known whether the same breeding stock occurs in the Gascoyne Coast, West Coast and South Coast Bioregions, although there is likely be connectivity between Bioregions due to adult migration and larval dispersal, which could result in a single stock across some/all Bioregions. Adult sea mullet typically occur in estuaries, except in winter when they migrate to ocean waters to spawn. Juveniles recruit to estuaries, where they remain until maturity. Trends in catch rates of sea mullet in Oyster Harbour and the Peel-Harvey Estuary are assumed to be indicative of abundance trends in the South Coast and West Coast Bioregions, respectively. These estuaries are permanently open to the sea. Catch rates of sea mullet in other estuaries that are seasonally closed can vary according to the extent of connectivity to the sea (i.e. sand bar openings) rather than regional abundance. In the Gascoyne Coast Bioregion, catch rates in Shark Bay are assumed to be indicative of regional abundance trends.

The annual commercial catch rate of sea mullet since 1980 in Shark Bay, Peel-Harvey Estuary and Oyster Harbour suggest a stable long-term trend in the availability of sea mullet in the Gascoyne Coast, West Coast and South Coast Bioregions, respectively (West Coast Nearshore and Estuarine Figure 10).

Whitebait (Acceptable): Highly variable annual catches and catch rates are characteristic of this fishery. Variations in catch level are correlated with the strength of the Leeuwin Current in the previous year and with rainfall (Gaughan *et al.* 1996¹). The total commercial catch of 35 t in 2011 was the lowest since the commencement of the commercial whitebait fishery in the early 1970s. Highly unusual oceanographic conditions, resulting in a 'heatwave' event along the west coast of WA (Pearce *et al.* 2011²), occurred in 2011 and are likely to be the main reason for the low catch level.

Anecdotal reports and fishery-independent recruitment surveys by the Department in the Perth area are in agreement with local commercial catch and catch rate trends, all suggesting low abundance of whitebait in the Perth area in recent years due to poor juvenile recruitment (West Coast Nearshore and Estuarine Figures 3 and 11). An increase in juvenile recruitment was observed in 2011/12, which is expected to result in an increase in adult abundance in the Perth area in the following year. The annual catch and catch rate trends of whitebait in the Bunbury area suggest relatively stable long term abundance of whitebait in this area.

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

² 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.

Indicator species - estuarine

Black bream (Acceptable - Swan-Canning; Not assessed - other estuaries):

In the Swan-Canning Estuary, commercial and recreational catch rates suggested an increase in black bream availability between 1990 and 2000, followed by a slight decline from 2000 to 2006 (Smith 2006). Voluntary recreational logbook fisher catch rates suggest a slight decline in the availability of black bream in this estuary from 2005/6 to 2010/11 (West Coast Nearshore and Estuarine Figure 12). Black bream in other West Coast estuaries are not assessed.

Cobbler (Acceptable - Peel-Harvey; Not assessed - Swan-Canning and Leschenault):

Commercial catch rates suggest a stable trend in the availability of cobbler in the Peel-Harvey Estuary from 1990 until 2010. An increase in the catch rate in 2011 suggests the highest level of abundance since 1990 (West Coast Nearshore and Estuarine Figure 13). Cobbler in the Swan-Canning Estuary was assessed via catch rate trends until a fishing ban was imposed in 2007. Anecdotal information suggests ongoing low abundance of the estuarine stock. Cobbler in Leschenault Estuary has not been assessed since the commercial fishery closure in 2000.

Perth herring (Not assessed): Perth herring was assessed via commercial catch rate trends in the Swan-Canning Estuary until cessation of fishing for this species in 2007. Catch rates suggested a major decline in the availability of Perth herring after 1980. A single breeding stock of Perth herring occurs in the West Coast Bioregion. Swan-Canning catch rates are assumed to be representative of regional availability. Limited fishery-independent evidence suggests regional abundance remains relatively low compared to historical levels. However, insufficient information is available to assess current stock status. The development of fishery-independent monitoring methods is required for this species. Low spawning success due to environmental degradation in the upper reaches of West Coast estuaries and low rainfall are believed to be the main causes of low stock abundance.

Non-Retained Species

Bycatch species impact:

Low

The small-scale commercial fisheries in nearshore and estuarine waters mainly use gill, seine and haul nets that are deployed in a targeted manner. Few non-target species are taken. Mesh size regulations ensure that target species caught by these methods are within an appropriate size range. Minimal discarding occurs because virtually all fish taken can be retained and marketed.

Recreational fishers mainly use line-based methods in nearshore and estuarine waters. This method can result in the capture and release of a significant number of non-target species and undersized fish. The risks associated with post-release mortality vary considerably among species. In general, fish in nearshore and estuarine waters are captured from shallow depths and suffer less barotrauma-related injuries than deep water species.

Protected species interaction: Negligible

Interactions with protected species by the fishing gear used in these commercial fisheries is expected to be negligible. Estuarine birds have been known to interact with fishing nets, but none have been reported in recent years and the risk to their populations is negligible. Commercial fishers are required to report all interactions with protected species.

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

Ecosystem Effects**Food chain effects: Low**

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

The current low abundance of whitebait in the Perth area is believed to be due to environmental factors and unrelated to fishing. Whitebait in Warnbro Sound is an important source of food for the local colony of little penguins (*Eudyptula minor*). Low abundance of whitebait is believed to have contributed to poor breeding success by these penguins in recent years (B. Cannell, pers. comm.).

Habitat effects: Low

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

Social Effects**Commercial - nearshore**

In 2011, there was only 1 licensee operating in the Cockburn Sound (Fish Net) Managed Fishery employing 2 fishers per month. Landings from this fishery are used to supply restaurant and retail sectors in the Perth metropolitan area.

In 2011, there were 3 licensees (involving up to 7 fishers) operating within the West Coast Salmon Fishery during the western Australian salmon season. There were 6-31 commercial fishers per month employed in various fisheries targeting Australian herring during 2011. Australian herring and western Australian salmon fishers in the West Coast Bioregion supply local bait and human consumption markets.

Commercial - estuarine

In 2011, there was an average of 12 commercial fishers operating per month in estuaries of the West Coast Bioregion, largely supplying fresh fish to meet demand for locally-caught product.

Recreational

The nearshore and estuarine waters of the West Coast Bioregion are key areas for recreational fishing and other leisure activities such as snorkelling. Therefore nearshore and estuarine environments have a high social value in the region.

Interviews conducted during the 2011 Statewide Recreational Boat Fishing Survey will provide important data on the social aspects of the West Coast Bioregion boat-based fisheries in 2012.

Economic Effects**Estimated annual value (to fishers) for 2011:**

Level 1 - <\$1 million (finfish only)

Fishery Governance**Commercial****Current Fishing (or Effort) Level:**

West Coast Estuarine Fishery	Acceptable
Cockburn Sound (Fish Net) Fishery	Acceptable
South West Salmon Fishery	Acceptable
West Coast Australian herring fisheries	Acceptable (but under assessment)

Whitebait (West Coast Beach Bait + South West Beach Seine Fisheries)	Acceptable
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Target commercial catch range:**West Coast Estuaries (Peel/Harvey only)**

75 – 220 tonnes (finfish only)

Cockburn Sound (Fish Net) Fishery

30 – 112 tonnes (finfish only)

Salmon (South West + South Coast Fisheries)

1200 – 2800 tonnes

West Coast Australian herring fisheries

70 – 185 tonnes

Whitebait fisheries

60 – 275 tonnes

In the Peel-Harvey Estuary, the commercial catch of finfish in 2011 was 73 t, which was below the target range. This was the first year that the catch has been outside the target range. The Peel-Harvey fishery is primarily a blue swimmer crab fishery. The low 2011 finfish catch was a consequence of an effort shift towards targeting crabs. In the Cockburn Sound Fish Net Fishery the total catch of finfish in 2011 (31 t) was relatively low but was within the target range. The Cockburn Sound finfish catch has been below the target range for 4 of the past 6 years. The total catch of western Australian salmon (West Coast and South Coast landings combined) in 2011 (171 t) was below the target range. The salmon catch has now been below the target range for 5

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consecutive years. The West Coast herring catch in 2011 (37 t) was below the target range. The West Coast herring catch has been below the target range for 7 of the past 8 years (similar to the trend in the South Coast herring catch, which has been below the target range for 8 consecutive years). In 2011, the commercial catch of whitebait (35 t) was below the target range. This is only the second year that the whitebait catch has been outside the target range (2006 was the first).

Recreational

Current Fishing (or Effort) Level NA

Target catch range: Not developed

New management initiatives

The Department will be considering the results of recently completed research on the status of key nearshore species stocks and examining their implications for current management arrangements.

External Factors

Climate change is expected to have impacts on nearshore and estuarine ecosystems. Changes in environmental variables such as ocean temperature, currents, winds, nutrient supply, rainfall, ocean chemistry and extreme weather conditions are expected to have major impacts on marine ecosystems (Hobday *et al.* 2008¹). These impacts are expected to create both difficulties and opportunities for fisheries.

Many nearshore species are known to have their abundance levels affected by annual variation in coastal currents (particularly the Leeuwin and Capes Currents). These currents appear to influence the recruitment patterns of larvae of species such as whitebait, tailor, Australian herring and western Australian salmon and thus their subsequent recruitment into each fishery (Lenanton *et al.* 2009²).

In 2011, a very strong Leeuwin Current resulted in unusually warm ocean temperatures in coastal waters of the southern West Coast Bioregion and the western South Coast Bioregion. This 'heatwave' event caused widespread fish kills in the West Coast Bioregion. During and after this event there were reports of atypical distributions of various species (e.g. tropical species occurring in temperate waters) and unusual fish behaviour. The event altered the distribution and behaviour (eg. spawning activity, migration) of many nearshore finfish species, which is likely to have affected the catch levels of these species in 2011 and may continue to affect them in subsequent years.

The abundance of nearshore and estuarine species is likely to be affected by the quantity and quality of habitats that are available for spawning, feeding and/or nursery areas. Habitat loss is ongoing due to coastal development in the West Coast Bioregion and this is likely to result in further reductions in the abundance of nearshore and estuarine species. For example, loss of seagrass in Cockburn Sound is likely to have reduced garfish abundance. Since the 1950s, approximately 80% of the seagrass meadows in Cockburn Sound have been lost as a result of environmental degradation (Cockburn Sound Management Council 2005³). Juveniles of King George whiting are also strongly associated with seagrass and so may be impacted by habitat loss in Cockburn Sound.

West Coast Bioregion estuaries are highly modified, and often degraded, environments. In these estuaries, the impacts of environmental factors on stock abundances are likely to be at least as important as fishing pressure. Anecdotal reports suggest that habitat and climatic changes have altered the composition and abundance of fish communities in West Coast Bioregion estuaries, although lack of historical monitoring makes many of these changes difficult to quantify. However, in the Swan-Canning Estuary, abundant fishery data provides evidence of marked declines in fish abundance since 1990 or earlier (Smith 2006⁴). Stock declines in West Coast Bioregion estuaries are most pronounced among 'estuarine-dependent' species, i.e. those that rely on estuarine habitats for spawning, feeding and/or nursery areas (e.g. cobbler, Perth herring, black bream). Whilst not strictly estuarine-dependent, sea mullet and yelloweye mullet exhibit a strong preference for estuarine habitats when available. The status of these species may also be affected by the availability and quality of estuarine habitats. A variety of barriers to fish passage occur in estuaries (e.g. weirs, dredge plumes) which can disrupt the life cycle of migratory species (e.g. mullet, Perth herring).

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

¹ Hobday AJ, Poloczanska ES and Matear RJ (eds). 2008. Implications of Climate Change for Australian Fisheries and Aquaculture: a preliminary assessment. Report to the Department of Climate Change, Canberra, Australia. August 2008.

² Lenanton RC, Caputi N, Kangas M & Craine M 2009 The ongoing influence of the Leeuwin Current on economically important fish and invertebrates off temperate Western Australia – has it changed? *Journal of the Royal Society of Western Australia* 92: 111–127.

³ Cockburn Sound Management Council. 2005. Environmental Management Plan for Cockburn Sound and its Catchment. Department of Environment, Perth.

⁴ Smith KA. 2006. Review of fishery resources and status of key fishery stocks in the Swan-Canning Estuary Fisheries Research Report 156. Department of Fisheries, Perth.

WEST COAST NEARSHORE AND ESTUARINE TABLE 1

Total annual catches of finfish (except sharks and rays) from the estuarine and beach-based nearshore commercial fisheries in the West Coast Bioregion, 2007 to 2011.

Species	Scientific name	Catch (tonnes)				
		2007	2008	2009	2010	2011
Western Australian salmon	<i>Arripis truttaceus</i>	622.9	333.4	494.6	69.0	6.3
Whitebait	<i>Hyperlophus vittatus</i>	99.1	57.9	139.6	100.6	34.8
Sea mullet	<i>Mugil cephalus</i>	99.6	94.8	103.0	102.1	56.8
Australian herring	<i>Arripis georgianus</i>	41.5	34.7	34.6	30.6	36.9
Yelloweye mullet	<i>Aldrichetta forsteri</i>	37.0	26.2	26.1	24.7	11.5
Whiting species	<i>Sillago</i> spp.	22.9	21.7	23.9	22.5	21.6
Southern garfish	<i>Hyporhamphus melanochir</i>	11.5	11.0	15.7	15.8	19.2
Cobbler	<i>Cnidoglanis macrocephalus</i>	0.8	6.9	9.3	5.4	7.1
Perth herring	<i>Nematalosa vlamingi</i>	5.6	0.7	1.6	0.1	0.4
Tailor	<i>Pomatomus saltatrix</i>	1.7	1.5	7.1	4.8	6.3
King George whiting	<i>Sillaginodes punctata</i>	0.9	5.1	2.0	5.9	4.4
Trevally	Carangidae	2.0	1.2	2.1	3.5	2.1
Yellowtail scad	<i>Trachurus novaezelandiae</i>	2.2	2.5	1.2	0.9	1.2
Black bream	<i>Acanthopagrus butcheri</i>	0.9	1.0	1.1	2.6	0.7
Blue sprat	<i>Spratelloides robustus</i>	14.5	13.7	7.1	0.1	0.3
Other finfish	Teleostei	4.1	1.3	0.2	5.7	5.9
TOTAL		967.2	613.6	869.2	394.3	215.5

WEST COAST NEARSHORE AND ESTUARINE TABLE 2

Estimated total catches of key species by recreational fisheries in nearshore and estuarine waters in the West Coast Bioregion in 2000/01 (Henry and Lyle 2003¹).

Species	Scientific name	2000/01 Catch (tonnes)
Australian herring	<i>Arripis georgianus</i>	438
Tailor	<i>Pomatomus saltatrix</i>	187
Whiting	<i>Sillago</i> spp.	154
King George whiting	<i>Sillaginodes punctata</i>	60
Trevally	<i>Pseudocaranx</i> spp.	42
Southern garfish	<i>Hyporhamphus melanochir</i>	35
Black bream	<i>Acanthopagrus butcheri</i>	24
TOTAL		940

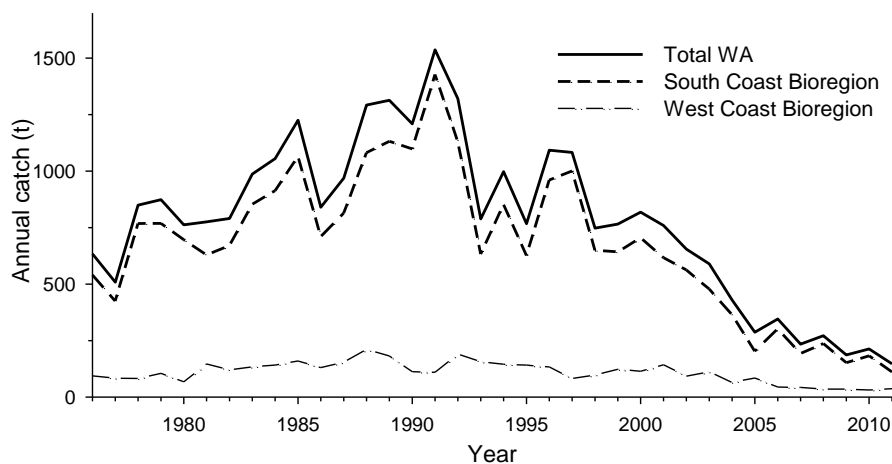
WEST COAST NEARSHORE AND ESTUARINE TABLE 3

Total annual catch estimates (+ standard error) (tonnes) of key nearshore species by boat-based recreational fishers in the West Coast Bioregion in 1996/97 and 2005/06 (Sumner *et al.* 2008²).

Species	Scientific name	1996/07 Catch (se)	2005/06 Catch (se)
Whiting	<i>Sillago</i> spp.	58 (9)	46 (3)
Australian herring	<i>Arripis georgianus</i>	46 (7)	40 (2)
Trevally	<i>Pseudocaranx</i> spp.	38 (10)	34 (4)
King George whiting	<i>Sillaginodes punctata</i>	28 (4)	19 (1)
Snook	<i>Sphyræna novaehollandiae</i>	23 (11)	9 (2)
Western Australian salmon	<i>Arripis truttaceus</i>	12 (5)	17 (3)
Tailor	<i>Pomatomus saltatrix</i>	14 (4)	3 (0.7)
Southern garfish	<i>Hyporhamphus melanochir</i>	7 (2)	2 (0.2)

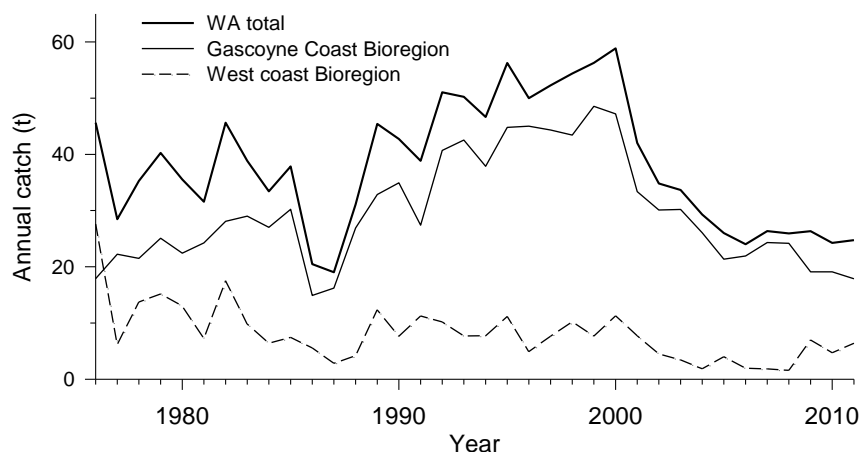
¹ Henry GW and Lyle JM. 2003. The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

² Sumner NR, Williamson PC, Blight SJ and Gaughan DJ. 2008. A 12-month survey of recreational boat-based fishing between Augusta and Kalbarri on the West Coast of Western Australia during 2005-06. Fisheries Research Report 177. Department of Fisheries, Perth.



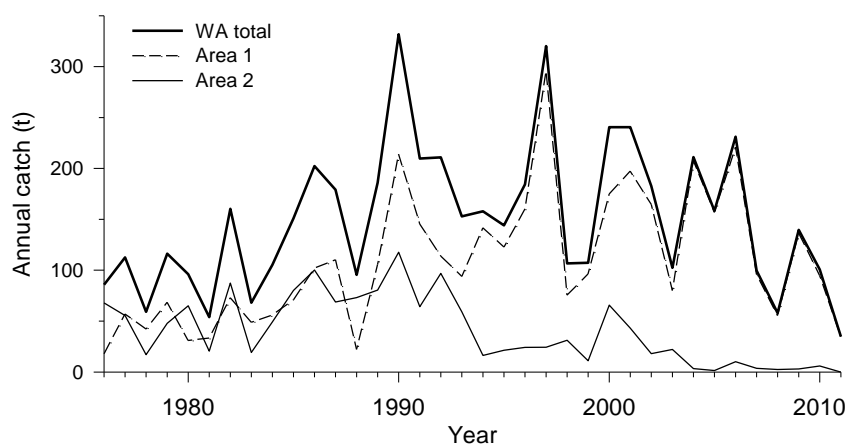
WEST COAST NEARSHORE AND ESTUARINE FIGURE 1

Annual commercial catches of Australian herring, by Bioregion, 1976 –2011.



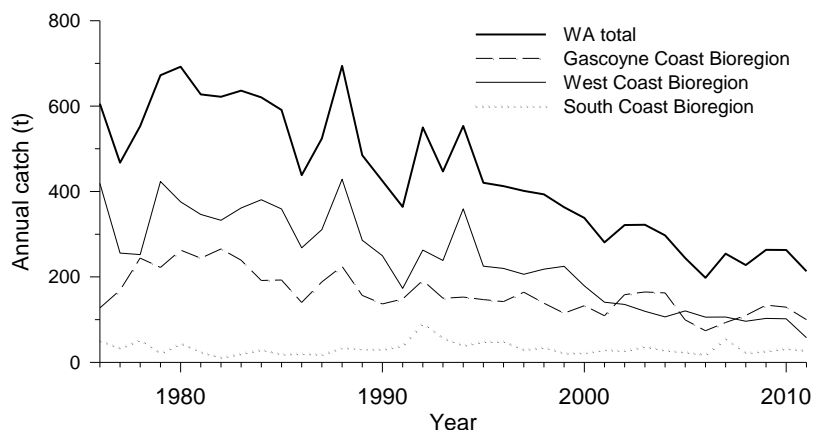
WEST COAST NEARSHORE AND ESTUARINE FIGURE 2

Annual commercial catches of tailor, by Bioregion, 1976 –2011. Minor catches in South Coast Bioregion are not shown, but are included in WA total.



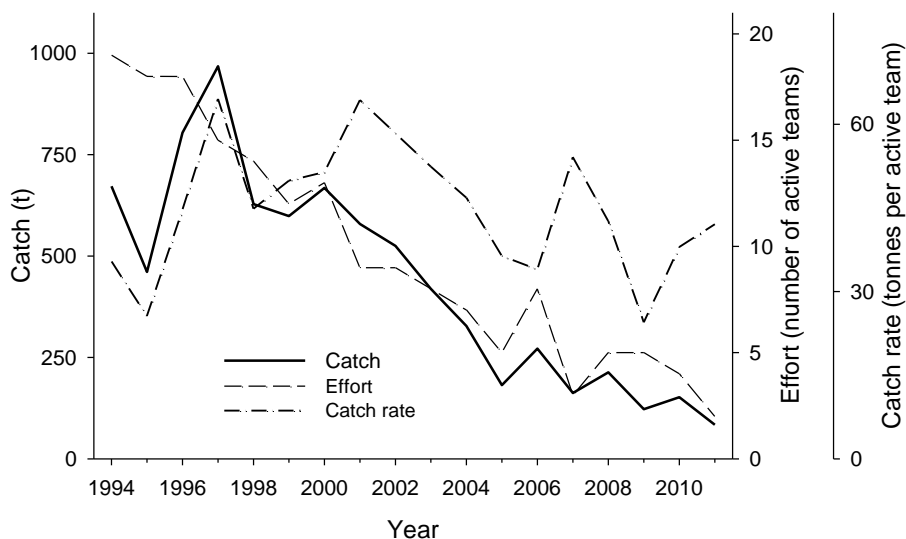
WEST COAST NEARSHORE AND ESTUARINE FIGURE 3

Annual commercial catches of whitebait in West Coast Bioregion, by fishing area, 1976 –2011. Area 1 = Bunbury; Area 2 = Perth/Mandurah.



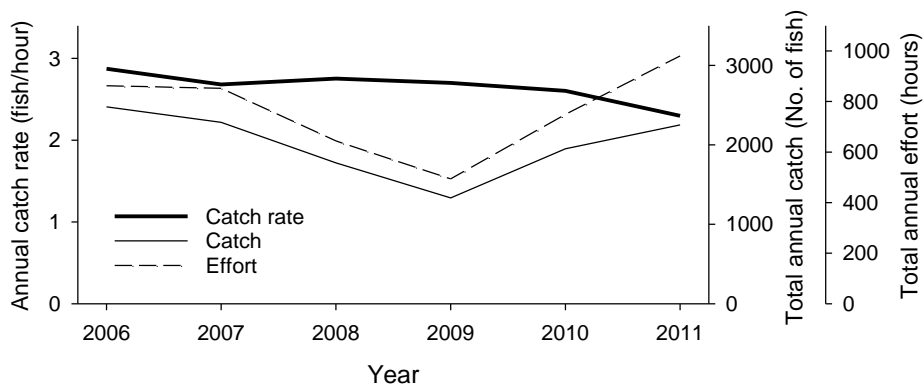
WEST COAST NEARSHORE AND ESTUARINE FIGURE 4

Annual commercial catches of sea mullet, by Bioregion, 1976 –2011. Minor catches in North Coast Bioregion are not shown, but are included in WA total.



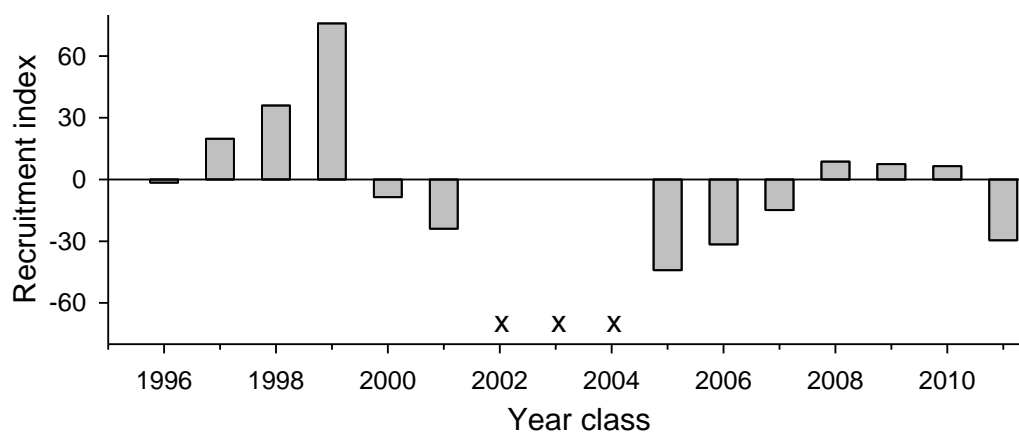
WEST COAST NEARSHORE AND ESTUARINE FIGURE 5

Total annual catch, effort and catch rate of Australian herring by the South Coast commercial trap net fishery, 1994 – 2011.



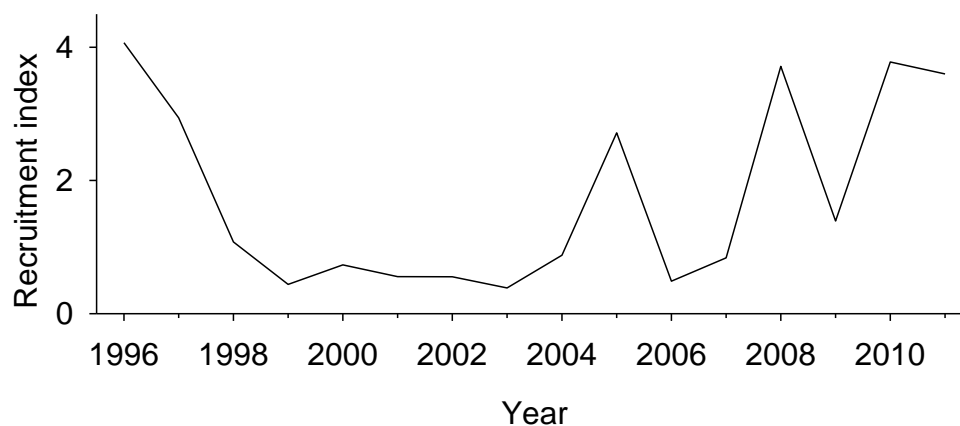
WEST COAST NEARSHORE AND ESTUARINE FIGURE 6

Total annual catch, effort and catch rate of Australian herring by voluntary recreational logbook fishers in Perth metropolitan area (shore fishing only), 2006 – 2011.



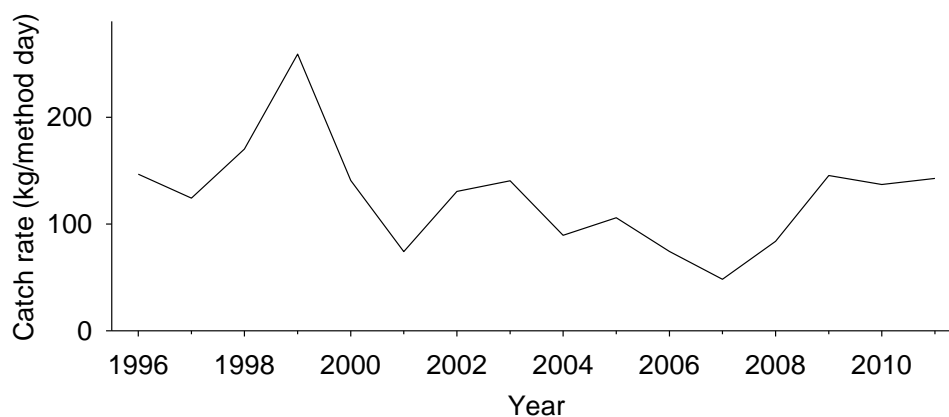
WEST COAST NEARSHORE AND ESTUARINE FIGURE 7

Annual fishery-independent relative recruitment index for Australian herring in the South Coast Bioregion, 1996 – 2011. (x – no sampling conducted in that year). (Normalised data. Bars above the line reflect better than average number of recruits. e.g. a value of "6" represents six times higher than the average level).



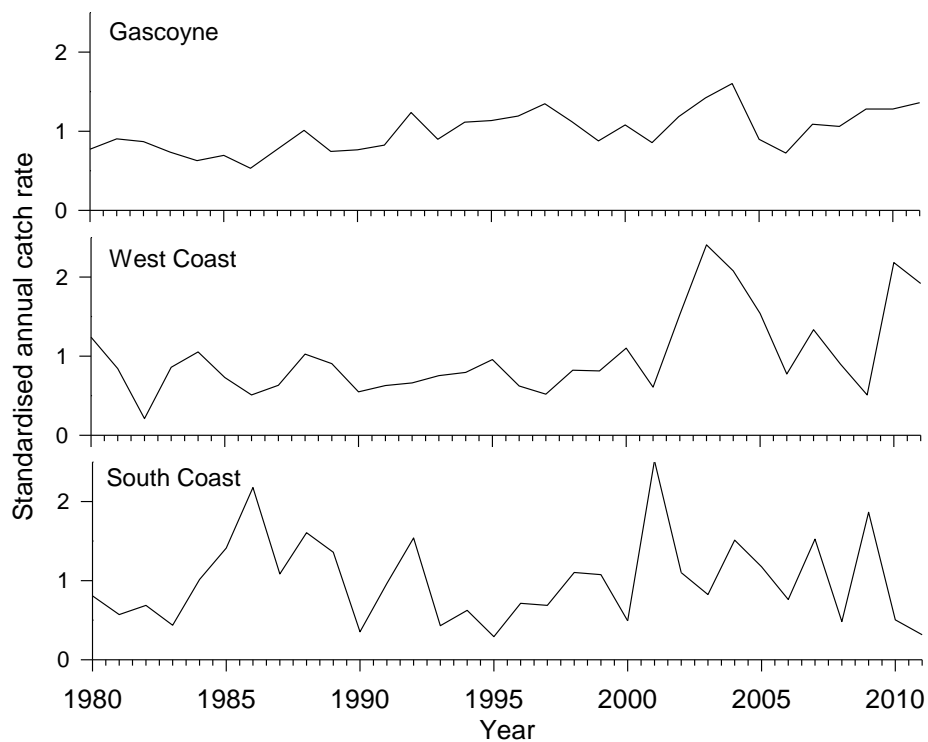
WEST COAST NEARSHORE AND ESTUARINE FIGURE 8

Annual recruitment index for tailor in the West Coast Bioregion, 1996 – 2011, derived from volunteer fisher catch rates of age 0+ juveniles in the Swan-Canning Estuary.



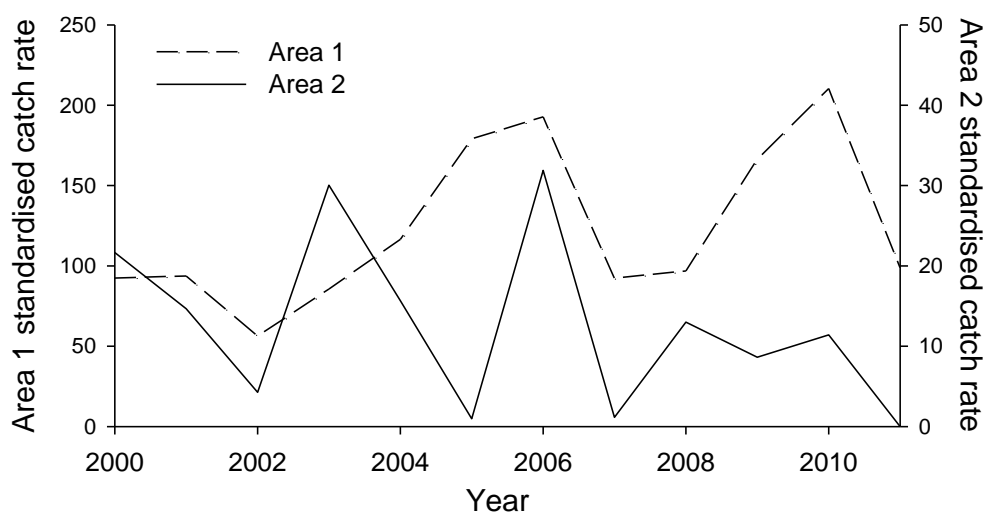
WEST COAST NEARSHORE AND ESTUARINE FIGURE 9

Standardised annual commercial catch rate of southern garfish in Cockburn Sound, 1996 – 2011.



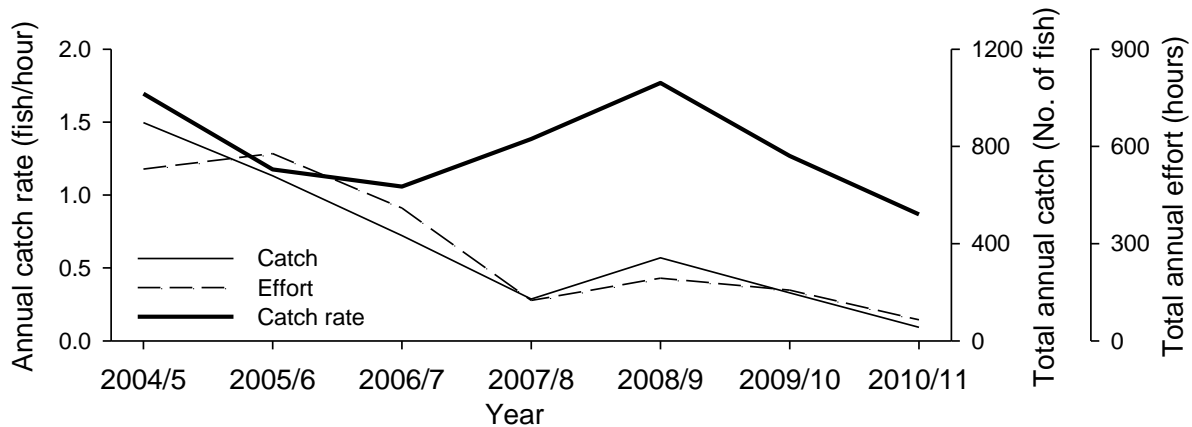
WEST COAST NEARSHORE AND ESTUARINE FIGURE 10

Standardised annual commercial catch rates of sea mullet in Gascoyne, West Coast and South Coast Bioregions, 1996 – 2011.



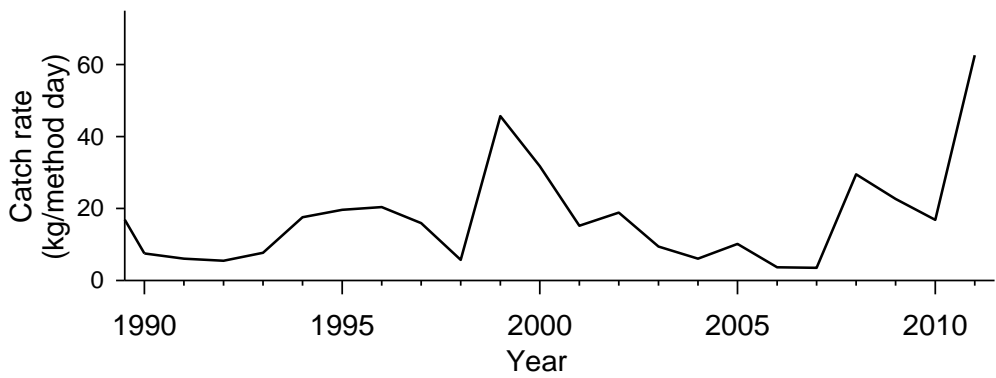
WEST COAST NEARSHORE AND ESTUARINE FIGURE 11

Standardised annual commercial catch rate (kg/method day) of whitebait in Area 1 (Bunbury) and Area 2 (Perth/Mandurah), 2000 – 2011.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 12

Total annual catch, effort and catch rate of black bream by voluntary recreational logbook fishers in the Swan-Canning Estuary, 2004/5 – 2010/11.



WEST COAST NEARSHORE AND ESTUARINE FIGURE 13

Standardised annual commercial catch rate of cobbler in the Peel-Harvey Estuary, 1990 – 2011.

West Coast Purse Seine Fishery Report: Statistics Only

B. Molony, E. Lai and M. Holtz

Fishery Description

The West Coast Purse Seine Fishery mainly captures pilchards (*Sardinops sagax*) and the tropical sardine (or scaly mackerel) *Sardinella lemuru* (referred to as sardinella) by purse seine in the West Coast Bioregion. Smaller catches of Perth herring (*Nematalosa vlaminghi*), yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*), maray (*Etrumeus teres*) and other species are also reported.

Boundaries

There are three defined fisheries. The Perth metropolitan fishery operates between 31° S and 33° S latitude (West Coast Purse Seine Figure 1). The Southern Development Zone covers waters between 33° S and Cape Leeuwin. The Northern Development Zone covers waters between 22° S and 31° S.

Management arrangements

This fishery is managed through a combination of input and output controls incorporating limited entry, capacity setting and controls on gear and boat size.

Access to the Perth Metropolitan fishery is limited to 12 licences that must fish in accordance with the *West Coast Purse Seine Management Plan 1989*. Both pilchards and sardinella are the main target species in the Metropolitan fishery. There are three fishing boat licences with a specific condition that permits the taking of fish using a purse seine net that is hauled by the use of a power block within specific waters of the Southern Development Zone. Two of those fishing boat licences may also retain pilchards. A further three fishing boat licences permit the taking fish using a purse seine net that is hauled by the use of a power block in the Northern Development Zone and sardinella is the main target species.

Currently, a notional combined total allowable catch (TAC), covering both the Perth metropolitan fishery and the Southern Development Zone, is set for pilchards and another for other small pelagic species. For the 2010/11 licensing period (1 April 2010 – 31 March 2011) a notional TAC of 2,328 t for pilchards, with separate TAC of 672 t for the other small pelagic species (including sardinella) is in place. The notional TAC for pilchards has been in place since 2006/07, and is based on approximately 10% of the west coast pilchard stock. The Northern Development Zone has a separate notional TAC. Reaching or exceeding the notional TACs will trigger a management response.

Landings and Effort

Effort levels increased in 2011 to more than 200 fishing days (less than 60 days in 2010). However, fewer than five vessels reported fishing during the 2011 season. Total catches of pilchards and sardinella exceeded 175 t in 2011, up from approximately 10 t in 2010. The 2011 catch is the highest reported since 2009 (45.2 t in 2009, less than 10 t in 2010) but well below catches recorded in the mid to late 1990s (West Coast Purse Seine Figure 2).

Fishery Governance

Target commercial catch range: 0 – 3,000 tonnes

Current Fishing (or Effort) Level: Acceptable

Total effort and catch have declined in recent years due to factors other than stock size (e.g. demand, economics). In addition, fishers have reported that the presence of schools is not as predictable as in previous years. Warmer oceanic conditions may influence the behaviour and distribution of schooling pelagic species, making them less available in traditional fishing grounds.

No future pilchard spawning biomass estimates are scheduled for West Coast pilchard stocks. The most recent pilchard spawning biomass estimate (2004) indicated that pilchard stocks on the west coast had recovered to pre-virus levels of approximately 20,000 – 30,000 tonnes.

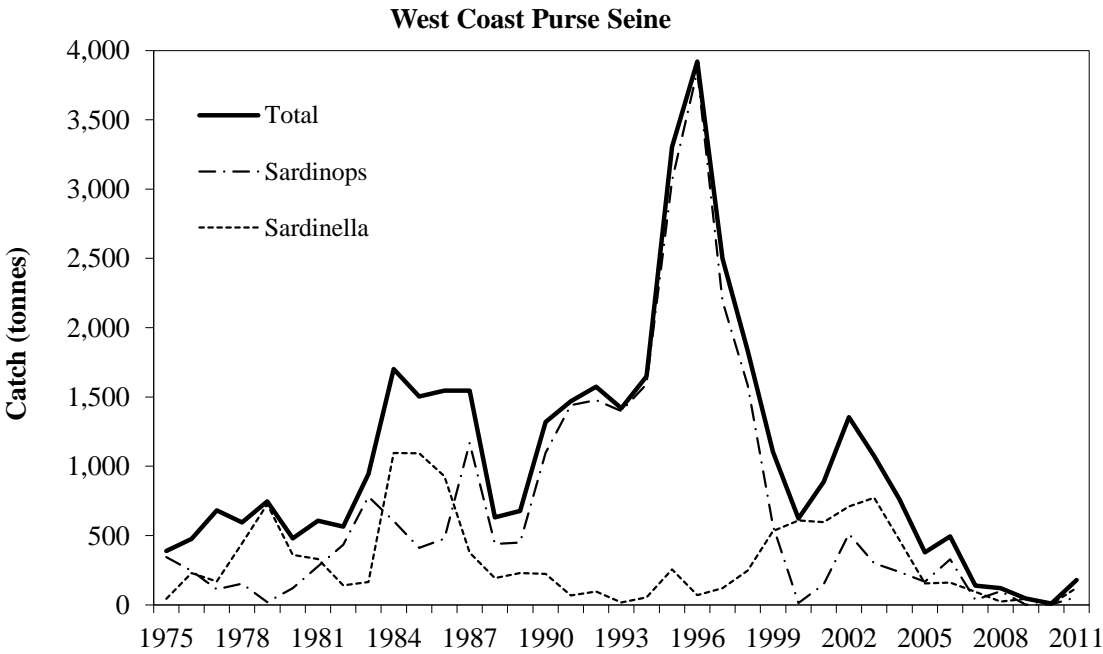
New management initiatives (2011/12)

The implementation of a formal quota system with tradeable, individually transferable quota (ITQ) units and a TAC has been a consideration for this fishery for the past ten years. However the implementation of quota for this fishery is considered to be on hold indefinitely, given that catch of pilchards and the effort expended in this fishery has not returned to normal levels since the second pilchard mass mortality event in 1999.

Depending on priorities, the Department may in the future develop a new management plan for this fishery which will incorporate the Southern and Northern Development zones along with the Perth metropolitan fishery into a single West Coast Purse Seine fishery.



WEST COAST PURSE SEINE FIGURE 1
Map of the extent of the West Coast Purse Seine Managed Fishery.



WEST COAST PURSE SEINE FIGURE 2
Annual catches of pilchards (*Sardinops*) and sardinella in the West Coast Purse Seine Fishery, 1975 –2011.

West Coast Demersal Scalefish Resource Status Report

D. Fairclough, E. Lai, M. Sawyer, M. Holtz, T. Nicholas

Main Features				
Status		Current Landings		
Stock level	Recovering	Commercial sector		
		All scalefish:		
Fishing Level		WCDSIMF (2011)		411 t
Commercial:	Acceptable	Demersal suite:		
Recreational:	Acceptable	WCDSIMF (2011)		382 t
		Other (DGDLF, WCRLF, CSLPF, SWTMF;		
		2011 or 2010/11)		56 t
		Total demersal suite		438 t
			WCDSIMF	Other
		Indicator species	(2011)	(2011 or 2010/11)
		West Australian Dhufish	67 t	13 t
		Snapper	182 t	8 t
		Baldchin Groper	15 t	3 t
		Recreational sector (last available estimate, 2009/10)		
		Indicator species:		
		West Australian Dhufish		85 t
		Snapper		24 t
		Baldchin Groper		19 t
		Charter sector (2010/11)		
		Indicator species:		
		West Australian Dhufish		12 t
		Snapper		8 t
		Baldchin Groper		9 t

Fishery Description

The West Coast Demersal Scalefish Resource comprises inshore and offshore suites of demersal scalefish species that are exploited by different commercial fisheries and recreational and charter fishers that operate in the West Coast Bioregion (WCB). The West Coast Inshore Demersal suite occurs in waters 20-250 m deep with approximately 100 species of this suite caught by these fisheries. The most important species are the West Australian Dhufish (*Glaucosoma hebraicum*) and Snapper (*Pagrus auratus*) with other species captured including Redthroat Emperor (*Lethrinus miniatus*), Bight Redfish (*Centroberyx gerrardi*) and Baldchin Groper (*Choerodon rubescens*). The West Coast Offshore Demersal suite, which occurs in waters > 250 m deep, includes Eightbar Grouper *Hyporthodus octofasciatus*, Hapuku *Polyprion oxygeneios*, Blue-eye Trevalla *Hyperoglyphe antarctica* and Ruby Snapper *Etelis carbunculus*.

Commercial

The West Coast Demersal Scalefish (Interim) Managed Fishery (WCDSIMF) is a handline and drop line fishery and it is the main commercial fishery that targets demersal species in the WCB. The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) and Zone 1 of the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLF), referred to collectively as the temperate Demersal Gillnet and Demersal Longline Fisheries (DGDLF), target sharks and rays but also retain demersal scalefish. Other commercial fisheries that may take a small amount of demersal species in the WCB include the West Coast Rock Lobster Managed Fishery (WCRLF), the Cockburn Sound Line and Pot Managed Fishery (CSLPF) and the South-West Trawl Managed Fishery (SWTMF). The Commonwealth Western Deepwater Trawl Fishery and the Great Australian Bight

Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery, that operate in waters of the WCB deeper than 200 metres, also catch demersal species.

Fishing and Aquatic Tour Industry (Charter)

Demersal scalefish are targeted by the fishing activities of the charter boat industry in the WCB. Line fishing is the main method used by operators licensed to fish in that sector. A small number of fishing tour operators also cater for recreational diving charters.

Recreational

Recreational fishers that target demersal species in the WCB are almost exclusively boat-based. Line fishing is the main method used by recreational fishers, although spear fishing also occurs, but mainly in shallow waters, i.e. < 20 m deep.

Note - The WCDSIMF and the charter and recreational sectors in the WCB are collectively referred to as the West Coast Demersal Scalefish Fishery (WCDSF).

Governing legislation/fishing authority

Commercial

West Coast Demersal Scalefish (Interim) Management Plan 2007

West Coast Demersal Interim Managed Fishery Permit

West Coast Demersal Gillnet and Demersal Longline Interim Management Plan 1997

West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery Permit

Joint Authority Southern Demersal Gillnet and Demersal Longline Management Plan 1992

Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery Licence

Cockburn Sound (Line and Pot) Management Plan 1995

Cockburn Sound (Line and Pot) Managed Fishery Licence

South West Trawl Management Plan 1989

South West Trawl Managed Fishery Licence

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation.

Consultation process

Commercial

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

Recreational

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

Boundaries

Commercial fishery

The WCDSIMF encompasses the waters of the Indian Ocean just south of Shark Bay (at 26°30'S) to just east of Augusta (at 115°30'E) and extends seaward to the 200 nm boundary of the Australian Fishing Zone (AFZ). The commercial fishery is divided into five management areas comprising four inshore areas and one offshore area. The inshore areas, i.e. Kalbarri, Mid-West, Metropolitan and South-West, extend outwards to the 250 m depth contour, while the Offshore Area extends the entire length of the fishery from the 250 m depth contour to the boundary of the AFZ (West Coast Demersal Scalefish Figure 1). The Metropolitan Inshore Area was closed to commercial operators in the WCDSIMF and WCDGDLF in November 2007 (West Coast Demersal Scalefish Figure 1).

The boundaries of each of the other fisheries that catch demersal species in the WCB are given in their separate sections of this State of the Fisheries report.

Fishing and Aquatic Tour Industry (Charter) and Recreational fishery

The boundaries applicable to the charter and recreational sectors in the WCB encompass the waters of the Indian Ocean just south of Shark Bay (at 27°S) to just east of Augusta (at 115°30'E) and extend seaward to the 200 nm boundary of the AFZ (West Coast Demersal Scalefish Figure 1).

Management arrangements

Commercial

The WCDSIMF was established in January 2008, following the introduction of the *West Coast Demersal Scalefish (Interim) Management Plan 2007*. Permit holders are permitted to retain all scalefish (other than a number species that are under specific State or Commonwealth management) and are not permitted to take sharks and rays.

Access to the Fishery is restricted to 60 Interim Managed Fishery Permit holders. Gear and other restrictions apply (in the form of maximum numbers of lines and hooks and arrangements regulating the carriage of lines and fish) and boats are monitored under the Vessel Monitoring System (VMS).

Each of the four inshore management areas is allocated a maximum number of hours of fishing time that may be fished on an annual basis, with the Metropolitan Area currently allocated zero hours. Units are allocated to permits and provide entitlement in "hours" of fishing time. The use of VMS allows fishing effort to be monitored and entitlement use acquitted accordingly. The total capacity of the Fishery restricts fishing effort at a level to ensure that catches of all scalefish and also of the suite of demersal species do not exceed catch objectives (see below). The capacity can be adjusted as required.

The primary management objective for the WCDSIMF is to maintain catches of all scalefish and the suites of demersal species below 50 % of those recorded in the WCB during 2005/06 to reduce fishing mortality to a level that will enable recovery of all of these stocks. The status of the three indicator species (Snapper, Western Australian Dhufish and Baldchin Groper) is used to indicate the status of the entire West Coast Inshore Demersal Suite of scalefish species.

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The catch in each management area should also not exceed 50 % of the 2005/06 catch in that area. The average annual catch for each indicator species in the WCDSIMF and in each of the areas where they are an indicator should also remain below 50 % of their 2005/06 level.

The other commercial fisheries that take demersal scalefish in the WCB (DGDLF, WCRLF, CSLPF and SWTMF) are subject to limited entry and input and/or output controls and the same management objective of maintaining catches of the suite of demersal species below 50 % of those recorded by those fisheries during 2005/06.

The detailed management arrangements of each of the other fisheries that catch demersal species in the WCB are given in their separate sections of this State of the Fisheries report.

Since 2008, fishers in the WCRLF have been permitted to retain for personal consumption only demersal species that have been caught in rock lobster pots. These fish are not permitted to be sold.

Fishing and Aquatic Tour Industry (Charter)

There are two types of fishing tour licence categories.

Fishing Tour Operators Licence: The focus is on fishing activities, where fish can be taken home at the end of the tour.

Restricted Fishing Tour Operators Licence: The focus is on eco-tourism activities, such as snorkelling or scuba diving, with fishing only allowed for the purpose of a meal eaten during the course of the tour. No fish can be taken home at the end of the tour and any fishing for a meal must be done with a handline. Fishing rods are not permitted on this tour category.

Within each category, there is the provision for a boat-based operation (boat size larger than 7.5 m), a combination land/aircraft/boat (boat size less than 7.5 m) based operation and a land-based operation. Except where extraordinary circumstances can be demonstrated by the applicant, new Fishing Tour Operators Licences are no longer granted. Applications for Restricted Fishing Tour Operators Licences are still considered. Currently, the consideration of any Tour Operator's Licence Application is carried out in accordance with Regulation 128J of the Fish Resources Management Regulations 1995 and Ministerial Policy Guideline No. 12 'Assessment of Applications for the Granting, Renewal or Transfer of Fishing Tour Operators Licences and Aquatic Eco-Tourism Operators Licences'.

All fishing is subject to recreational fishing regulations (see below), however passengers onboard a fishing tour are not required to hold an individual Recreational Fishing from Boat Licence.

Recreational

The recreational fishery for demersal scalefish in the WCB is managed using input (e.g. size limits, seasonal closures and spatial closures) and output controls (e.g. daily bag limits, boat limits and possession limits).

A suite of new management arrangements was introduced during 2009/10 aimed at reducing the recreational take of demersal scalefish in the WCB by at least 50 % from 2005/06 levels. These arrangements included changes to bag, boat and size limits for demersal scalefish species, a requirement to carry a release weight (to assist in minimising the effects of barotrauma) and the implementation of a closure prohibiting

fishing for "high risk" demersal scalefish for two months between 15 October and 15 December.

Since 2 March 2010, all persons fishing from a powered boat anywhere in the state have been required to hold a Recreational Fishing from Boat Licence or fish in the company of a licence holder. The Recreational Fishing from Boat Licence will provide a state-wide database of recreational boat fishers for survey purposes.

Research summary

Research on demersal species in the WCB focuses on monitoring the status of indicator species. Level 3 stock assessments based on fishing mortality are conducted at periodic intervals for each of the indicator species (West Australian Dhufish, Snapper and Baldchin Groper) within the West Coast Inshore Demersal Suite. Annual Level 1 assessments of catch are also used to monitor these species and the indicator species for the West Coast Demersal Offshore Suite (Hapuku, Blue-eye Trevalla, Bass Groper). See Fisheries Occasional Publication No. 85 http://www.fish.wa.gov.au/Documents/occasional_publications/fop085.pdf.

To enable the Level 3 assessments, fish frames of the indicator species are collected annually from both recreational and commercial fishers across the different areas of the WCB (West Coast Demersal Scalefish Figure 1). Otoliths obtained from these frames are used to determine age compositions for species in relevant management areas, from which estimates of fishing mortality are calculated and stock status determined. The next stock assessment of the three inshore demersal indicators will be conducted in 2012/13.

Catch and effort data both for the commercial and charter sectors are obtained annually from fishers' daily/trip logbooks, which provide fine-scale data from 10 nm × 10 nm and 5 nm × 5 nm blocks, respectively.

A Statewide survey of boat-based recreational fishing was conducted during 2011/12 through a collaboration between the Department of Fisheries and Edith Cowan University. Approximately 3,000 fishers from the "Recreational Fishing from Boat" licence database took place in phone-diary surveys in conjunction with validation surveys of boat-based fishers at ramps. Estimates of catch and effort for this fishery will be available in late 2012.

Estimates of the catch of demersal species in this bioregion by other fisheries (DGDLF, WCRLF, CSLPF, SWTMF) are determined annually from compulsory logbook data. Full details are reported in the relevant fisheries reports.

WA Marine Science Institute-funded research on the stock structure of West Australian Dhufish, Snapper and Baldchin Groper in the WCB is complete. This was a collaborative project between the Department of Fisheries, Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Murdoch University. The methods used included both genetic and otolith microchemistry techniques plus an examination of oceanographic influences on larval dispersal. Scientific papers have been published on the stock structure of West Australian Dhufish and Baldchin Groper.

Acoustic telemetry is being used to investigate site-fidelity of adult Snapper to Cockburn Sound spawning aggregations. Data on the movements of tagged Snapper will be collected by remotely deployed receivers until 2013. These data will be used to assess the risks associated with targeting Snapper that are either migrating to or aggregating in Cockburn Sound.

Surveys of the numbers of Snapper eggs in Cockburn Sound were conducted in 2011 to produce an estimate of spawning stock biomass using a daily egg production model. Results will be available as part of the 2012/13 stock assessment.

A State Natural Resource Management-funded project, focused on small juvenile West Australian Dhufish (< 150 mm in length), is investigating the habitat types that are important for newly-recruited juvenile dhufish and the feasibility of developing a recruitment index.

A collaborative FRDC-funded project between Curtin University and the Department of Fisheries is almost complete. This study is determining whether West Australian dhufish and Snapper produce sound and thus the feasibility of using passive acoustic monitoring of these species.

A collaborative project between CSIRO and the Department of Fisheries commenced in late 2011. This one year pilot study is investigating the temporal and spatial occurrence of West Australian dhufish eggs and larvae in the South-west and Metropolitan Areas of the WCB. The project combines traditional plankton collection and analysis with rapid DNA screening of samples to investigate the occurrence of dhufish in samples, in conjunction with current modelling to guide the plankton sampling regime. The project may be extended to three years if the pilot project is successful.

Retained Species

Commercial production

All scalefish

WCDSIMF (2011)	411 tonnes
Demersal suite	
WCDSIMF (2011)	382 tonnes
DGDLF, WCRLF, CSLPF, SWTMF	
(2011 or 2010/11)	56 tonnes
Total	438 tonnes

Indicator species

WCDSIMF (2011)	
West Australian Dhufish	67 tonnes
Snapper	182 tonnes
Baldchin Groper	15 tonnes
DGDLF, WCRLF, CSLPF, SWTMF	
(2011 or 2010/11)	
West Australian Dhufish	13 tonnes
Snapper	8 tonnes
Baldchin Groper	3 tonnes

Total

West Australian Dhufish	80 tonnes
Snapper	190 tonnes
Baldchin Groper	18 tonnes

Landings

Catches are reported from the most recent complete season of logbook data, which differ among the commercial fisheries that catch demersal species in the WCB. Thus, catches are reported for 2011 for the WCDSIMF and SWTMF and for 2010/11 for the DGDLF and WCRLF.

Catches by commercial fishers in the WCDSIMF increased by 46 t from 365 t in 2010 to 411 t in 2011. The majority of the increase could be attributed to catches of demersal species, which increased to 382 t in 2011 from 340 t in 2010. In 2011, catches of demersal species comprised 375 t and 7 t of inshore and offshore demersal species, respectively. While the catches of demersal species by the WCDSIMF in 2011 remained similar to 2010 in the Kalbarri area (144 vs 146 t), the South-west (50 vs 59 t) and Offshore areas (7 vs 13 t), the catch for the Mid-west area increased by 58 t.

The WCDSIMF catch in 2011 comprised 79 scalefish species or species groups. Fifty three of those belonged to the inshore and offshore demersal suites and 26 belonged to the pelagic and nearshore suites. Six species/species groups comprised 88 % of the total catch of scalefish, with the largest catches being of Snapper (182 t), West Australian Dhufish (67 t) and Redthroat Emperor (54 t). Other significant catches were of Redfish species (*Centroberyx* spp., 29 t), Samson Fish (16 t) and Baldchin Groper (15 t). Catches of offshore demersal species were low, e.g. Eightbar Grouper (4 t), Hapuku (1 t), Bass Groper (< 1 t) and Blue-eye Trevalla (< 1 t).

Catches of demersal scalefish by temperate demersal gillnet and longline fisheries in the WCB decreased in 2010/11 to 53 t, 22 t less than in 2009/10, while 3 t were taken by other commercial fisheries combined (WCRLF, CSLPF and the SWTMF).

West Australian Dhufish: The total catch of West Australian dhufish by the WCDSIMF increased from 54 t in 2010 to 67 t in 2011. The catch in the Kalbarri (5 t) and South-west areas (19 t) were similar in 2011 to those in 2010. However, in the Mid-west area, 44 t of dhufish were caught in 2011, an increase of 13 t from 2010 (West Coast Demersal Scalefish Figure 2). Catches of dhufish by the DGDLF decreased from 16 t in 2009/10 to 13 t in 2010/11, while < 0.5 t was taken by the other commercial fisheries.

Snapper: In 2011, the WCDSIMF catch of Snapper (182 t) was substantially greater than in 2010 (156 t) and 2009 (110 t). While catches in the Kalbarri area in 2011 (88 t) declined by 8 t from those in 2010, those in the Mid-west area increased by 33 t to 91 t. As in previous years, only 3 t was landed in the South-west Area (West Coast Demersal Scalefish Figure 3). While Snapper catches of the DGDLF in the WCB decreased from 11 to 7 t between 2009/10 and 2010/11, other fisheries retained a similar total amount to previous years, i.e. ca 1 t.

Baldchin Groper: The WCDSIMF caught 15 t of Baldchin Groper in 2011, 3 t more than 2010 (West Coast Demersal Scalefish Figure 4). The majority was obtained from the Mid-west area (13 t) and primarily in the Abrolhos Zone A of the

WEST COAST BIOREGION

WCRLF (9.5 t), with the remainder being caught in the Kalbarri Area. Baldchin Groper catches by other fisheries in the WCB in 2010/11 remained low (ca 2.5 t).

Charter fishing (2010/11)

Top 15 demersal scalefish species **39 tonnes**

Indicator species

West Australian Dhufish **12 tonnes**

Snapper **8 tonnes**

Baldchin Groper **9 tonnes**

The total catch of the demersal species/species groups that comprise the top 15 by weight typically caught by the charter sector was approximately the same in 2010/11 (39 t) as the previous year (based on 94 % of logbook returns at the time of this report; see West Coast Demersal Scalefish Figure 5). The catch of West Australian Dhufish and Baldchin Groper increased slightly from 2009/10 to 2010/11, while that of Snapper decreased (West Coast Demersal Scalefish Figure 5). Species in the West Coast Offshore Demersal Suite comprised less than 1 t of charter catches.

Recreational fishing

(last available estimate 2009/10)

Top 15 demersal scalefish species **155 tonnes**

Indicator species

West Australian Dhufish **85 tonnes**

Snapper **24 tonnes**

Baldchin Groper **19 tonnes**

About 155 t of the top 15 demersal species/species groups were estimated to have been caught by boat-based fishers in the WCB in 2009/10, which is thus approximately half of the catch of those species in 2005/06 (303 t; West Coast Demersal Scalefish Figure 5). Estimates of catches of West Australian Dhufish (85 t), Snapper (24 t) and Baldchin Groper (19 t) retained in 2009/10 were also less than those in 2005/06, i.e. 181 t, 40 t and 26 t, respectively (West Coast Demersal Scalefish Figure 5).

Fishing effort/access level

Commercial

In 2011, 51 vessels fished in the WCDSIMF. Fifteen vessels fished in the Kalbarri Area, 40 in the Mid-west, 7 in the South-west and 10 in the Offshore Area. Note that some vessels have entitlements to fish in more than one inshore area, while all can access the Offshore Area.

The total number of days fished in 2011 (1,572) increased from 1,502 in 2010 and was commensurate with an increase in the number of hours fished (hours searching + hours fishing) from 15,500 h in 2010, to 16,000 h in 2011.

Effort recorded by other fisheries that catch demersal species in the WCB is given in their separate sections of this State of the Fisheries and Aquatic Resources Report.

Recreational

Effort in the recreational sector has not been estimated for 2009/10.

Fishing and Aquatic Tour Industry (Charter)

Based on 94 % of logbook returns having been submitted at the time of this report, the number of charter licences reported to have undertaken charter fishing operations in 2010/11 (57) declined from that of 2009/10 (63). However, the number of fisher days increased from 18,963 to 21,478.

Stock Assessment

Assessment complete **Yes**

Assessment level and method:

Level 3 - Fishing mortality
(Periodic - next due in 2012/13)

Level 1 - Catch by sector (Annually)

Breeding stock levels

West Australian Dhufish: **Recovering**

Snapper: **Recovering**

Baldchin Groper: **Recovering**

Inshore Demersal: The last level three assessment of the status of stocks of inshore demersal species in the different management areas of the WCB was conducted on data collected in 2007/08. The assessment estimated fishing mortality rates (*F*) for each of the indicator species (West Australian Dhufish, Snapper and Baldchin Groper), which reflect the status of the entire West Coast Inshore Demersal suite of species in the WCB. The above assessment was independently reviewed and supported the view that at that time the breeding stocks for both West Australian Dhufish and Baldchin Groper were declining, while that of Snapper was considered to be inadequate. The assessment confirmed the results of a previous assessment in 2007, which recommended that management action was required to achieve at least a 50% reduction in catches of that suite across all sectors, in order to initiate recovery of stocks in the suite.

Level one monitoring of resource status is conducted annually by comparing the catch of the demersal suite (where available) for each fishery and sector of the WCDSF with acceptable catch levels (50 % of 2005/06). As the current or most recent catch levels for this suite and the indicator species are below the acceptable catch range, the stocks are assessed as recovering.

The next detailed assessment of fishing mortality rates is scheduled for completion in 2012/13, based on fishery-dependent samples of the three indicator species collected between 2008/09 and 2010/11. This will provide information on whether reduced catches are resulting in a greater proportion of older fish in stocks. The assessment will also evaluate the most appropriate measure of effort and catch per unit effort (CPUE) in the WCDSIMF.

Offshore Demersal: A level one assessment of catch is conducted annually for the offshore demersal suite, including Eightbar Grouper, Bass Groper, Hapuku, Blue-eye Trevalla and Ruby Snapper. These species are particularly vulnerable

to overfishing, as their biological characteristics indicate that they are long-lived and would therefore have low rates of natural mortality and productivity (Wakefield and Newman, 2008¹; Wakefield et al., 2010²). In addition, some aggregate to spawn and most suffer barotrauma when caught, due to the depths in which they are fished (> 250 m). Given the current low level of catches, risks to the biological sustainability of the stocks of these species in the WCB are considered to be medium.

Using the assessments of the indicator species as outlined above, the additional management actions have reduced the ecological risks to the suites of inshore and offshore demersal species in the WCB (see Fletcher et al., 2010³). The inshore suite still has high risks associated with meeting social and economic objectives for the community. This combination of factors means that this suite of species still has a high priority for the Department with the inshore demersal suite requiring continued close monitoring and assessment. The offshore demersal suite is currently considered to have a medium level priority.

Non-Retained Species

Bycatch species impact Medium

Line fishing for demersal species using baited hooks is highly selective⁴. Other demersal species that are caught but not normally retained during demersal fishing activities (including inedible species, e.g. Silver Toadfish, and small species, such as wrasses) are often susceptible to the effects of barotrauma and may not survive. Note that while they are not bycatch species, post-release survival of target species, such as West Australian Dhufish and Snapper decreases when caught in waters > about 30 m deep⁵, but this is likely to be indicative of many species caught but not retained in this fishery.

Protected species interaction Negligible

As line fishing is highly selective, interactions with protected species by commercial, charter and recreational fishers in the WCDSF are low. Commercial WCDSIMF and charter fishers

are required to record protected species interactions in their logbooks. During 2011, commercial fishers in the WCDSIMF caught two grey nurse sharks, which were released alive. In 2010/11, three interactions with protected species (grey nurse sharks) were reported by charter fishers, each animal being released alive.

Ecosystem Effects

Food chain effects Low

An FRDC study⁶ examined the last 30 years of catch data by commercial wetline, gillnet and longline fisheries in the WCB and found that while the species composition in catches had changed over time, which may be a function of changes in targeting or differences in reporting methods, there was no evidence of a decline in the trophic level or mean size in catches.

Habitat effects Negligible

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

Social Effects

Commercial

The total number of crew members employed per trip by the 51 permitted vessels that fished in the WCDSIMF in 2011 ranged from zero to four, while the majority employed was two.

Fishing and Aquatic Tour Industry (Charter)

In 2010/11, 111 charter operators were licensed to operate in the WCB via a Fishing Tour Operators Licence, compared with 125 in 2009/10. Twenty one held a Restricted Fishing Tour Operators Licence. The number of people employed in the charter industry has not been estimated.

Recreational Fishing

Over 123,000 Recreational Fishing from Boat Licenses have been issued in Western Australia as at 2nd March 2012.

Economic Effects

Estimated annual value (to fishers) for 2011:

Level 2 - \$1-5 million

The estimated economic value of the WCDSIMF in 2011 was in the range of \$1-5 million, as it was in 2010.

¹ Wakefield, C.B., & Newman, S.J. (2008) Age estimation and reproductive status of an exceptionally large blue-eye trevalla (*Hyperoglyphe antarctica*, Centrolophidae) captured off the south coast of Western Australia. *Cybius*, 32, 321-324.

² Wakefield, C.B., Newman, S.J. & Molony, B.W. (2010) Age-based demography and reproduction of hapuku, *Polyprion oxygeneios* (Polyprionidae), from the south coast of Western Australia: implications for management. *ICES Journal of Marine Science*, 67, 1164-1174.

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

⁴ Bycatch interactions of the gillnet and longline sector are presented in the relevant report.

⁵ see Fisheries Research Report No. 191
http://www.fish.wa.gov.au/Documents/research_reports/frr191.pdf

⁶ 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.

Fishery Governance

Commercial

Current Fishing (or effort) level **Acceptable**

Catch (or effort) limit range (acceptable catch levels):

All scalefish

WCDSIMF **449-469 tonnes**

Demersal suite

WCDSIMF **408 tonnes**

All fisheries combined (WCDSIMF, DGDLF, WCRLF, CSLPF, SWTMF)..... < 450 tonnes

The primary management objectives for the WCDSIMF are to reduce total catch of all scalefish, of the demersal suites including each of the indicator species, i.e. West Australian Dhufish, Snapper and Baldchin Groper, by at least 50 % of those caught by wetline fishers in the WCB during 2005/06. In addition, catches of the demersal suites in the WCB by other fisheries, i.e. DGDLF, WCRLF, CSLPF, AIMWTMF and the SWTMF, should remain at or below 50 % of those in 2005/06.

In 2011, catches of all scalefish (411 t) and of the suite of demersal species (382 t) by the WCDSIMF were below 50 % of those of 2005/06, i.e. 449-469 and 408 t, respectively. The total catch of demersal species in a full year of fishing (either 2010/11 or 2011) by the WCDSIMF, DGDLF, WCRLF, CSLPF and the SWTMF was 438 t which is below the 450 t benchmark. WCDSIMF catches of West Australian Dhufish (67 t) and Baldchin Groper (15 t) also remained below 50 % of the 2005/06 level (i.e. 72 and 17 t, respectively). However, the catch of Snapper in 2011 (182 t), which was taken almost exclusively in the Mid-west and Kalbarri Areas, was above the relevant benchmark (120 t) for the fishery. This reflects a commensurate increase in effort (hours spent fishing and searching) in the WCDSIMF. As the entitlements available to permit holders in 2011 were not fully acquitted, there is potential for further increases in effort and catch in subsequent years if catch rates remain similar or increase. Catches of Snapper and the other indicator species will need to be monitored closely in coming years to determine whether this trend continues and further management intervention becomes necessary.

Charter/recreational Current Fishing level

Demersal suite **Acceptable**

Catch (or effort) limit range (acceptable catch level): **< ca. 200 tonnes**

Catches of the suite of demersal species (represented by the top 15 species/species groups) and of the indicator species by the charter and recreational sectors in the WCB should remain below 50 % of 2005/06 catches, i.e. < ca 200 t. From the latest available data from the recreational (2009/10) and charter sectors (2010/11), the estimated catch of the top 15 species/species groups by the charter and recreational sectors was 194 t. Using data for the charter (2010/11) and recreational (2009/10) sectors, total catches of West Australian Dhufish (97 t) and Snapper (32 t) were less than

50 % of those in 2005/06, i.e. 109 and 33 t, respectively. However, the combined catch of Baldchin Groper (28 t) was greater than 50 % of that in 2005/06 (19.5 t).

New management initiatives

Commercial

Formal catch management guidelines are being developed to determine how the various target catch adjustments by the different commercial sectors that take demersal species will be most efficiently achieved.

A new management plan for the WCDSIMF is to be progressed during 2013, which will include a review of the fishery's management arrangements and the management objectives for the demersal scalefish resource in the WCB and will incorporate the outcomes of the stock assessment of key indicator species scheduled for 2012/13. This review will also include an evaluation of the management arrangements of the other relevant commercial fisheries (DGDLF, WCRLF, CSLPF and SWTMF) as they relate to those fisheries' take of demersal species in the WCB and the development of a formal harvest strategy and catch control guidelines designed to accommodate any recognised variations in recruitment levels.

Recreational/Charter

The Department of Fisheries has undertaken a Statewide Recreational Boat Fishing Survey, which started in January 2011. For the first time, the Department will be able to estimate the quantity of fish retained and released for each WA fisheries bioregion. This information, which should be available toward the end of 2012, will assist the Department in managing the State's fisheries and aquatic ecosystem resources to help to ensure there are *fish for the future*.

A review of the effectiveness of the recreational fishing arrangements implemented in the WCB to achieve the 50 % reduction in catch from 05/06 levels will be made during 2013, following the results of the Statewide Recreational Boat Fishing Survey.

Integrated Fisheries Management

Integrated Fisheries Management (IFM) is one of the policies aimed at making sure that Western Australia's fisheries continue to be managed in a sustainable and equitable manner into the future. The IFM process is formally underway for the demersal scalefish resource in the WCB. Two Fisheries Management Papers relevant to the implementation of IFM for the demersal scalefish resource in the WCB were released in July 2010 (see Fisheries Management Papers 237 and 247 <http://www.fish.wa.gov.au/About-Us/Publications/Pages/Fisheries-Management-Papers.aspx>). It is expected that the final decisions regarding the sectoral allocations for the West Coast Demersal Scalefish Resource will be made in the second half of 2012.

External Factors

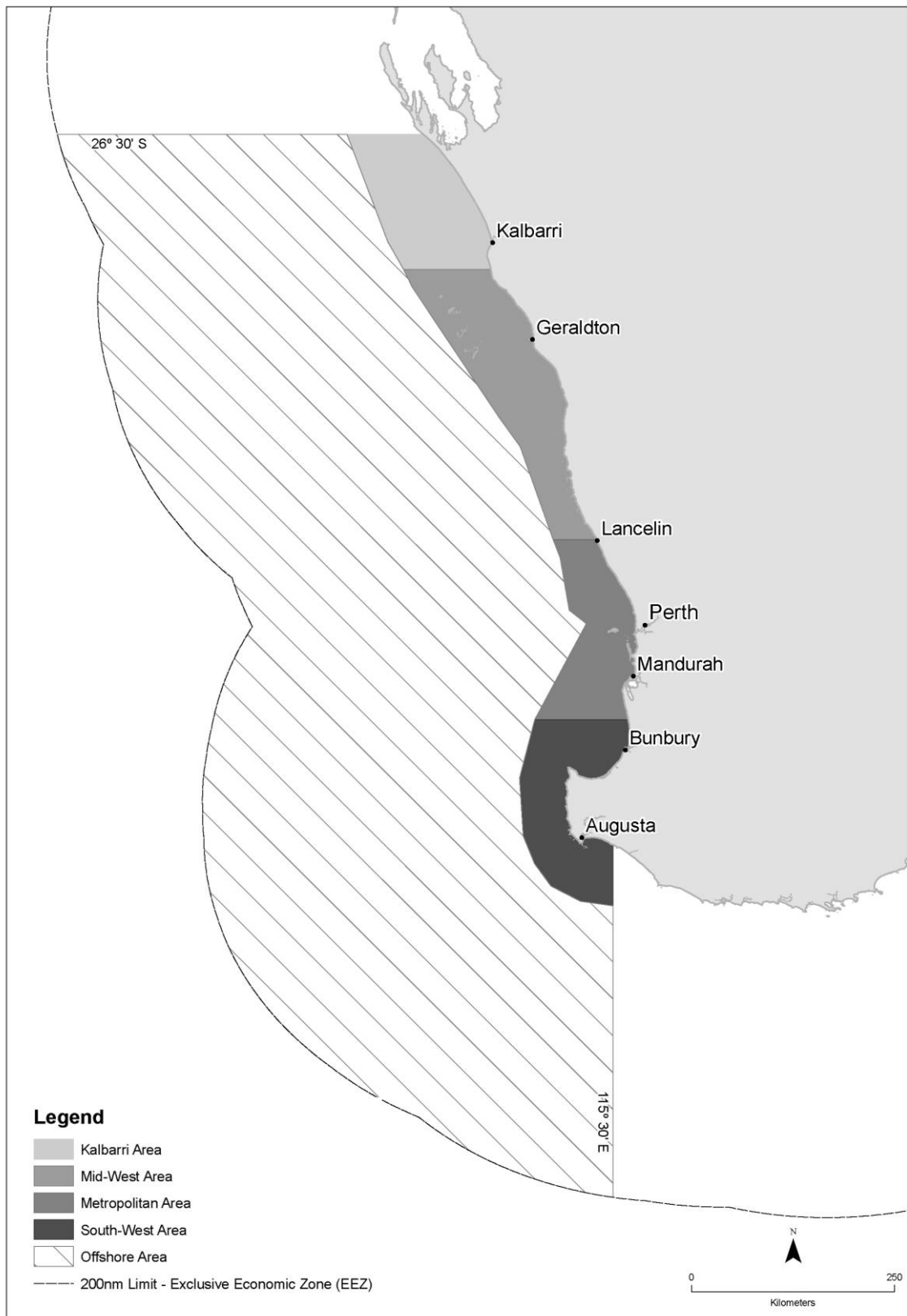
Recruitment success of both West Australian Dhufish and Snapper varies from year to year and is influenced by environmental factors. Thus, the stocks of those species and catches in the fishery are dominated by a limited number of strong recruitment years. This is likely to be similar for other long-lived demersal species in the WCB.

Cockburn Sound is the only known spawning aggregation location for Snapper in the WCB. Juveniles also use the area as a nursery for approximately one and a half years following settlement, before leaving Cockburn Sound. Ongoing industrial development in the area may have detrimental effects on the environmental conditions that are important for both spawning and juvenile survival and thus influence future recruitment success from Cockburn Sound to the WCB.

The Commonwealth Western Deepwater Trawl Fishery and Great Australian Bight Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery fish in waters of the WCB from the 200 m isobath to the boundary of the AFZ. These fisheries target species such as Deepwater Flathead *Platycephalus conatus* and Bight Redfish *Centroberyx gerrardi*. The geographical overlap of these fisheries with the WCDSF indicates that they are likely to be fishing the same stocks.

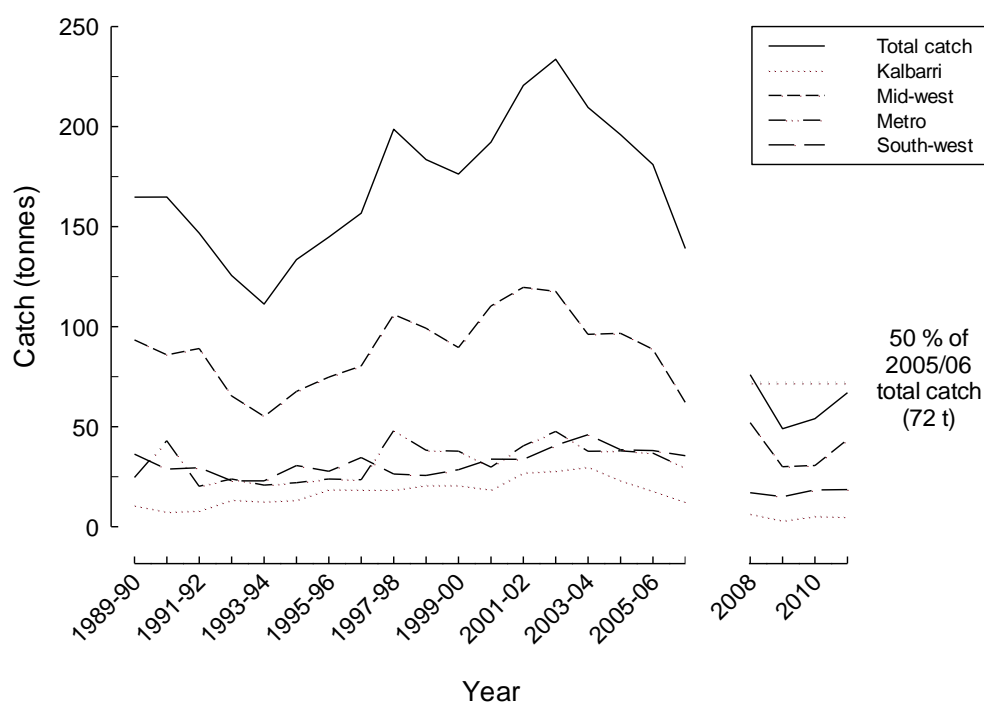
The Commonwealth's South-West Marine Bioregional Plan incorporates the aim of introducing marine reserves, which have proposed areas closed to fishing. This has the potential to restrict access to fishing in parts of the WCB to all sectors, i.e. commercial, recreational and charter.

The changing climate may lead to increased average water temperatures or acidification from absorption by the ocean of increased atmospheric CO₂, which in turn could influence aspects of the biology of demersal species, such as spawning success and thus recruitment patterns. Extreme events, such as the marine heatwave recently reported, may have severe negative effects, including increased mortalities (http://www.fish.wa.gov.au/Documents/research_reports/frr222.pdf).



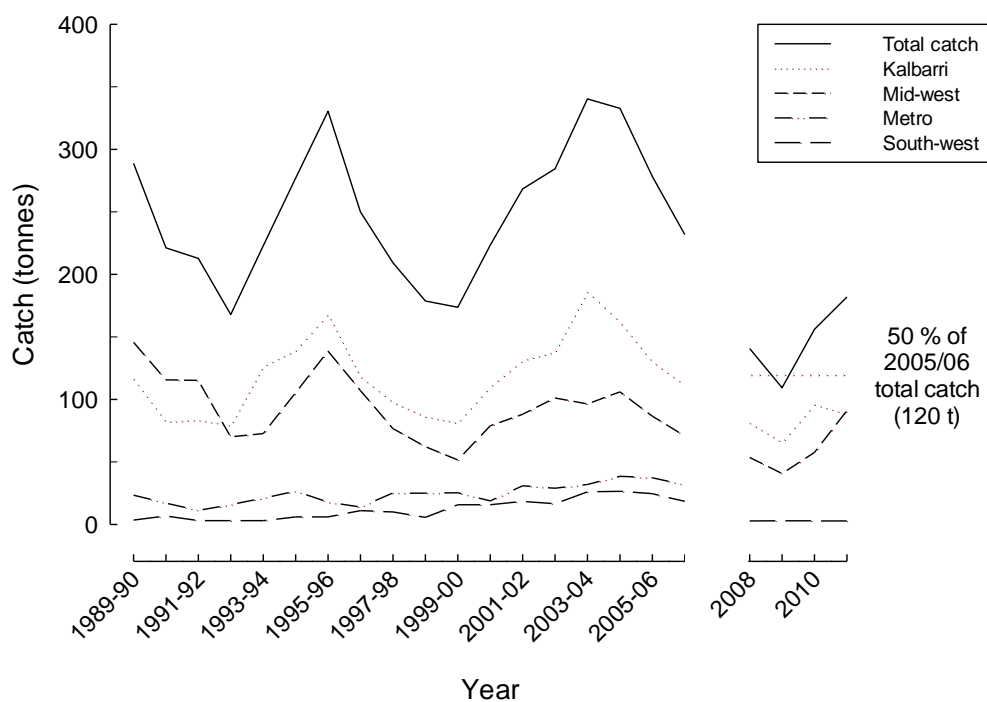
WEST COAST DEMERSAL SCALEFISH FIGURE 1

Map of the boundaries of the West Coast Demersal Scalefish Fishery extending from 26°30' S to 115°30' E. The northern boundary shown applies to the West Coast Demersal Scalefish (Interim) Managed Fishery (WCDSIMF) and is the proposed future boundary for the charter and recreational fishery. The Kalbarri, Mid-west, Metropolitan and South-west areas apply only to the WCDSIMF and extend from the coast to the 250 m depth contour, while the offshore area encompasses the waters from the 250 m depth contour outwards to the boundary of the 200 nm Australian Fishing Zone boundary (AFZ) and from 26°30' S to 115°30' E. Note the Metropolitan Area is currently closed to fishing by the WCDSIMF.



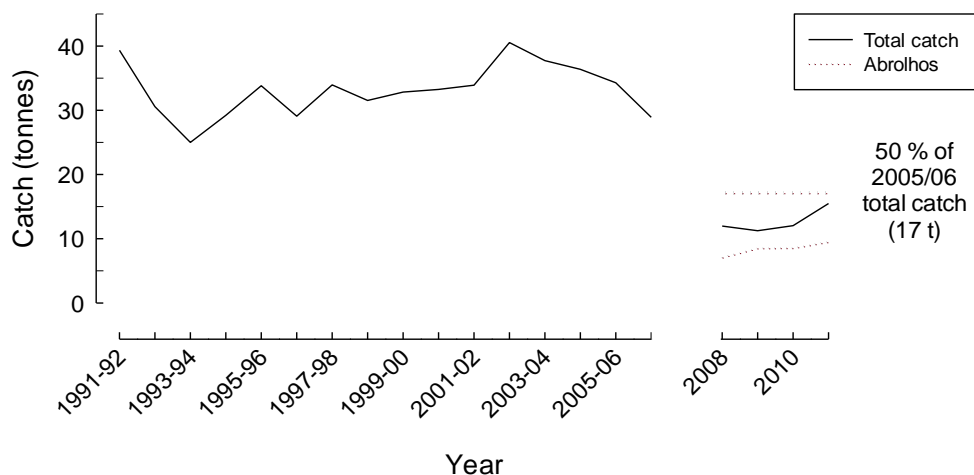
WEST COAST DEMERSAL SCALEFISH FIGURE 2

Total catch and catch by area of West Australian Dhufish *Glaucosoma hebraicum* by commercial wetline fishers in the West Coast Bioregion between 1989/90 and 2006/07 and in the West Coast Demersal Scalefish (Interim) Managed Fishery between 2008 and 2011.



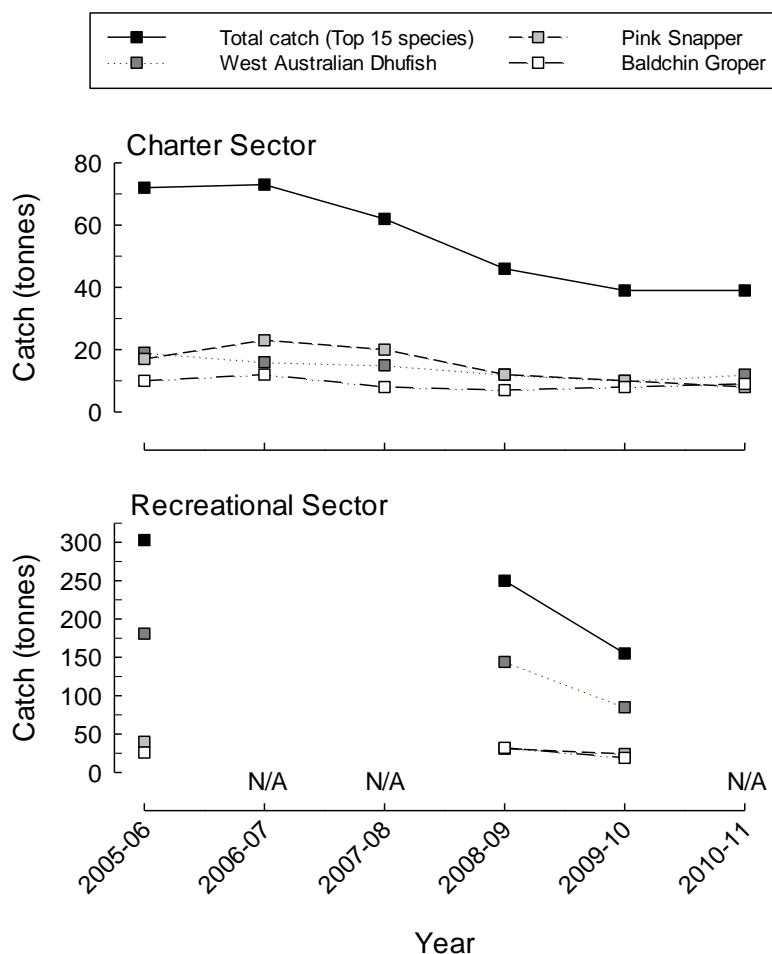
WEST COAST DEMERSAL SCALEFISH FIGURE 3

Total catch and catch by area of Snapper *Pagrus auratus* by commercial wetline fishers in the West Coast Bioregion between 1989/90 and 2006/07 and in the West Coast Demersal Scalefish (Interim) Managed Fishery between 2008 and 2011.



WEST COAST DEMERSAL SCALEFISH FIGURE 4

Total catch of Baldchin Groper *Choerodon rubescens* by commercial wetline fishers in the West Coast Bioregion (WCB) between 1991/92 and 2006/07 and by the West Coast Demersal Scalefish (Interim) Managed Fishery in the WCB and the Abrolhos Zone A of the Western Rock Lobster fishery between 2008 and 2011.



WEST COAST DEMERSAL SCALEFISH FIGURE 5

Catch of the top fifteen demersal species and of West Australian Dhufish, Snapper and Baldchin Groper caught by the Charter and Recreational sectors in the West Coast Bioregion between 2005/06 and 2010/11. N/A, catch estimates not available.

Octopus Fishery Status Report

A. Hart, D. Murphy, S. Leporati, L. Joll

Main Features

Status		Current Landings	
Stock level	Adequate	Commercial – Statewide	166 t
Fishing level	Acceptable	Recreational – Statewide (2001 estimate)	17 t

Fishery Description

The octopus fishery in Western Australia primarily targets *Octopus cf. tetricus*, with occasional bycatch of *O. ornatus* and *O. cyanea* in the northern parts of the fishery, and *O. maorum* in the southern and deeper sectors.

Fishing activities targeting octopus in Western Australia can be divided in four main categories. The West Coast Rock Lobster Managed Fishery (WCRLF) harvests octopus as a by-product, and historically accounted for the majority of total octopus landings, although the Developing Octopus Fishery (DOF) is now the major octopus fishery. The Cockburn Sound (Line and Pot) Managed Fishery (CSLPPF), uses unbaited or passive (shelter) octopus pots; the DOF uses both passive shelter pots and active (trigger pots) traps to selectively harvest octopus. Recreational octopus fishing consists of by-catch from recreational lobster pots, and targeted octopus fishing, mostly by SCUBA divers. In addition to these 4 main sectors, numerous trawl and trap fisheries land small amounts of octopus as a by-product.

Governing legislation/fishing authority

Commercial

Cockburn Sound (Line and Pot) Management Plan 1995

Cockburn Sound (Line and Pot) Managed Fishery Licence

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

West Coast Lobster Management Plan 1993

West Coast Rock Lobster Managed Fishery Licence

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation.

Consultation process

Commercial

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

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department

undertakes direct consultation with the community on specific issues.

Boundaries

Recreational octopus fishing is permitted to operate throughout Western Australian waters, with the exception of reserves and sanctuaries. Each commercial fishing sector is limited spatially to the boundaries inherent in their legislative instruments. Octopus caught in the WCRLF are restricted to the boundaries of that fishery (between latitude 21° 44' S and 34° 24' S). Octopus catch in the CSLPPF is limited to Cockburn Sound. Octopus caught in the DOF are limited to the boundaries of the developmental fishery, which is an area bounded by the Kalbarri Cliffs (26°30'S) in the north and Esperance in the south. Within the DOF there is also spatial separation of the areas fished by "Exemption holders".

Management arrangements

The keeping of octopus as a by-product in the WCRLF is permitted without catch restrictions or size-limits, however the catch rate of octopus within the fishery is monitored as a performance indicator to ensure it is maintained within historical levels (see WCRLF status report).

The CSLPPF is managed through input controls in the form of limited entry and boat size restrictions. In 2011 explicit pot allocations were put in place, with total allowable pot number of 13,000 allocated to the fishery. This allocation has been designed to achieve an average target catch of 25 tonnes for the fishery.

The DOF is also managed through limited entry (currently only 5 exemption holders) and limits on octopus pot allocations specific for passive (shelter) and active (trigger) octopus traps. Effort is spatially controlled, with each exemption holder allocated a specific area of coast. Sustainable harvest levels and pot allocations in the DOF are currently being examined through a combination of exploration of new areas, and associated biological and stock assessment research.

The current recreational bag limit for octopus is 15 octopus, with a boat possession limit of 30 octopus. The Recreational Fishing (Permitted Fishing Methods) Notice (527) currently permits recreational fishers to use unbaited octopus traps when fishing from a boat (note that recreational fishers cannot dive from shore using traps to take octopus). However, the Fish Traps Prohibition Notice 1994 (677)

WEST COAST BIOREGION

prohibits all persons from taking fish by means of fish traps, with the exception of those persons that hold a recreational fishing licence and are using a rock lobster trap. No minimum size currently applies to octopus as the animals are not amenable to management by this method.

A comprehensive Ecologically Sustainable Development assessment of this fishery has also been undertaken to identify any potential sustainability risks requiring direct management. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Current stock assessment is focused on reporting of annual catch and effort statistics from commercial fisheries, reported on a monthly basis. In the DOF, additional reporting of daily catch and effort statistics by spatial location is also undertaken. The daily logbook provides details of the octopus fishing operations such as the depth, habitat, pot types used and soak times (the period of time pots remain in the water until next pull). Details on catch include catch size categories and estimates of undersize catch. The location of the fishing gear is recorded with a GPS position to enable a more precise spatial breakdown of fishing activities and the identification of fishing zones. In 2008 and 2009, two student projects investigating aspects of biology and ecology of *Octopus cf. tetricus* were also completed.

The Department has obtained a research grant from the Fisheries Research and Development Corporation (FRDC) for a project titled "Innovative development of the *Octopus tetricus* fishery in Western Australia". Results from this project will inform industry and management on the potential for expansion of the DOF and project completion is scheduled for October 2013.

Retained Species

Commercial landings (season 2011):

166 tonnes (live weight)

Recreational catch estimate (season 2001):

17 tonnes (live weight)

Landings

Commercial: In 2011 the total commercial octopus catch was 166 t live weight, a decrease of 7% over last year's catch of 178 t (Octopus Figure 1).

On a sector-specific level, octopus catch from the WCRLF increased 26% (from 27 to 34 tonnes) from 2010, catch from the CSLP has remained stable with 24 t, compared to 25 t in 2010, while the catch from the DOF decreased 10% from 119 tonnes to 107 tonnes (Octopus Figure 1).

The DOF has steadily risen from 4% of the total catch in 2001 to 65% in 2011 (Octopus Table 1). At the same time, share of catch from the lobster fishery has declined from 86% to 20%, primarily as a result of effort reductions, which have occurred in that fishery.

Recreational: No annual estimate of recreational catch exists for octopus. In 2001, the national recreational and

indigenous fishing survey¹ estimated a total catch of 25,600 octopus in WA. Using an average weight of 0.7 kg, this amounts to a total catch 17 tonnes.

Fishing effort/access level

Commercial: Fishing effort in the commercial octopus fishery is measured as the amount of days fishing in which octopus was caught. Total octopus effort (days on which octopus were landed) in the WCRLF in 2011 was 7,063 days, a 12% reduction from 8,071 days in 2010 (Octopus Table 1). Days fished in the CSLP and DOF were 218 and 522 respectively, a decrease of 20% and 28% respectively, from 2010 (Octopus Table 1).

Stock Assessment

Assessment complete:

Preliminary

Assessment level and method:

Level 2 - Catch rate

Breeding stock levels:

Adequate

Catch per unit effort: The catch per unit effort (CPUE) from the three main sectors (WCRLF, CSLPF, DOF) are the principal indicator of abundance of octopus.

The CPUE for octopus from the WCRLF was 4.8 kg/day, which was a 90% increase over the long-term average (2001-2009) of 2.5 kg/day (Octopus Figure 2). Otherwise it has been fairly stable between 2001 and 2010, varying between 2.3 and 3.4 kg/day. The increase in the last two years probably reflects the reduced level of fishing and the changing pattern of fishing with multiple day pulls being used

The CPUE for octopus in the CSLPF and DOF sectors was 110 and 206 kg/day respectively. CPUE has increased over time in both these sectors, from 30 kg/day in 2001 (Octopus Figure 2). This pattern is assumed to reflect increases in fishing efficiency, rather than abundance increases, primarily as a result of the developmental nature of these sectors, and the move to more efficient trigger traps.

A standardised CPUE (SCPUE) analysis for the CSLPF and DOF was also undertaken, based on daily catch and effort logbook data which provide more precise estimates of effort. This methodology is still under development, however preliminary trends have been estimated and are compared with the raw CPUE.

SCPUE for shelter pots has shown an increasing trend between 2008 and 2011 (Octopus Figure 3). SCPUE for trigger pots was similar in 2008, 2009 and 2011 at 1.2 kg / pot. In 2010 there was a sharp increase up to 1.9 kg / pot. This was the first year of major development of the fishery, with catch increasing from 30 to 110 t as the fishery expanded into areas which previously had little effort applied to them and the experience of operators with new gear increased.

¹ Henry, G.W. and Lyle, J.M. (eds). 2003. The national recreational and indigenous fishing survey. FRDC project no. 99/158. NSW Fisheries Final Report Series No. 48.

The initial performance measures for the fishery relate to breeding stock maintenance as indicated by catches remaining in the range 50 – 250 t and catch rate remaining above 70 kg/ day in the CSLP and DOF sectors. Both the catch and catch rate measure was met. Target catch ranges and performance indicators will be reviewed as more information becomes available.

Non-Retained Species

Bycatch species impact: Negligible

For the WCRLF, octopus are bycatch. The selective method of fishing used for the CSLP and DOF results in a minimal level of bycatch of other species.

Protected species interaction: Negligible

There are currently no protected species known to be taken in this fishery.

Ecosystem Effects

Food chain effects: Negligible

This fishery harvests only a small amount of octopus per annum. The effect from this harvesting on the rest of the ecosystem, given that the catch is spread over a wide region, is likely to be insignificant.

Habitat effects: Negligible

Rock lobster potting in the WCRLF occurs primarily on sand areas around robust limestone reef habitats covered with coralline and macro-algae, and these habitats are considered resistant to lobster potting due to the hard nature of the bottom substrate. In the CSLP and DOF, octopus-specific pots are set in similar habitats to those fished in the WCRLF, as well as sandy and seagrass areas, particularly in Cockburn sound. These are not expected to impact on benthic habitats as the soak times are at long-intervals, averaging 14 days in the DOF and 25 days in the CSLP.

Social Effects

Each dedicated octopus fishing vessel employs between 2 and 3 people. In 2011, ~ 187 vessels caught octopus, although the vast majority of these landings were small (< 100 kg), as they were by-catch in the WCRLF. Within the octopus specific fisheries, 6 vessels fished in the CSLP, and 11 vessels in the DOF. There is also a substantial processing and value-added component to the octopus catch with factories in Fremantle and Geraldton.

Economic Effects

Estimated annual value (to fishers) for 2011:

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

The estimated annual value for 2011 was ~ \$1.2 million based on an average product price of \$10/kg (head off) or \$7/kg live weight.

Fishery Governance

Target catch range: 50 – 250 tonnes

This is a preliminary target range due to the developing nature of the fishery. Current fishing level of 166 tonnes is within the target range.

New management initiatives (2011/12)

The DOF moved into a new phase in its management arrangements during 2011/12. While one operator had pioneered the development and usage of trigger traps, the opportunity to use this gear was provided to other Exemption holders in the fishery during the year. In conjunction with this change the spatial management framework of the fishery was also modified to align it with the northern and southern zones of the West Coast rock lobster fishery. Permitted gear usage levels (both trigger traps and shelter pots) were set at levels designed to ensure sustainability while exploring the scope for an increased level of catch. The movement to increased use of trigger traps and a broadening of the geographic scale of the fishery have necessitated keeping the management arrangements within an Exemption framework while the fishery establishes a new equilibrium. A move to a more formal management framework is unlikely to occur for at least two years.

The CSLP management plan is currently under review and discussions were being held between Industry and the Department of Fisheries to sort out the octopus fishing gear usage and entitlement levels. It is likely that changes to this plan will be made in 2012/2013.

External Factors

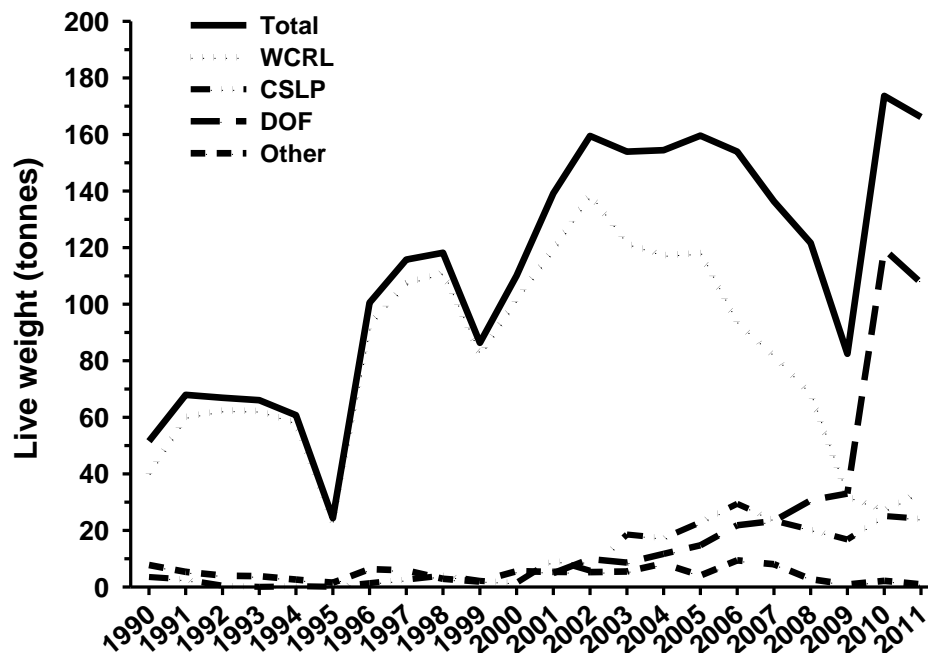
Cephalopods in general, including octopus, are known to be subject to large environmentally-driven fluctuations in abundance. If the fishery expands to reach a catch level approaching maximum possible yields, this year-to-year variability in abundance may prove a significant issue for the fishery. In particular, a "marine heatwave" experienced on the West Coast in the summer of 2010/11, where water temperatures reached 3 degrees C above average, may prove to have a significant effect on the fishery.

The move of the rock lobster fishery from an effort-controlled fishery to a catch quota fishery will change the octopus catch in the fishery. The low puerulus settlement in the lobster fishery has also resulted in the recent reductions of fishing effort of 50-70%.

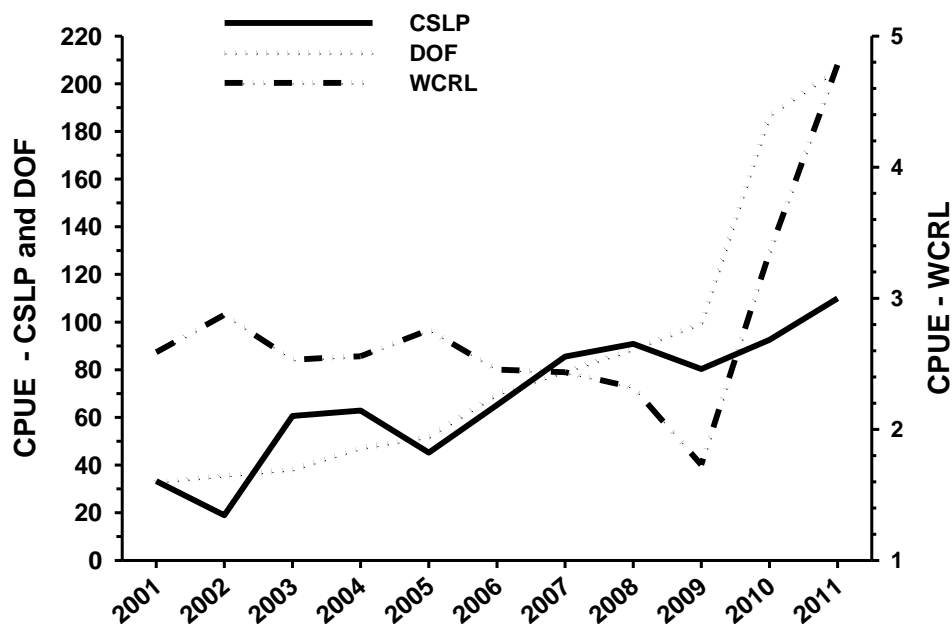
OCTOPUS TABLE 1

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

Year	WCRLF	CSLPF	DOF	Other	WCRLF	CSLPF	DOF
	Percentage of total catch				Effort (total days fished)		
2001	86	6.9	3.5	3.8	46,100	287	149
2002	87	3.6	6.2	3.2	48,300	300	278
2003	79	12.1	5.6	3.6	47,900	306	225
2004	76	11.1	7.6	5.3	45,900	273	249
2005	74	14.3	9.2	2.5	42,800	505	284
2006	62	19.7	11.6	6.3	38,000	451	250
2007	63	18.1	12.9	6.1	33,500	274	211
2008	61	18.0	19.0	2.4	29,400	222	241
2009	39	20.3	40.0	1.0	19,299	256	248
2010	16	14.4	68.7	1.2	8,071	271	639
2011	20	14.5	64.7	0.5	7,063	218	522

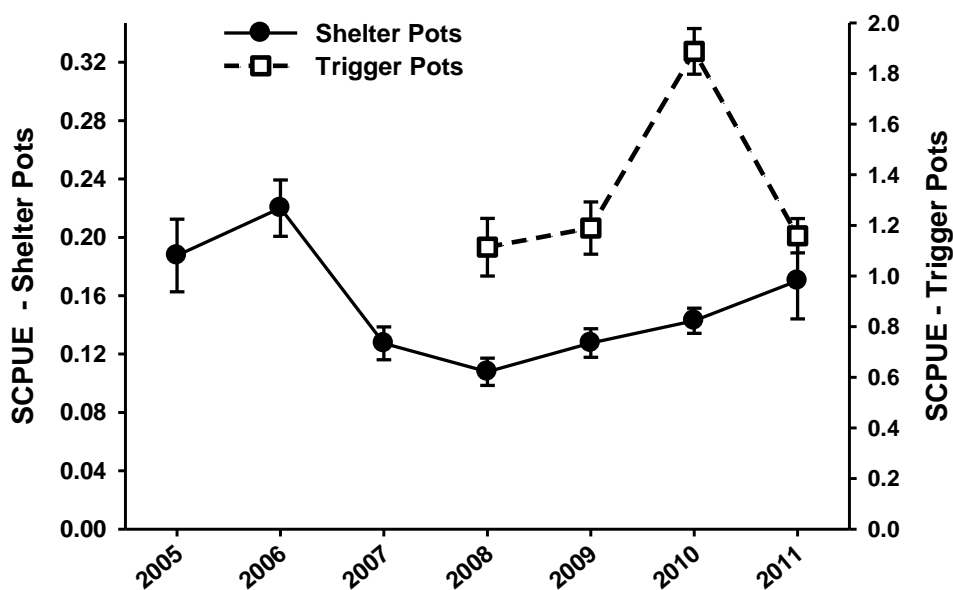
**OCTOPUS FIGURE 1**

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



OCTOPUS FIGURE 2

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



OCTOPUS FIGURE 3

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

AQUACULTURE

Regional Research and Development Overview

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

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

The Department of Fisheries is now responsible for the environmental management of aquaculture in WA waters under the terms of a Memorandum of Understanding it has executed with the Department of Environment and Conservation. Environmental management will be effected principally through a requirement for licensees (with some exceptions) to develop and operate according to a Management and Environmental Monitoring Plan (MEMP). The Department is writing a set of Guidance Statements to assist licensees in the preparation of MEMPs.

A focus of the Department of Fisheries in the Abrolhos Islands area is the regulation of the pearling industry, based on species such as the blacklip oyster *Pinctada margaritifera*. The production of pearls from several other species such as *Pinctada albina* and *Pteria penguin* is also increasing in importance. More recently, attention has focused on the naturally-occurring Akoya oyster (*Pinctada imbricata*). A recent project, initiated by industry partners, demonstrated Akoya pearls can be produced successfully and provided the industry sector with the information it needs to continue to improve production strategies, reduce production costs, improve pearl quality and enhance the market value of the cultured Akoya pearls.

There is significant interest in coral and live rock aquaculture in the Abrolhos Islands. Several aquaculture licences have been issued authorising the production of naturally-occurring coral and live rock at sites at the Abrolhos Islands and others are being assessed.

Given the increasing interest in aquaculture in the vicinity of the Abrolhos Islands, the Department of Fisheries has started the development of a dedicated aquaculture policy for that area. The policy development process will involve substantial communication and consultation with stakeholders.

Through its Fish Health Unit, the Department of Fisheries worked closely with the Marine Fishfarmers Association and the Mid West Development Corporation on a successful project to test the feasibility of farming yellowtail kingfish in sea cages at Geraldton. The project demonstrated and validated the technical and commercial feasibility of offshore marine finfish aquaculture in WA coastal waters. Information generated by the project will underpin the future growth of the industry in the Mid-West region.

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

To assist in addressing the regulatory and approvals issues concerning aquaculture development in WA coastal waters, the Department of Fisheries has received Government funding of \$1.85 million over 2½ years to establish two aquaculture zones in the Kimberley and Mid West regions. Through this project, the Department of Fisheries will secure strategic environmental approvals for the zones from the Environmental Protection Authority, thereby streamlining the approvals processes for commercial projects within zoned areas and providing an “investment ready” platform for prospective investors.

The Department’s review of aquaculture licence conditions is scheduled to start in the 2012/13 fiscal year. The outcome of the review will deliver higher levels of consistency, transparency and certainty in licensing and compliance arrangements across all aquaculture industry sectors.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education in commercial and recreational fisheries in the West Coast Bioregion is undertaken by Fisheries and Marine Officers (FMOs) based at the Busselton, Bunbury, Mandurah, Rockingham, Fremantle, Hillarys, Lancelin, Jurien, Dongara and Geraldton offices, as well as aboard the large ocean-going patrol vessels *P.V's Mc Laughlin, Hamelin and Walcott*. The Department's MarineDiscoveryWest education team delivers targeted education programs throughout the West Coast region. These programs are delivered by Community Education Officers based in Busselton and Fremantle, with the assistance (where available) of Fisheries Volunteers based in some regional centres within the bioregion. Staff from the MarineDiscoveryWest team and the Naturaliste Marine Discovery Centre also provide education services and activities at Hillary's and in the Regions.

Services provided by land-based officers include processing inspections, landing and gear inspections, licensing checks, wholesale/retail checks and inshore sea-based patrols utilizing vessels ranging in size from 5 m to 12 m. They also provide support to seagoing personnel and provide a wide variety of educational and extension services through formal and informal media to commercial fishers, fishing related operations (wholesale/retail/processors), other resource management agencies and community members.

The Department also delivers at-sea marine safety compliance services on behalf of the Department of Transport in the Metropolitan region extending from Mandurah to Lancelin (excluding the Swan/Canning Rivers). Outside of this area, marine safety is unfunded and inspections are carried out in combination with fisheries compliance inspections.

Activities during 2010/11

During 2010/11, Fisheries and Marine Officers delivered a total of 24 334 hours of compliance and community education services in the field (West Coast Bioregion Compliance Table 1). This represents a 26% increase in field compliance over the previous year. A major component of this time was focused on the West Coast Rock Lobster Managed Fishery and recreational fishing. A continuing emphasis was placed on employing risk- and intelligence-based approaches to compliance planning and prioritization.

The Quota Management System commenced for the West Coast Rock Lobster Fishery on 15 November 2010. This presented a number of new requirements for fishers. The Department introduced a comprehensive education program during the course of the year, to assist fishers in their understanding of how to operate under the new Management Plan. The education program included both a number of preseason education sessions, and a high level of field education over the first few months. Attempts were made to contact all fishers at least twice during the season.

Other compliance activity for the West Coast Rock Lobster Managed Fishery focused on the outcomes of the Compliance Risk Assessment process. Routine compliance operations targeted catch disposal records, quota weight declarations, container security, over potting, Sea Lion exclusion devices

and other pot design issues, and black market operations.

Within the West Coast Rock Lobster Managed Fishery, 300 vessels had their catch inspected by FMOs on at least one occasion, with an average of 7 checks per vessel throughout the fishery (West Coast Compliance Table 2). On average 6.6 baskets were inspected per vessel, a decrease on the number of 11.4 baskets per vessel in 2009/10. The percentage of total catch inspected was 0.16 - 0.2% of the catch inspected (compared to 1.1 - 1.4% in 2009/10). These declines are reflective of the change of focus of compliance under a quota management system. The observed per-animal non-compliance rate for the catch was higher than the previous season with an estimated range of 0.0015 - 0.0023. This range has been used to estimate that between 8.0 and 12.4 tonnes of illegal rock lobster were consigned during 2010/11.

In addition to the rock lobster fishery, FMO's focused activity on ensuring high levels of compliance in other commercial fisheries such as the abalone, demersal scalefish (Wetline), crab, shark, scallop, pilchard and estuarine fisheries. A dedicated effort was applied to the Abalone 'black market' trade with a substantial prosecution resulting in four people being prosecuted and convicted.

Overall, compliance in the west coast bioregion by commercial fishers was similar to previous years, with the number of prosecutions marginally higher at 41 compared to 34 in 2009/10. The number of infringements decreased from the previous year, with a total of 16 infringement notices being issued. Infringement warnings decreased from 134 to 36.

A new initiative in 2010/11 was the introduction of the recreational mobile patrol teams. Five dedicated recreational fishing mobile patrols commenced operating within the bioregion based at Geraldton, Hillarys, Fremantle, Mandurah and Busselton will deliver fisheries compliance and education services to the recreational fishing community. They were supported by one of the state-wide recreational mobiles during the period of peak activity.

The mobile patrols enhanced the Department's visibility with the recreational fishing sector, and significantly supported the educational activities of field staff. This resulted in a significant increase in field contacts with recreational fishers, with FMOs achieving 71 257 field contacts, a 39% increase from 2009/10. The majority of the field contact and compliance effort focused on marine finfish (particularly the high risk demersal finfish), rock lobster, abalone, and crabs.

The Department continues to work collaboratively with the Department of Environment and Conservation (DEC) in delivering compliance services to marine parks throughout the bioregion. This collaborative approach has worked very effectively, particularly during the metropolitan abalone season (which occurs predominately within the Marmion Marine Park), and in the Jurien Marine Park, where DEC officers undertake joint patrols with FMOs thereby increasing the effectiveness of compliance service delivery. The level of non-compliance encountered in these parks is low.

Throughout the year FMOs undertook joint patrols with other agencies including the Department of Transport, Australian

WEST COAST BIOREGION

Customs Service and WA Police Service. The Department also continued to provide at sea resources to assist the Department of Environment and Conservation in the disentanglement of whales in the West Coast Bio Region. This assistance led to the successful disentanglement of a number of humpback whales entangled with primarily rock lobster fishing gear.

In the bioregion, the Department has had a growing role in shark response as part of the whole of government approach to the shark hazard program. During the year, FMO's provided support to incident responses and other program activities.

Initiatives in 2011/12

The second year of the implementation of the Quota Management System in the West Coast Rock Lobster fishery will see an ongoing high level of industry liaison and education to ensure a high level of voluntary compliance with the additional management changes from 20010/11. An ongoing priority is to ensure integrity with quota figures, and compliance focus will maintain on consignment weights and weight declarations. This will entail attention on catch recording regime and on landing and processor inspections to ensure that the relevant catch entitlement details are being recorded. There will also be a significant effort in the gathering of intelligence and dealing with black market operations as the catch limits reduce the number of lobster available in the domestic market. Compliance focus will be

on ensuring the catch limits, both individually and collectively, are not exceeded.

For the Abrolhos Islands, new regulations will be introduced for Sea Lion Exclusion devices and a prohibition on bait bands. There will be attention to fisher education and liaison on these requirements with field compliance checks.

Ensuring that only licensed wetline fishers are taking fish for a commercial purpose in the West Coast Demersal Scalefish Interim Managed Fishery will remain a compliance priority throughout the bioregion.

The increased focus on recreational fishing compliance will continue, particularly with the ongoing operation of the recreational mobile patrols operating within the Bio Region. Compliance and management personnel will continue to refine compliance planning to deliver greater efficiencies and outcomes through the use of risk assessments and intelligence processes.

In the Metropolitan area, MarineDiscoveryWest staff will continue their focus on school-based incursions working on sustainability and education themes developed as part of the state-wide education strategic plan. They will continue to deliver information and education activities at major events such as the Mandurah Boat Show and Crab Fest. The Naturaliste Marine Discovery Centre continues to play its role as the hub for education programs in the Metropolitan area, catering to students from kindergarten through to tertiary levels, school and environmental educators and the broader community.

WEST COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and detected offences within the west coast bioregion during the 2010/11 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	24,334 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY ¹	
Field Contacts by Fisheries & Marine Officers	247
Infringement warnings	36
Infringement notices	16
Prosecutions	41
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	71,257
Infringement warnings	1,405
Infringement notices	903
Prosecutions	267
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY ²	
Field Contacts by Fisheries & Marine Officers	6,281
Fishwatch reports ³	574
VMS (Vessel Days) ⁴	19,732

1 Commercial West Coast Rock Lobster contacts are excluded from these totals and detailed in West Coast Compliance Table 2.

2 Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "Other" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of these contacts are recreational in nature (e.g. personal contacts in Marine Parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises etc. are also included in this category. This table includes contacts made by PV's Hamelin and PV Houtman. Contacts made by PV Walcott are included in North Coast Compliance Table 1.

3 This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors.

4 VMS (Vessel Days) represents the number of vessel days recorded in the bioregion. That is, a count for each day that each vessel was polled within the bioregion.

WEST COAST COMPLIANCE TABLE 2

Summary statistics for Commercial West Coast Rock Lobster compliance in all bioregions in the 2010/11 fishing season.

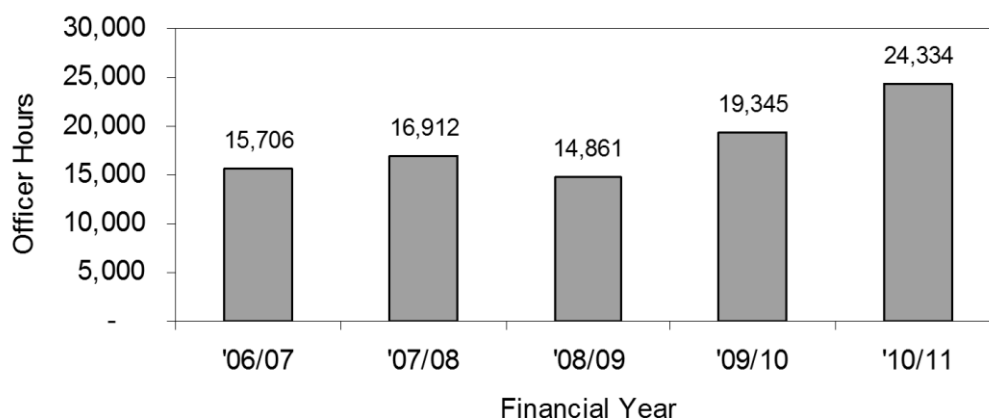
TOTAL COMPLIANCE HOURS¹	16,630 Officer Hours
Field Contacts by Fisheries & Marine Officers	934
INSPECTIONS OF CONSIGNMENTS (Factory checks for Totally Protected Fish (TPF))	
Number of unique vessels checked	300 (61)
Average number of inspections per vessel	7 (0.2)
Average number of baskets checked per vessel ²	6.6 (5.1)
Proportion of total commercial catch inspected for TPF	0.16-0.20%
TPF Non-compliance rate (per-animal basis) ³	0.0015 – 0.0023
Total consigned commercial catch ('000 kg)	5,502
Estimated total illegal catch (TPF) consigned ('000 kg)	8.0-12.4

1 Includes all time spent on compliance related tasks e.g. investigations, prosecutions etc.

2 Calculated as the total baskets checked per vessel divided by total inspections per vessel.

3 A rate of 0.001 indicates 1 illegal animal detected in every 1,000 animals checked.

West Coast Bioregion Compliance Patrol Hours

**WEST COAST COMPLIANCE FIGURE 1¹**

“On Patrol” Officer Hours showing the level of compliance patrol activity delivered to the west coast bioregion over the previous 5 years. The 10/11 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1 and Table 2. (The totals exclude time spent on other compliance related tasks e.g. travel time between patrol areas, preparation and planning time etc.)

1 These figures do not include 3,728 “on-patrol” hours delivered in 2010/11 by PV Hamelin and PV Houtman.

The total on-patrol hours for each of the Department’s 3 large patrol vessels is reported in the compliance summary of the most relevant bioregion: PV Walcott in North Coast, PV Houtman and PV Hamelin in West Coast.

GASCOYNE COAST BIOREGION

ABOUT THE BIOREGION

The marine environment of the Gascoyne Coast bioregion represents a transition between the fully tropical waters of the North West Shelf and the temperate waters of the west coast. Offshore ocean temperatures range from about 22°C to 28°C, while the inner areas of Shark Bay regularly fall to 15°C in winter. The major fish stocks are generally tropical in nature, with the exceptions of the temperate species, pink snapper, whiting and tailor, which are at the northern end of their range off 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 very infrequent cyclones, but is affected at times by river outflows from inland cyclone-based summer rainfall. The limited local rainfall comes mostly from the northern edge of winter storm fronts.

The waters off the Gascoyne Coast are also strongly influenced by the unusual southward-flowing Leeuwin Current, generated by flow from the Pacific through the Indonesian archipelago. This tropical current becomes evident in the North West Cape area and flows along the edge of the narrow continental shelf where, coupled with low rainfall and run-off plus the north flowing Ningaloo current creates the highly diverse Ningaloo Reef system and fish fauna associated with the latter.

The outer area of the large marine embayment of Shark Bay is also influenced by the warm winter current. The inner waters of the embayment are hypersaline, owing to the high evaporation and low rainfall of the adjacent desert areas. The World Heritage-listed Shark Bay is unusual for its extreme hypersalinity at the bay heads, the extensive Wooramel seagrass bank, and associated banks and channels. The sea floor of both Shark Bay and the continental shelf is typically sandy compared to Exmouth Gulf, which has more mud areas and greater turbidity.

The Gascoyne region has been identified as one of the 18 world ‘hotspots’ in terms of tropical reef endemism and the threats facing them. The article ranks this region of Western Australia as the second most diverse marine environment in the world in terms of tropical reef species, and also indicates that it is subject to the second lowest level of environmental threat of the 18 areas that were investigated.

The Ningaloo reef in the north of the region is the largest continuous reef in WA and is one of the most significant fringing reefs in Australia. The bioregion also has extensive areas of mangroves, mostly in Exmouth Gulf while extensive seagrass beds are located in a number of areas.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

Commercial fishing is a very significant industry in the region, with three of the State’s more valuable fisheries – the Shark Bay Prawn, Exmouth Gulf Prawn and Shark Bay Scallop fisheries – landing combined catches valued in the range of \$40 – \$50 million annually. These trawl based fisheries have operated sustainably in the region since the mid-1960s and are internationally recognised as ‘best practice’ in terms of both management and research. The fishery for blue swimmer crabs which operates throughout the waters of Shark Bay, has grown in the last decade to currently be the largest Western Australian crab fishery.

The Gascoyne Coast bioregion also has an offshore demersal scalefish fishery and the Denham-based beach seine fishery which have operated since the 1960s, and provide a significant proportion of the catch of the pink snapper and whiting for the state. The demersal line fishery that originally targeted pink snapper 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 (jobfish). These are all managed as the Gascoyne Demersal Scalefish Fishery. Formal management arrangements for the mackerel fishery that operates in this bioregion were introduced in 2004.

The special features of the Gascoyne coast, coupled with the warm, dry winter climate and accessible fish stocks, have made it a focal point for winter recreation by the Western Australian community. Fishing is a key component of many tourist visits. A full range of angling activities is available, including beach and cliff fishing (e.g. Steep Point and Quobba), embayment and shallow-water boat angling (e.g. Shark Bay, Exmouth Gulf and Ningaloo lagoons), and offshore boat angling for demersal and larger pelagic species (e.g. off Ningaloo).

Recreational fishing is predominantly for tropical species such as emperors, tropical snappers, groupers, mackerels, trevallies and other game fish. Some temperate species at the northern end of their ranges, such as pink snapper, tailor and whiting, provide significant catches, particularly in Shark Bay.

In addition, the Gascoyne Coast bioregion supports extensive scuba diving and snorkelling activities, particularly inside the coral lagoons of the Ningaloo reef system. Specialised ‘eco-tourism’ activities include whale shark and manta ray observation at Ningaloo and dolphin and dugong viewing in Shark Bay.

Aquaculture development in the Gascoyne is largely restricted to the production of pearls and pearl oysters in the major embayments. Hatchery production of oysters is of critical importance in this region, driven by the irregular and therefore unreliable recruitment of both large species of pearl oysters in the wild. Hatcheries in Carnarvon and Exmouth supply significant quantities of *Pinctada maxima* spat to pearl

farms in Exmouth Gulf and the Montebello Islands, while several hatcheries supply juveniles of the blacklip pearl oyster *Pinctada margaritifera* to the bioregion's developing black pearl farms.

ECOSYSTEM MANAGEMENT

Extensive trawl closures inside the 200m depth zone in the Shark Bay and Exmouth region provide protection to sensitive benthic habitat, including coral reef, sand flats and seagrass beds of the continental shelf. These areas provide significant fish nursery, breeding and feeding habitat (Gascoyne Ecosystem Management Figure 1). The extent of these areas means that 35% of the entire shelf region (< 200 m) of the Gascoyne Coast Bioregion could be classified as a marine protected area with an IUCN category of IV (as per Dudley, 2008¹; Gascoyne Ecosystem Management Table 1). The effective area that is not trawled is, however, much greater such that over 90% of the waters less than 200 m depth are not trawled (Gascoyne Ecosystem Management Table 1).

In addition to the trawl based, benthic habitat management protection, specific commercial fishing regulations implemented in the 1970s and 1980s preclude the use of large-mesh gillnets and long-lines throughout the region, to prevent the incidental entanglement of dugongs and turtles which inhabit the region. These controls have also provided protection for the large shark species which are a feature of this region. More recently, bycatch reduction devices ('grids') installed in trawl nets have increased the protection for sharks, rays and the occasional turtle encountered on the trawl grounds.

There are also a number of other 'formal' marine protected areas in this bioregion that have been established under both the Conservation and Land Management Act 1984 and the Fish Resources Management Act 1994 (see Gascoyne Ecosystem Management Figure 2). These include the Ningaloo and Shark Bay marine parks, the Murion Islands Marine Management Area, and the Quobba and Miaboolya Beach Fish Habitat Protection Areas.

The Commonwealth Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) is also undertaking a process of identifying additional protected areas for Commonwealth waters between Shark Bay and the Northern Territory border. The Draft Plan is expected to include proposed marine protected areas, and has been released for a 3 month public consultation period.

The Commonwealth Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) has also undertaken a Marine Bioregional Planning process for Commonwealth waters between Shark Bay and the Northern Territory border. The federal minister for the environment has recently announced the final reserve network proposed for the north-west which spans the Gascoyne and North Coast bioregions.

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

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets/Resources using the EBFM framework

Under the Integrated Marine and Coastal Regionalisation for Australia scheme, the bioregion has been divided into 4 meso-scale regions: Zuytdorp, Shark Bay, Ningaloo, and Exmouth Gulf (IMCRA, V 4.0, 2006). This sub-regional scale of management has now been adopted by the Department through the implementation of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher, et al., 2010)² see How to Use section for more details.

In terms of ecological assets (= resources), the Department utilises the following categories for the IMCRA regions within the Gascoyne Bioregion:

- Ecosystem structure and biodiversity (on a meso-scale basis);
- Captured fish species
- Protected species (direct impact – capture or interaction);
- Benthic habitats; and
- External impacts.

For some assets a finer level of division of the IMCRA ecosystems is used by the Department. This incorporates the recent management initiatives to recognise that there are different suites of exploited fish and invertebrates across the continental shelf.

These sub-components are defined by depth contours (Nearshore 0-20m; Inshore 20-250m; Offshore >250m). The full set of ecological assets identified for ongoing monitoring are presented in Gascoyne Ecosystem Management Figure 3.

Risk Assessment of Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined Gascoyne Ecosystem Management Figure 3 are often made up of individual components at the species or In some cases at the stock level. The risks to each of the individual 'stocks' or lower level components are mostly detailed in the individual fishery reports presented in the remainder of this section of the document. The following table (Gascoyne Ecosystem Management Table 2) provides an overview and cumulative assessment of the current risks to the ecological assets of the Gascoyne Coast Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied.

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

These bioregional level risks are now used by the Department as a key input into the Department's Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this bioregion.

Summary of Monitoring and Assessment of Ecosystem Assets

The Department is a contributor and supporter of the extensive ecological research and monitoring that has been undertaken in the Ningaloo Marine Park, much of which was funded by the recently completed WAMSI Node 3 (see www.WAMSI.org.au for full details).

Each of the fisheries is undertaking monitoring that feeds into the assessment of the various assets outlined above. It is expected that the community structure analyses completed as part of the FRDC project by Hall and Wise (2011)¹ will become a regular part of the monitoring of this bioregion. It is also expected that the biodiversity trawl surveys will be repeated at regular intervals.

The Ranked Risk Assessment of Multiple Fisheries (RRAMF) was tested for the Gascoyne Coast Bioregion of Western Australia using fishery-independent data for general teleost and elasmobranch bycatch; and fishery-dependent data for threatened, endangered and protected species (TEPs). This method allows ranking of bycatch species within each fishery and the accumulation of the ranks across multiple fisheries by incorporating the relative impact of each fishery. This study found no high or unacceptable risks (Evans and Molony, 2010)².

Currently there are no introduced marine pest monitoring programs being undertaken in the Gascoyne Coast bioregion. However, ongoing research includes an assessment of the likelihood of a marine pest being introduced into ports and quantification of the risk associated with recreational vessels for the introduction and translocation of marine pests into this bioregion. Further detail may be found in the Appendix section entitled "Activities of the Marine Biosecurity Research Unit during 2011/12".

GASCOYNE ECOSYSTEM MANAGEMENT TABLE 1

The areas and proportions of the Gascoyne Coast Bioregion making up continental shelf waters (< 200 m depth) where habitats are protected from the physical disturbance of trawl fishing. The areas which are formally closed to trawling would be equivalent to meet the IUCN criteria for classification as marine protected areas as category IV. The area of habitat effectively protected refers to the total area of the shelf (< 200 m) where trawling doesn't occur.

Total Area of Shelf	Area of shelf equivalent to IUCN marine protected area <= category IV (%)	Maximum area of actual trawling activity	Total area of habitat effectively protected from direct damage (%)
15800 sq nm	5600 sq nm (35%)	1100 sq nm	14700 sq nm (93%)

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

² Evans, R. and Molony, B. W. 2010. Ranked Risk Assessment for Bycatch in Multiple Fisheries: a Bioregional Risk Assessment Method. Fisheries Research Report No. 212. Department of Fisheries, Western Australia. 88pp..

GASCOYNE ECOSYSTEM MANAGEMENT TABLE 2**RISK LEVELS FOR EACH ASSET.**

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level components. Low and Moderate values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, is not being generated by fishing activities.

Ecosystem Structure and Biodiversity

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Zuytdorp	Marine	LOW	An assessment of the community structure and trophic level of all commercially caught fish species in the Gascoyne Bioregion over the past 30 years through an FRDC project found no evidence of systematic changes that could be evidence of an unacceptable impact on this ecosystem (Hall and Wise, 2011) ¹ .
Ningaloo	Marine	LOW	See above. In addition, a significant level of research and monitoring is being undertaken in the Ningaloo marine park region by DEC, CSIRO, AIMS and universities.
Exmouth Gulf	Marine	LOW	There is significant protection for all sensitive habitats and restrictions on the level of impacts that can occur in less sensitive habitats. A major project surveying biodiversity on and off the trawl grounds in Exmouth indicated that trawled areas have similar diversity to the larger adjacent untrawled areas. The ecosystem in this region could be at risk if a number of proposed developments are implemented.
Shark Bay Gulfs	Marine	LOW	There is significant protection for all sensitive habitats and restrictions on the level of impacts that can occur in less sensitive habitats. A major project surveying biodiversity on and off the trawl grounds in Shark Bay indicated that trawled areas have similar diversity to the larger adjacent untrawled areas.

Captured fish species

Captured Species	Aquatic zone	Ecological Risk	Status and Current Activities
Finfish	Nearshore (0-20m depth)	MODERATE	This indicator species for this suite (e.g. whiting) are all considered to have adequate breeding stocks, fishing catch and effort has been occurring at the same acceptable levels for over 40 years and there are no additional risks that have been identified. Annual catch and effort monitoring is continuing.
	Inshore demersal (20-250m depth)	MODERATE	The key indicator species for this suite is pink snapper which is currently in a rebuilding phase and spangled emperor, in northern part of the bioregion, is considered to be suffering overfishing (but the overall stock is at an acceptable level). Pink snapper are sampled to provide representative catch-at-age data for used in an integrated stock assessment model which is updated every 3 years (most recently in 2012). Comprehensive research on spangled emperor and goldband snapper has generated 'weight of evidence' based assessments. Monitoring of commercial catches and age structure is continuing and further research is planned to refine estimates of the key biological parameters

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.

Captured Species	Aquatic zone	Ecological Risk	Status and Current Activities
	Offshore demersal (>250m depth)	MODERATE	Concerns around deeper-water species (e.g. ruby snapper, various cods) are largely due to uncertainty in the stock status of these species and their long-lived, slow growing life histories. The main risk to these stocks comes from potential increases in fishing by Commonwealth licensed trawlers who operate outside of 200 m depth and the current discussions about altering this line.
	Pelagic	MODERATE	The stock status and fishing levels on these species (e.g. Spanish mackerel) are both at acceptable levels
	Shark Bay Gulf Demersals	MODERATE	The spawning biomass of pink snapper has returned above the target level (40%) in both the Eastern Gulf and Denham Sound but remained below the threshold level (30%) in Freycinet. These inner gulf stocks are monitored using daily egg production method [DEPM] surveys to estimate spawning biomass approximately every 3-5 years and intermittent surveys of recreational catch. It is possible that grass emperor will be added to the set of indicators for this suite.
	Nearshore (Crabs)	MODERATE	There are a number of issues related to resource sharing and gear conflicts between the Shark Bay crab trap and Shark Bay prawn and scallop trawl fisheries. A recent (2011 stock assessment) concluded that there was conflicting evidence about the level of impact the current catch levels were having on the stock. Subsequent to this review, the relative abundance of all size classes of crabs in Shark Bay declined significantly. The reasons for this unexpected and substantial decline appear to be linked to several adverse extreme environmental events and this has already had a significant impact on the 2011/12 fishing season. .
Invertebrates	Prawns and Scallops	MODERATE	Management of the prawn and scallop fisheries is based on input controls which include limited entry, seasonal and area openings and closures, gear controls. Permanently closed nursery areas within the fishery prevent the fishing of small size prawns while spatio-temporal closures serve to maintain tiger prawn breeding stocks above the threshold abundance level. To ensure that sufficient stock remained for spawning, the fishing arrangements provide a threshold catch rate limit for the scallop fleet to cease fishing. All the stocks of prawns are at acceptable levels. The stock of scallops, however, declined significantly after the 2011 season had ended and this is likely to have been generated by the same set of environmental conditions that affected the crab stocks
	Pearl Oysters	MODERATE	The recent stock levels of pearl oysters in this region have been low. Recovery management arrangements have already been implemented and minimal catches have been taken in recent years.

Protected species

Protected species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Turtles/ Sea Snakes	LOW	While protected species including dugongs, turtles and sea snakes occur in the Gascoyne region area, only sea snakes and occasionally turtles are encountered in the trawl catches. Both of these species are typically returned to the sea alive. Grids are now compulsory, which has largely eliminated the capture of any turtle or other large animal. The number of turtles captured now is very low and most of these are returned alive. Turtle captures and their status at release are monitored and reported.
	Mammals	NEGLIGIBLE	There are no recorded captures of mammals by the trawl fisheries in this bioregion.

GASCOYNE COAST BIOREGION

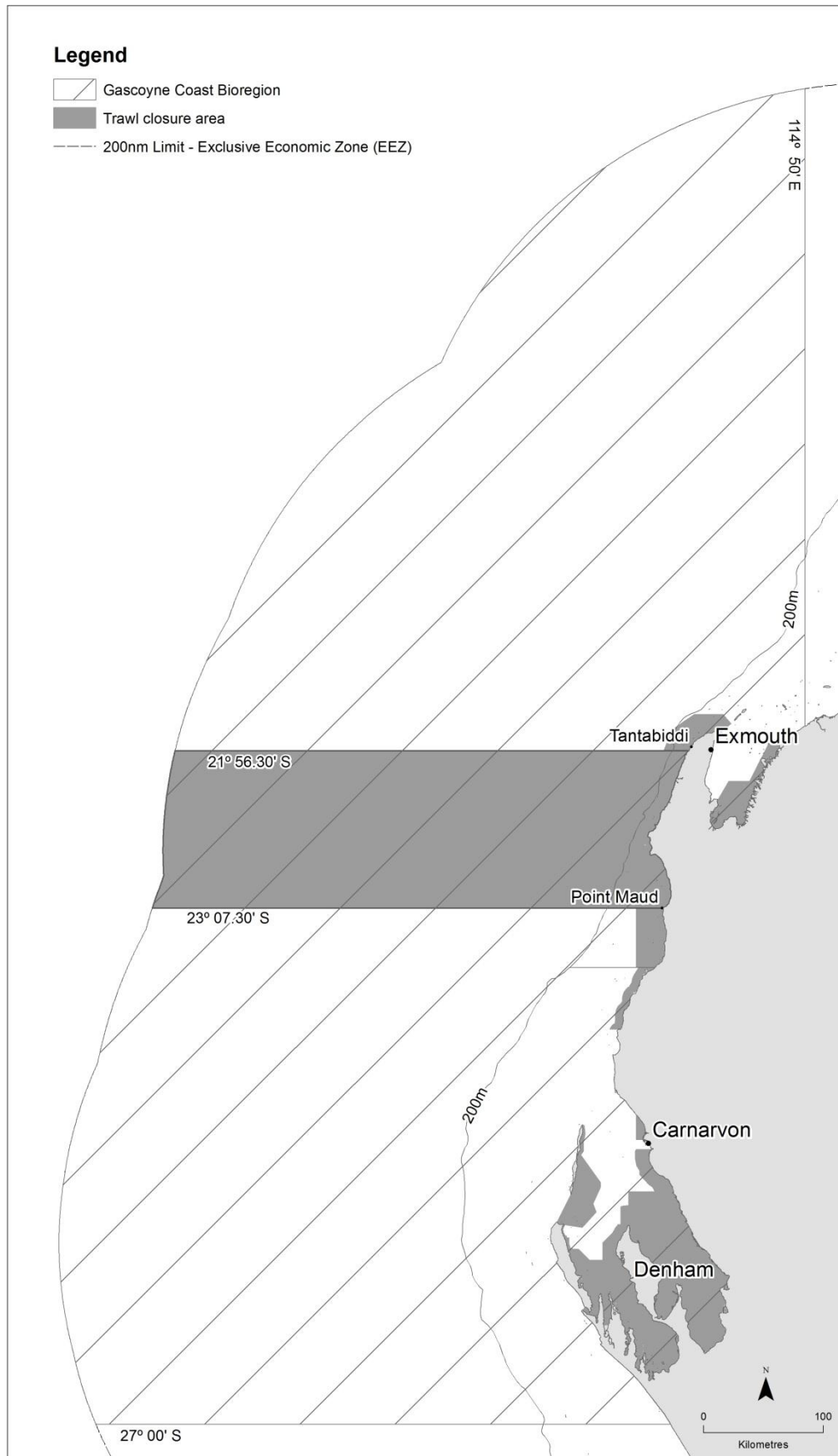
Protected species	Species	Risk	Status and Current Activities
Protected 'Fish' Species	Fish	LOW	There are no protected fish species (including syngnathids) specifically at risk in this region.

Benthic habitat

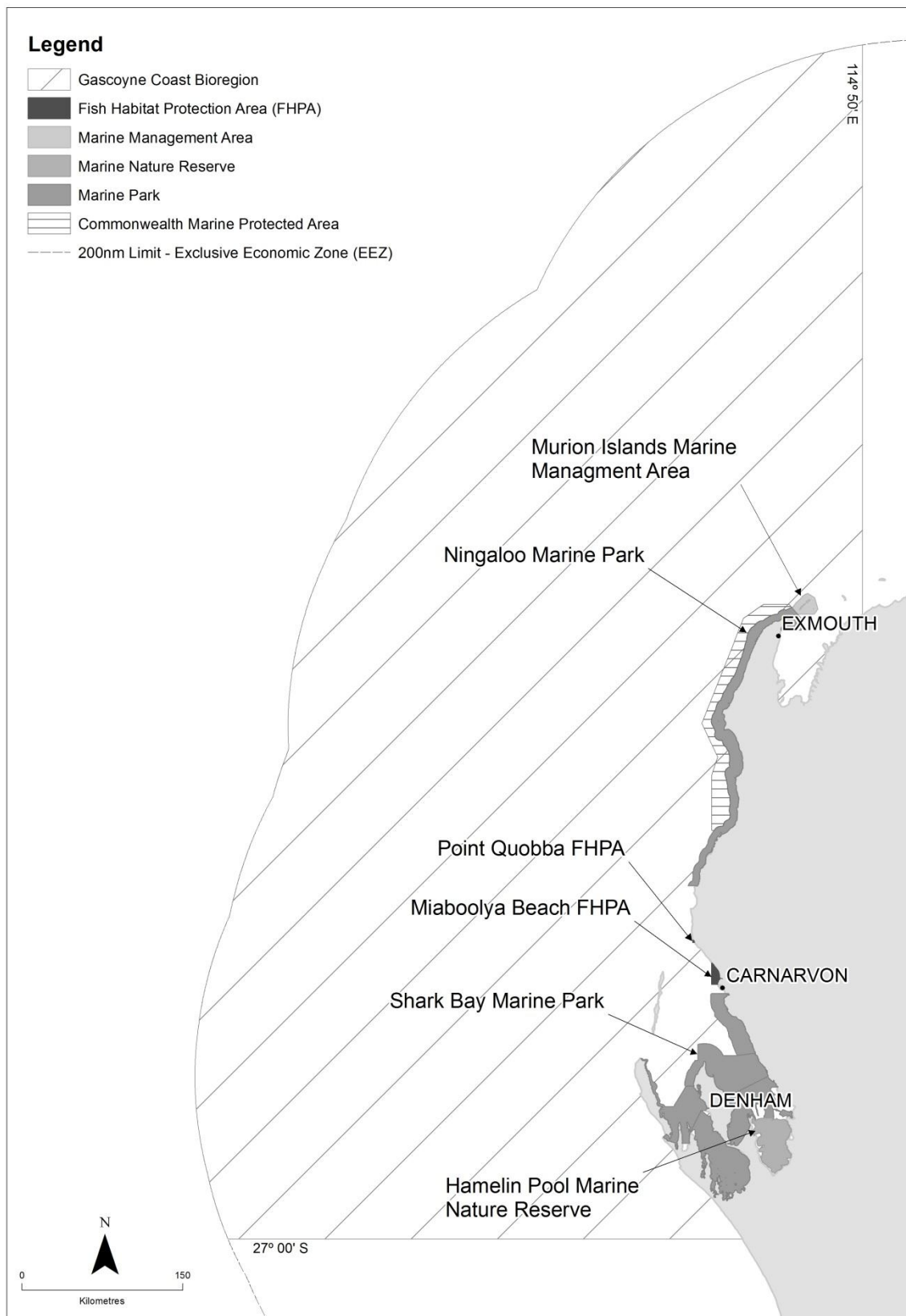
Benthic Habitat	Category	Risk	Status and Current Activities
Exmouth Gulf	Sand Mud Sponge	LOW	There is a large permanent closure to trawling on the eastern and southern sides of the Gulf which protect sensitive habitats that operate as nursery areas. In the area open, trawling effort is focused in the deeper central and north-western sectors of Exmouth Gulf. Owing to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little physical impact. The total area trawled each year has to remain below 40%. The area trawled each year is monitored.
Shark Bay Gulfs	Sand Sponge	MODERATE	The majority of sponge/coral habitats and other sensitive habitats are now contained within specific trawl closures and there are limits to the trawled area to less than 40% of the sand habitats. The area trawled each year is monitored.
	Seagrass	NEGLIGIBLE	There are extensive, permanent closures in the Shark Bay fishery covering all inshore seagrass areas.
Ningaloo	Sand Coral	LOW	There are no trawl activities in these areas. The main risk is to coral habitat from tourism and other boating related activities.
Zuytdorp	Sand Reef	NEGLIGIBLE	There are few direct impacts to these habitats.

External Drivers

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	LOW	This issue is not currently identified as being as high a risk as in some other WA bioregions due to lower level of international and interstate shipping.
Climate	MODERATE in short term	Being a transitional region, the biota in this bioregion are at enhanced risk of being affected by climate change. Projects to examine potential impacts on this bioregion are now underway or planned
	HIGH in medium term	

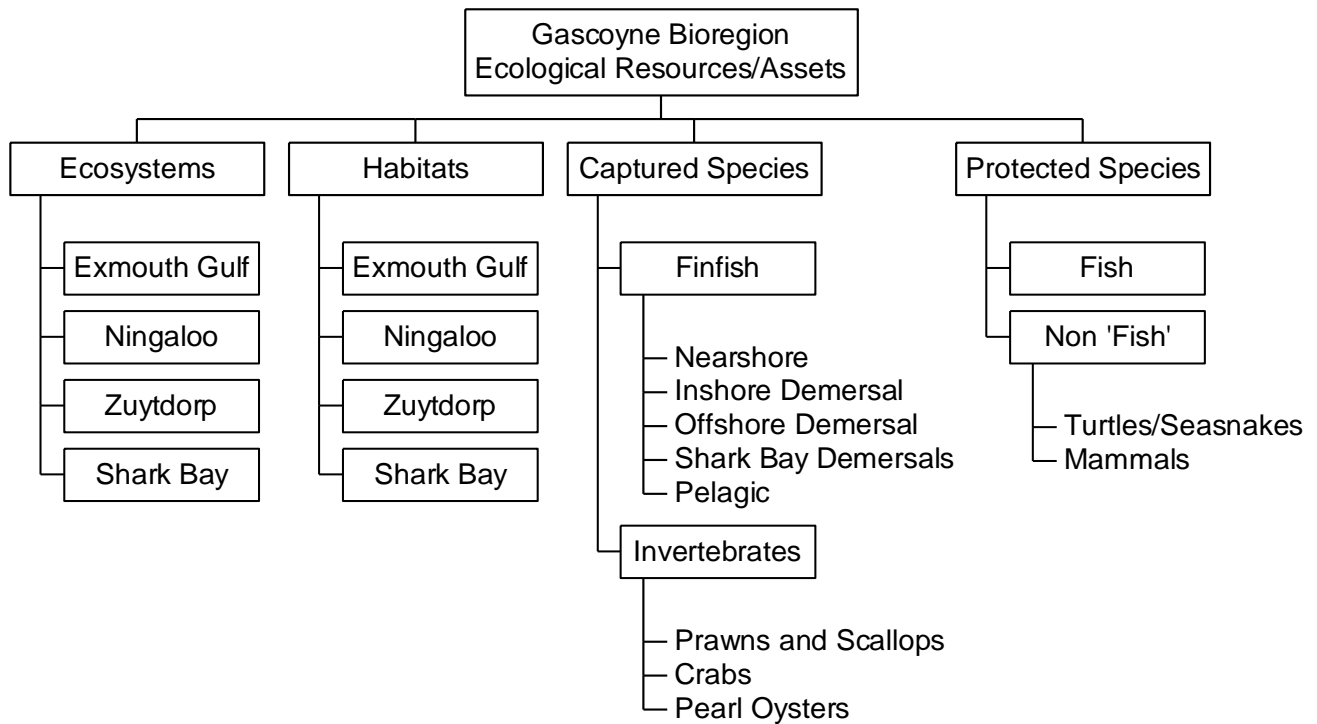
**GASCOYNE ECOSYSTEM MANAGEMENT FIGURE 1**

Map showing areas permanently closed to trawling in the Gascoyne Coast bioregion. The areas permanently closed are consistent with IUCN marine protected area category IV.



GASCOYNE ECOSYSTEM MANAGEMENT FIGURE 2

Map showing current and proposed marine parks and FHPAs in the Gascoyne Coast

**GASCOYNE ECOSYSTEM MANAGEMENT FIGURE 3**

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

FISHERIES

Shark Bay Prawn and Scallop Managed Fisheries Status Report

E. Sporer, M. Kangas, S. Brown and L. Pickles

Main Features

Status		Current Landings	
Stock level		King Prawns	1310 t
Prawn	Adequate	Tiger Prawns	689 t
Scallop	Adequate	Endeavour Prawns	15 t
Fishing level		Scallops	295 t
Prawn	Acceptable		
Scallop	Acceptable		

Fishery Description

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

The Shark Bay Scallop Managed Fishery catches the saucer scallop (*Amusium balloti*), and is usually WA's most productive scallop fishery. These two managed fisheries are limited entry and both use low opening, otter trawls as the fishing method and incorporate in-season real time management to ensure sustainability and maximise economic efficiency.

Governing legislation/fishing authority

Shark Bay Prawn Management Plan 1993

Shark Bay Prawn Managed Fishery Licence

Shark Bay Scallop Management Plan 1994

Shark Bay Scallop Managed Fishery Licence

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

Consultation process

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

Boundaries

The boundaries of the Shark Bay Prawn Managed Fishery and the Shark Bay Scallop managed Fishery are located in and near the waters of Shark Bay as presented in Shark Bay Prawn and Scallop Figures 1 & 2. These diagrams outline the boundaries of the two fisheries plus show all the area closures (both temporary and permanent) and the specific areas trawled in the 2011 season.

Management arrangements

Management of the prawn and scallop fisheries is based on input controls, which include limited entry, seasonal and area openings and closures, gear controls and limits on crew numbers. Both fleets undertake trawl fishing using otter trawl systems. Each fleet has a separate standard net size and gear configuration.. Within the Shark Bay Scallop Managed Fishery in 2011 the Minister adopted a formal catch share management objective for the annual scallop catch between A Class (scallop only) and B Class (scallop and prawn) boats of 70% and 30% respectively.

Bycatch reduction devices ('grids') are mandatory for all prawn and scallop trawl nets. In addition, secondary bycatch reduction devices (fish escape devices) are mandatory for nets of prawn boats because they fish with small size mesh codends. Scallop boats have larger 100 mm mesh codends resulting in only a small amount of bycatch being taken during trawl operations and therefore do not require the secondary devices.

Prawn and scallop fishery management arrangements are designed to keep effort at levels that will maintain sufficient spawning stock levels of target species and achieve optimal yields. Management arrangements are also aimed at catching prawns and scallops at the best size and condition for the market, thereby maximising the economic return. The prawn fleet operates under an exemption from both the net size and the 375- hull unit rule to provide for trawl gear amalgamation

using quad trawl gear configuration to generate improved economics. In late 2010, a Voluntary Fisheries Adjustment Scheme (VFAS), for the Shark Bay Prawn Managed Fishery was approved resulting in the removal of 9 licences from the fishery, reducing the fleet from 27 to 18 Licensed Fishing Boats. This was formalised in early 2011. The purpose of the VFAS was to improve the long-term economic efficiency through a reduction in the number of licences and by consolidating fishing gear onto 18 boats. The restructure has also resulted in an 8% reduction of the total headrope capacity for the fishery.

Scallop boats are authorised to operate with two 12.8 metre nets (7 fathoms) and boat units no greater than 375, but the scallop fleet also operates under an exemption from the 375-hull unit rule. The total net headrope capacity for the scallop fleet was 358.4 metres (196 fathoms). In late 2010, a VFAS for the Shark Bay Scallop Managed Fishery was approved and three licenses were removed from the fishery reducing the fleet from 14 to 11 licenses in early 2011 resulting the total net headrope capacity of the A Class Scallop fleet being reduced to 281.6 metres (154 fathoms).

The Research Division of the Department of Fisheries carries out daily monitoring of the scallop fleet catch to provide advice on when to close areas based on the threshold catch rates. This is the major real time component of the management strategy to control spatial and temporal fishing effort. The Vessel Monitoring System (VMS) continues to monitor the activity of all licensed fishing boats in this fishery.

The Commonwealth Government's Department of Sustainability Environment Water Populations and Communities (SEWPaC), has assessed the fisheries under the provisions of the EPBC Act 1999 and has accredited the fisheries for a period of five years (re-assessment in 2013), allowing product from the fisheries to be exported from Australia. The comprehensive ESD assessment of these fisheries found that the only material risks requiring direct management actions to ensure acceptable performance were the breeding stock levels of the targeted prawn and scallop species, bycatch species impacts, protected species interactions (including loggerhead turtles), habitat effects and provisioning effects. Boxed text in this status report provides the annual assessment of performance measures/indicators for each of these issues.

The 2011 prawn season fishing arrangements provided a season opening date on 3 March and closing 10 October providing a total of 171 nights fishing. During the season the fishing strategy involved flexible arrangements and voluntary rolling area openings, based on assessment of both king and tiger prawn size through fishery-independent surveys. The tiger prawn spawning area (TPSA) closed on 25 June.

The 2011 scallop season commenced 9 April and fishing ceased on 17 April when the average catch rate (based on the last 2 days of fishing) of 408 kg/hr was reached. Denham Sound was not opened to scallop fishing during the 2011 season because of low scallop abundance in that area.

Research summary

To complete research and monitoring activities the Shark Bay region is separated into two sectors for both prawn and scallops - Northern Shark Bay and Denham Sound. All data

are analysed separately for each sector of the fishery because the stocks of both these species within these regions appear to have little connectivity.

Prawns

The yearly cycle of operation for the prawn fishery is dynamic as it depends on the strength and timing of recruitment therefore the opening and closing dates for the fishing seasons vary each year depending on environmental conditions, moon phase and the results of fishery-independent surveys to estimate recruitment strength. The timing and spatial pattern of the fishing season allows the harvesting of the current season's recruits and the large residual prawns not caught in the previous fishing season. Permanently closed nursery areas within the fishery prevent the fishing of small prawns and provide habitat preservation, while spatio-temporal closures serve to maintain tiger prawn breeding stocks above the threshold abundance level.

Non-fishing periods occur around the full moon, commonly known as moon closures. These moon closure periods are variable and can range from five to ten days and are set out in the season arrangements. King prawns are sensitive to light, which makes them less active around the full moon and hence less catchable. Industry has voluntarily extended these closures to increase economic efficiency by shifting fishing effort away from these times of reduced catch rate.

From early August onwards, the Extended Nursery Area (ENA) is closed to protect smaller prawns (primarily king prawns) moving onto the trawl grounds from the nursery area. In addition, the Denham Sound opening occurs in July/August each year, which gives protection to these smaller prawns early in the season allowing a higher spawning biomass in this region.

Scallops

The scallop catch is taken by boats licensed to take only scallops (11 A class licences) and boats that also fish for prawns in the Shark Bay Prawn Managed Fishery (18 B class licences).

The opening date of the scallop fishing season is a compromise between maintaining breeding stock levels (measured by a pre-season survey of stock abundance and commercial catch rates during the fishing season) and the seasonal decline in meat condition associated with spawning.

An early opening has the aim of increasing the total weight of scallops caught by taking them at a time when the meat size is large prior to spawning. However, in some years there may be a need to assess meat size and condition before the season commences to meet these criteria. To ensure that sufficient stock remains for spawning, the fishing arrangements provide a threshold catch rate for the cessation of scallop fishing (400 kg meat/24 hour period in northern Shark Bay and 450 kg meat/night time fishing period in Denham Sound).

Research activities continue to focus on stock assessment and annual monitoring of the target stocks, particularly tiger prawns and scallop stocks. All boats complete detailed daily log books, and these, together with pre-season fishery-independent recruitment surveys and in-season surveys of size composition and spawning stock, provide the information for monitoring the status of the stocks. In-season prawn surveys have proved to be valuable in ensuring that the prawns are targeted at an optimal market size.

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Determining the status of the scallop stock in Shark Bay also requires real-time monitoring of catch levels to ensure the threshold catch rate levels and catch shares are both achieved. In addition, an annual research survey is carried out in November, which, together with existing detailed biological knowledge, enables an annual catch forecast to be provided. These survey data are also used as the basis for the management arrangements to take into account fishing scallops at an optimum size and allows for an adequate spawning stock to remain for the following year. A minimum estimated catch availability level for Denham Sound and northern Shark Bay has also been set to determine if commercial fishing can commence each season.

A FRDC project on research into prawn/scallop gear interactions, scallop and prawn larval movement patterns in Shark Bay and potential effects of area closures in scallop/prawn management commenced in March 2008 and was completed in 2012.

Retained Species

Commercial production (season 2011)

Prawns 2014 tonnes

Scallops 295 tonnes (whole weight)

Landings

Prawns

The total landings (whole weight) of major prawn species for this fishery was 2014 tonnes, comprising 1310 tonnes of king prawns, 689 tonnes of tiger prawns and 15 tonnes of endeavour prawns (Shark Bay Prawn and Scallop Figure 3). In addition, 117 t of coral prawns (various species, but mainly *Metapenaeopsis crassissima*) were landed. These total landings of major prawn species were higher than the interim target catch range set in 2009 (950 – 1450 t) but within the historical target catch range (1501 to 2330 tonnes). The target total catch levels are still being reviewed to reflect current fishing/targeting strategies and effort levels under normal environmental conditions.

King prawn landings (1310 t) were within the historical target catch range (1100 to 1600 tonnes). In 2010/11 the environmental conditions were unprecedented with higher than average water temperatures (by up to 4-5 degrees Celsius) in Shark Bay in early 2011 combined with two flood events. These appear to have increased prawn survival and increased recruitment levels. These events also increased prawn catchability and the flooding triggered prawns to be available on the trawl grounds earlier than normal and at a smaller size on average.

Tiger prawn landings (689 tonnes) were also within the historical target catch range (400-700 tonnes) but above the average catch of 533 tonnes over the last 16 years (1995-2010).

The king and tiger prawn catch rates during the combined recruitment surveys (March and April) in 2011 were the highest observed since 2001 and therefore the anticipated catches of both species were expected to be higher than seen in recent years. The relationship between survey indices and landings continues to be reviewed.

Scallops

The total scallop landings for this fishery, which includes the

catch from both A and B Class scallop boats, was 295 t (whole weight) (Shark Bay Prawn and Scallop Figure 4). All scallops landed were from northern Shark Bay (Red Cliff and North West Peron areas). A Class boats landed 206 t (70%) and the B Class boats landed 89 t. The 2010 scallop survey provided a 2011 catch prediction of 1340 t of scallop (whole weight) for northern Shark Bay. The catch prediction for Denham Sound was 155 t, below the 250 t level established as the minimum catch for scallop fishing to be undertaken in Denham Sound so no fishing took place in Denham Sound or “the Leads” area this season.

By-product

By-product landings from the prawn fleet included 293 t of blue swimmer crab (*Portunus armatus*), 2 t of coral crabs (*Charybdis feriata*), 14 t of squid, 20 t of cuttlefish, 1 t of bugs (*Thenus australiensis* and *parindicus*), < 1 t of octopus and mixed finfish species.

The blue swimmer crabs total season landings by the prawn boats were lower compared to the 2010 season landings (338 t). The monthly retention trend showed that there was a decline in abundance in the later months of the season.

By-product landings for the A class boats in the scallop fishery included 2 t of blue swimmer crabs (*P. armatus*), and < 1 t of bugs (*T. australiensis* and *parindicus*).

Fishing effort/access level

Eighteen prawn boats operated in 2011. All boats fished with quad gear configuration (four, 10.1 m nets). The mean annual total effort recorded historically by 27 prawn boats between 1990 and 2004 inclusive is 44,864 hours, fishing with twin gear (prior to 1990, the fleet consisted of 35 boats). An adjustment was made to the nominal effort for the increased headrope (37.5% per boat) towed by the 18 quad boats with the 2011 adjusted effort being 36,061 hours (twin-gear equivalent). This adjusted effort is lower than last year and the lowest seen since 1968 and well below the mean effort between 1990 and 2004. The impact of gear amalgamation means that effective effort has not reduced as much as nominal effort.

The cost of fishing (mainly high fuel prices and high value of the Australian dollar) has reduced effort due to economic reasons. The prawn season arrangements provided 170 nights fishing, however, only 162 nights were used. This was mainly because 11 boats ceased fishing at the September moon closure (7 to 16 September) and these boats only fished 146 nights.

The nominal effort recorded by the 9 A Class boats in 2011 was 1,393 hours. This is a marked decline of effort from previous years and has been compounded by both the reduction in the number of boats and low abundance and poor quality of scallops available. The effort is standardised as all boats tow 12.8 m (7 fathom) headrope nets.

Recreational component:

Nil

Stock Assessment

Assessment complete:

Yes

Assessment level and method:

Level 4 - Direct survey/catch rate

Breeding stock levels:

King prawns	Adequate
Tigers prawns	Adequate
Scallops:	Adequate

Prawns

The catch per unit of effort for the prawn fishery can be used as an indicator to monitor changes in stock levels from year-to-year. Spawning stock and recruitment indices are derived from survey data and commercial catch rate levels of tiger prawn spawning stock from logbook data. The conservative tiger prawn threshold catch rate levels are in place to maintain spawning stock above acceptable levels. Logbooks provide information on the daily catch (kg) of target species and effort (hours trawled) expended in specific fishing areas. Catch per unit effort can then be derived for each fishing area by each boat by species. Fishery-independent surveys are undertaken for king and tiger prawn stocks, which are monitored and assessed for size and catch rates from recruit surveys in March and April, king prawn surveys in Denham Sound in June and July, and tiger prawn breeding stock surveys in July and August. Fishery-independent recruitment surveys are undertaken as fishery-dependent data on key recruitment grounds is no longer available. Historically, fishing occurred in these grounds from 1 March and commercial catch rate information provided information on recruitment trends, however since late 1990s, no fishing occurs in these areas early in the season. The information is also used to determine the extent of areas to be opened to fishing to meet prevailing market requirements. These data will also be used in the future to forecast a predicted catch range for tiger and king prawns. The spawning stock surveys are undertaken to verify tiger prawn catch rates after the TPSA is closed to fishing. Some of the king prawn breeding stock is also protected by this closure and their catch rates are also recorded during the surveys.

Catch rate assessment

The overall king prawn catch rate of 36.2 kg/hr (for adjusted effort equivalent to twin gear units) in 2011 was higher than last year's rate of 27.5 kg/hr. The overall tiger prawn catch rate of 19.1 kg/hr was also a significant increase compared to 10.3 kg/hr in 2010. These catch rates indicate that the fishery is healthy, was fished efficiently and reflected the favourable environmental conditions in 2011.

Survey assessment and breeding stock levels

Fishery-independent recruitment index for tiger and king prawns in 2011 was higher than observed in 2010 and was reflected in the improved catches in 2011.

To maintain adequate tiger prawn breeding stock levels the, Tiger Prawn Spawning Area (TPSA) is closed when the mean catch rate reaches the threshold level. The threshold catch rate was conservatively adjusted for quad gear (four 10.1m nets) in 2007 (from 20 kg/hr) to 27.5 kg/hr, with a range of 25 to 30 kg/hr. In 2011, the daily catch rate was difficult to assess due to the sporadic fishing effort by boats in the TPSA. The tiger prawn catch rates in the fishing area directly south of the TPSA were deemed adequate to allow fishing to continue in the TPSA into June.

Two standard spawning stock surveys are generally undertaken around the third moon phase in July and August, in the TPSA. In 2011 survey catch rates for tiger prawns were

23.7 kg/hr in July and 18 kg/hr in August with a mean catch rate of 20.8 kg/hr, all below the threshold level. While the breeding stock level of tiger prawns is still considered adequate, both the threshold level and potentially even the specific area defined as the TPSA may need to be reviewed.

The catch rates for both tiger and king prawns decreased from July to August, indicating very little migration into the area in the latter part of the season and below-threshold catch rates in the TPSA. In consultation with industry, the TPSA was not re-opened during October (the last fishing period for the season) as occurred in 2010.

The king prawn catch rates were 19.9 kg/hr and 17.6 kg/hr respectively with a mean catch rate of 18.8 kg/hr which is within the historical range for this species (16-29 kg/hr). King prawn stock remains above the level where recruitment is affected by spawning stock levels and it is therefore adequate. Fluctuations in the annual king prawn harvest are most likely to have resulted from varying effort levels and environmental effects on recruitment, not from the spawning stock abundance.

Variable quantities of minor penaeids (predominantly coral prawns) are retained, depending on the catch of the target species. Owing to the small size of these species, it is likely that the majority of the stock is able to pass through the trawl mesh, suggesting that the overall exploitation is low and that breeding stock levels will therefore be adequate. Due to the low market prices received for these minor species their retention is minimal.

The main performance measures for the prawn fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2011, the breeding stock indicator for tiger prawns was below the threshold level of 25-30 kg/hr but still considered adequate. The king and tiger prawn annual landings were within the historical target range.

Scallops

Scallops mature at about one year of age and spawning typically occurs from April to November. Fishing is therefore controlled to ensure that sufficient scallops remain through the key spawning season (April to July), which is the critical period for generating the forthcoming seasons recruits.

The catch rate of 29.7 kg/hr from A class boats (based on scallop meat weight which is 20% of the whole scallop weight) was relatively low compared to recent years since 2004, when the fishing strategy changed.

The catch rate threshold was 400 kg/day fishing period in northern Shark Bay and scallop fishing ceased 17 April at an average catch rate of 408kg/hr (based on the last 2 days of fishing) leaving an adequate residual level of spawning stock. The 2010 annual scallop survey provided a catch prediction for the 2011 season in the northern area of 1340 t (range 1070-1600 t) whole weight. The shell height measurements showed that the stock was predominantly recruits (small size shell) with low numbers of residual scallops. The size structure of scallops and low abundance of residuals indicated that the season should have opened later than it did

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on 9 April. In Denham Sound, recruitment levels were low and the residual numbers were extremely low for a predicted catch of only 31 t meat weight. The low catch prediction for Denham Sound was deemed below the level (50 t meat weight) to allow scallop fishing this season in this area.

The performance measure is to ensure adequate breeding stock levels. This is achieved by cessation of fishing at the appropriate catch rate thresholds. The current cut-off catch rates continue to be reviewed. As the Denham Sound catch prediction was below the minimum abundance level for fishing, this area remained closed for the 2011 season. Also the fishing strategy has aimed at leaving part of the stock to be carried over to the following year providing a buffer in case of low recruitment and this should remain part of the sustainable fishing strategy.

Projected scallop catch next season (2012):

Nil tonnes (whole weight)

The catch projection for the 2012 season is based on the 2011 annual survey results. In northern Shark Bay, observed recruitment was very low. The catch prediction for this area is 42 t meat weight but this is predominantly recruitment with few residual scallops. In Denham Sound, both recruitment and residual levels were low and provided a low overall index giving a predicted catch of 11 t meat weight. Therefore the catch prediction for the fishery is at a very low level such that all the available stock should remain for spawning with no scallop taken. This low recruitment appears due to the extreme environmental conditions of early 2011 in Shark Bay due to the very strong La Niña and strong Leeuwin Current.

The catch predictions are based on catch trends involving historic fishing practices. These estimates are being revised to take into account management changes since 2005 that have been significantly altered by the timing that fishing occurs and allowing carryover of scallops.

Non-Retained Species

Bycatch species impact:

Low

Prawn trawlers

Bycatch composition for the prawn fishery is dominated by dead wire weed, which breaks off from the extensive shallow Wooramel seagrass bank annually over summer. The bycatch also contains a number of small size fish species mostly not taken by other sectors. Small blue swimmer crabs and other crustacean species are also taken in significant quantities but are generally returned to the sea alive. Overall bycatch taken in trawl nets are moderate relative to other subtropical trawl fisheries at about 4–8 times the prawn catch. Grid and secondary bycatch reduction devices (square mesh panels in cod-ends) are fully implemented and should further reduce the quantity of small fish retained in trawls. A comprehensive research survey found no significant difference in invertebrate or finfish abundance or diversity between trawled and untrawled areas.

The two performance measures for the fishery relate to: (i) its impact on biodiversity through the take of non-target (bycatch) species, and (ii) its impact on associated species, e.g. dolphins, through the discarding of bycatch (provisioning). In the case of biodiversity, a major project surveying bycatch species on and off the trawl grounds has been completed. Data analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas, indicating that the performance indicator will be met. For provisioning, the indicator has been met due to the lower and more targeted trawl effort and implementation of BRDs in the fleet. Both actions have reduced the rate of discards relative to the pre-BRD period.

Scallop trawlers

The total bycatch of fish and other fauna is minimal for the scallop fishery owing to the legislated design of the nets (which use 100 mm mesh) and the relatively short duration of the fishery.

Protected species interaction:

Low

Although protected species including whales, dolphins, dugongs, turtles and sea snakes are particularly abundant in Shark Bay generally, only sea snakes are seen regularly in the trawl catches in certain areas, and these are mostly returned to the sea alive. There has been a focus on improved reporting of interaction with protected species by fishers and in 2011, 119 sea snakes were reported as captured and returned to the sea alive and 24 were dead. The full implementation of bycatch reduction devices (grids) in the fishery since 2002 has generally eliminated the occasional capture of turtles in trawl nets.

One performance measure for the fishery is for 90% of turtles from non-BRD nets to be returned alive. These fisheries have BRDs (grids) in all nets so this performance measure is no longer valid. For the 2011 season 15 turtles were recorded as caught in nets in the prawn fishery and were recorded as being returned to the sea alive. For the scallop fishery, no turtle was reported as being taken in scallop nets.

Ecosystem Effects

Food chain effects:

Low

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

Habitat effects:**Prawn fishery****Moderate****Scallop fishery****Low**

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

Prawn trawlers

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

Scallop trawlers

The scallop fleet operates in approximately 3% of the overall fishery. The permitted trawl area inside Shark Bay is 1483 nm² and represents 32% of inner Shark Bay (excluding the closed areas) but actual trawling occurs in a much smaller area than this. Trawl fishing is focused in predominantly sand/shell habitats of the central bay, northwest of Cape Peron and in most years in the northern area of Denham Sound. The majority of sponge/coral habitats are contained within specific trawl closures to protect these areas.

Performance measures for habitat impact relate to the spatial extent of prawn trawling within Shark Bay's sand/shell and coral/sponge habitats. Both the prawn and scallop fleet permitted trawl areas are below the 40% level of the inner Shark Bay area. Most sponge/coral habitats in Shark Bay are now protected by fishery permanent closures, which will limit the actual trawl area below 40% at any time. In 2011 the performance measure was met as the total area trawled within inner Shark Bay by the prawn fleet was approximately 778 square nautical miles or 17% of inner Shark Bay and the scallop area trawled was approximately 109 square nautical miles or 3% of the inner Shark Bay.

Social Effects

These industries are a major contributor to regional employment. During 2011, approximately 100 skippers and other crew were employed in the prawn fishery. There are also approximately 100 processing and support staff directly employed at Carnarvon. Nor West Seafood is based in Carnarvon with administration, wharf and engineering staff based at the small boat harbour and a processing factory at Babbage Island. Approximately 70% of their work force is permanent. The prawn sector also utilises, wherever possible, Western Australian service companies providing engineering supplies, packaging, transport logistics, ship stores and fuel. For the scallop sector approximately 100 skippers and other crew are employed for the relatively short period in the region with support staff in Geraldton and Fremantle.

Economic Effects**Estimated annual value of major prawn and scallop for 2011:****Prawns Level 5 - > \$20 million (\$25.6 million)****Scallops Level 2 - \$1 - 5 million (\$1.5 million)**

The value of the fishery including crabs, coral prawns, scallops, squid and bugs to the prawn fleet is \$28.2 million. The estimated value of the scallop only fleet is \$1.5 million

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time, and average ex-boat prices were as follows:

King prawns	\$11.90/kg
Tiger prawns	\$14.60/kg
Coral prawns	\$3.80/kg
Scallops	\$5.00/kg
Crabs	\$5.80/kg

Fishery Governance**Target catch range:****Prawns (Historical range) 1501 – 2330 tonnes****Prawns (New interim range) 950 – 1450 tonnes****Scallop 1250 – 3000 tonnes whole weight**

Under previous effort levels, normal environmental conditions and based on catches in the 1990s following the restructuring of the fishery to 27 licences, the target catch range had been set for major penaeids at 1501 – 2330 t. Similarly, the target catch ranges for individual species were king prawns 1100 – 1600 t, tiger prawns 400 – 700 t and endeavour prawns 1 – 30 t.

The focus by industry is now to target larger size prawns, the resulting effort shift has reduced expected total landings to around the 950 to 1450 t under normal environmental conditions compared to historical catch ranges. After three years of below historical target total landings the 2010 and 2011 king and tiger prawn total landings (2014 t) have returned to be with the historical overall catch range. The interim range will be reviewed over the next three years (2012 to 2015) inclusive, and a new target catch range developed for the combined prawn catch and individual target species.

The scallop target catch range remains at approximately 1250 – 3000 t whole weight, based on catches over the five-year period 1995 – 1999. This period excludes the high catches of the early 1990s (Shark Bay Scallop Figure 4), apparently created by an unprecedented four years of El Niño conditions.

The projected catch for next season (265 t) whole weight, based on a pre-season survey, is below the target catch range.

New management initiatives (2011)

Implementation of a fixed catch share between the A (70%) and B (30%) Class boats.

External Factors

Increasing costs of fishing and lower returns due to the global economic climate and competition from imported and locally aquaculture small prawns, has focussed harvesting practices on targeting larger prawns during efficient catch rate periods and shifting the emphasis to domestic markets rather than export markets.

Increased fishing costs (fuel prices and high value of the Australian dollar and coupled with declining prawn prices in real terms), has lead industry maximise the return from all species taken in the fishery where possible, particularly scallops and blue swimmer crabs.

The major environmental factor influencing these stocks appears to be the flow of the Leeuwin Current along the outside of the embayment. A relationship between current strength (as measured by Fremantle sea level) and king prawn catches has been identified and may be used to indicate broad catch trends. The theory is that higher current flows increase water temperatures, which may increase the growth and catchability of the prawns. A relationship exists between sea level (at Fremantle) and the recruitment of scallops in Shark Bay, particularly in the Red Cliff area. Generally, high sea

levels corresponding to strong Leeuwin Current correlate with poor recruitment.

In 2011 the environmental conditions were favourable for both king tiger prawns. Rainfall produced two flooding events over the summer months (December 2010 and February 2011) and these would have triggered the migration of prawns from inshore areas onto the trawl grounds. Also, higher turbidity will have increased survival of juvenile prawns in nurseries. With the early arrival of tiger prawns on the trawl grounds and higher survival, high catch rates of tiger prawns in the early months of fishing occurred in 2011 and this was when most of the stock was taken. The strong La Niña conditions have generally resulted in below-average scallop recruitment and in 2011 increased water temperatures and flooding events may have contributed to high mortality of residual scallops in Shark Bay.

The Department of Fisheries is currently examining the mechanisms that control recruitment success in greater detail, in order to explain more of the inter-annual variation that occurs.



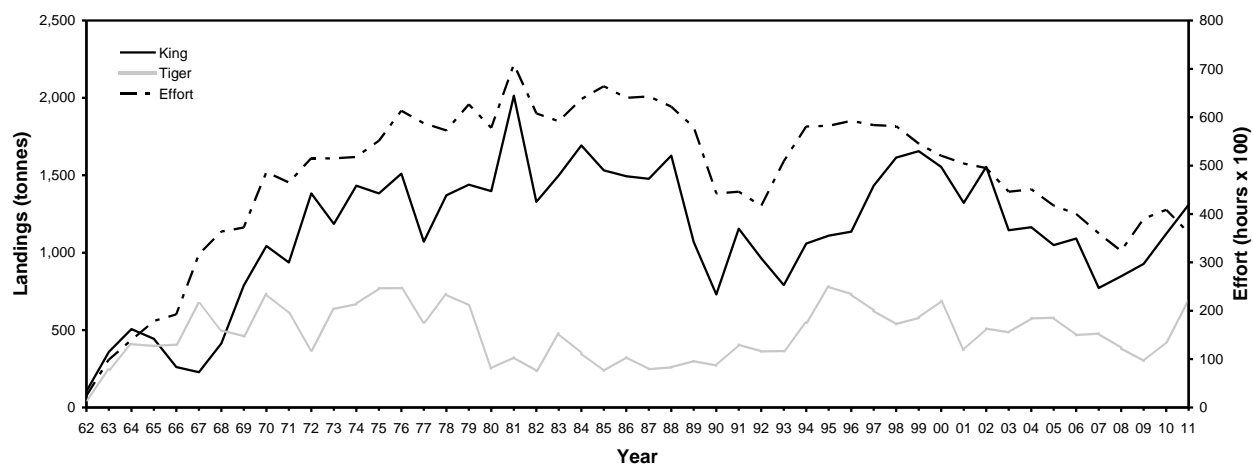
SHARK BAY PRAWN AND SCALLOP FIGURE 1

The main boundaries of the Shark Bay Prawn Fishery, Inner Shark Bay, TPSA, ENA, trawl closures, permitted trawl area (extends out to the 200m isobath) and area trawled in 2011.



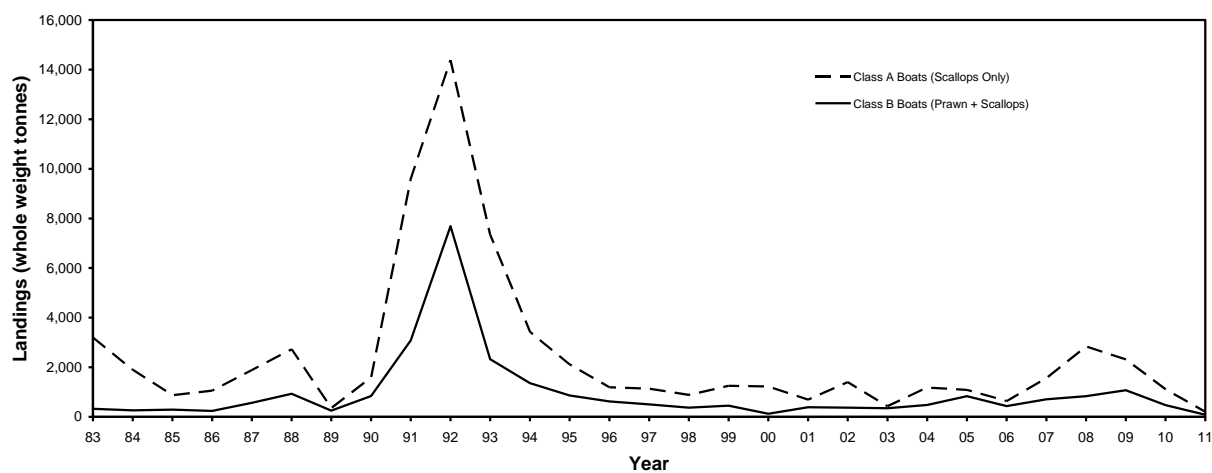
SHARK BAY PRAWN AND SCALLOP FIGURE 2

The main boundaries of the Shark Bay Scallop Fishery, permitted trawl area (extends out to the 200m isobath) and area trawled in 2011.



SHARK BAY PRAWN AND SCALLOP FIGURE 3

Shark Bay Prawn Managed Fishery annual landings and effort (adjusted to twin gear units) 1962 – 2011.



SHARK BAY PRAWN AND SCALLOP FIGURE 4

Shark Bay Scallop Managed Fishery annual landings 1983 – 2011.

Exmouth Gulf Prawn Managed Fishery Status Report

E. Sporer, M. Kangas, S. Brown and L. Pickles

Main Features

Status		Current prawn Landings	
Stock level	Adequate	Tiger	749 t
		Kings	97 t
Fishing level	Acceptable	Endeavours	130 t

Fishery Description

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

Governing legislation/fishing authority

Exmouth Gulf Prawn Management Plan 1989

Exmouth Gulf Prawn Managed Fishery Licence

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

Consultation process

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

Boundaries

The main boundaries for the Exmouth Gulf Prawn Managed Fishery are shown in Exmouth Gulf Figure 1. This diagram outlines the boundaries of the fishery, the areas where trawling is permitted, the areas actually trawled in 2011, the Tiger Prawn Spawning Area (TPSA) which is closed for part of the season, and the areas permanently closed to trawling.

Management arrangements

Management of this fishery is based on input controls, including limited entry, seasonal and area openings and closures, moon closures and gear controls. Management arrangements are designed to keep fishing effort at levels that will maintain a sufficient spawning biomass of prawns (particularly tiger prawns). The process for in-season fishing area opening/closing is dynamic and involves real-time management between the Department's Research Division

and the industry. Opening and closing dates varying each year, depending on environmental conditions, moon phases and the results of fishery-independent pre-season surveys that provide a catch prediction. The Department's Vessel Monitoring System (VMS) monitors the activities of all boats during the season.

Maximising economic efficiency continues to drive fleet restructure within the fishery, with less than 10 boats operating in the fishery during the 2010 season, involving headrope allocation being redistributed among the remaining boats. In recent seasons, management arrangements have provided for a fishing period of about 200 nights with a minimum of 28 non-fishing nights for moon closures during the period. For the 2011 season, official opening and closing dates were formally set at 1 May and 30 November respectively, providing a maximum of 181 nights (allowing five nights closure each full moon) for fishing. The season actually commenced on 8 May, based on results from pre-season surveys and it closed at 0800 hrs on 17 November. There were spatio-temporal closures during the early part of the season (April – July) to avoid fishing on small prawns.

Stringent measures are in place to ensure that spawning stock levels for tiger prawns are maintained at adequate levels and that the prospects of both recruitment and growth over-fishing are avoided. These measures will continue to be applied, while incorporating a flexible fishing regime to optimise size and value of prawns.

Bycatch reduction devices (BRDs) are mandatory in this fishery, with all boats required, by a condition on the managed fishery licences, to fish with a 'grid' and a secondary fish escapement device (FED) fitted in each net. Industry, in association with the Department, successfully gained certification from the US Department of State in 2008 of its BRD-compliance, for reducing the potential for turtle captures. This certification allows licensees to export product to the US market. Since 2002 industry has also used 'hopper' in-water sorting systems, which, provide an improved quality of prawns and reduced mortality for some bycatch species.

The Commonwealth Government's Department of Sustainability Environment Water Populations and Communities (SEWPaC), assessed the fishery in 2008 as being sustainable under the provisions of the EPBC Act 1999. This has provided the export accreditation for the fishery for a period of five years. The comprehensive ESD assessment of this fishery identified the only risks that

required specific management actions to ensure adequate performance were the breeding stock levels of target prawn species, bycatch species impacts, habitat and provisioning effects. Boxed text in this status report provides the annual assessment of performance measures/indicators related to these issues.

Research summary

Research activities continue to focus on stock assessment and surveys to monitor annual recruitment of tiger prawns, spawning stock levels and a pre-season survey of king prawn sizes to assist with harvesting strategies (these are detailed above in the management arrangements). An annual catch prediction for tiger prawns is also provided using an index derived from the recruitment survey data. Monitoring of fishing activity is undertaken in real time and using threshold catch rates to determine the specific timing of the closure of the tiger prawn spawning area. All boats complete detailed daily logbooks, which, together with survey data and factory catch unload records, provide a major source of information for managing the fishery. The joint evaluation and implementation of gear modifications to reduce bycatch and improve product quality is ongoing.

King prawn breeding stock levels in the fishery are maintained at adequate levels during normal environmental conditions through controls on fishing effort, their extended breeding period and lower catchability of the species compared to tiger prawns. Pre-season surveys for king prawns have been established since 2002 to provide an index of recruitment into the fishery and provide a catch prediction and understanding of prawn movement in this fishery. In 2011 two pre-season recruitment surveys were conducted and will be repeated in 2012 to improve the data series. Consideration may also be given to expanding sampling during the spawning stock surveys. The effect of the record high water temperatures in the Gascoyne region in early 2011 and their possible effect on the record low abundance of king prawns will also be examined.

Retained Species

Commercial production (season 2011):

976 tonnes

Landings

The total landings of major penaeids for the 2011 season were 976 t, comprising 97 t of king prawns, 749 t of tiger prawns, 130 t of endeavour prawns and 3 t of banana prawns. The tiger prawn landings were well above the normal catch range (250-550 t) and fourth highest record since the 1960's and the highest in over 30 years. Endeavour prawn landings were at the lower end but within the normal catch range of 120-300 t, however king prawn landings were well below the target catch range (350-500 t). The king prawn landings are the lowest they have been since the late 1960's, a trend that is consistent with other north-west prawn fisheries. The continued low king prawn landings is a concern, however, because of the trend of low annual landings since Cyclone Vance.

Recorded landings of by-product were: 58 t of blue swimmer crab (*Portunus armatus*), 6 t of squid, 2 t of bugs (*Thenus*

australiensis), and <1 t of coral prawns and octopus. The coral prawn catch is the lowest on record and is largely due to the high concentrations of tiger prawns with fishing effort focusing in areas where coral prawns are not in high abundance.

Recorded landings of blue swimmer crabs were higher this season compared to the last five years but within the historical range. Crabs and other byproduct are taken incidentally and are variable depending on abundance available on the trawl grounds each year. There appeared to be relatively high crab abundance on the trawl grounds possibly due to being flushed onto trawl grounds (due to high rainfall in the early part of the season). Fishers retain crabs at a minimum size of approximately 137 mm spine to spine measurement (compared to the recreational minimum size of 127mm). The larger minimum size was introduced on a voluntary basis into this fishery in 2007.

Fishing effort/access level

In 1990 a Voluntary Fishery Adjustment Scheme (VFAS) for the Exmouth Prawn Managed Fishery was approved and 3 Licenses were removed from the fishery reducing the fleet from 19 to 16 Licenses. The total allocation of net headrope capacity was reduced to 438.91 m (240 fathoms), based on 16 boats each towing 27.43 m (15 fathoms) of net headrope in twin gear configuration.

In 1998 industry fleet restructures commenced and boats commenced trialling a more efficient trawl gear configuration, quad gear, to improve the economic efficiency of the fleet. By 2000, all boats were towing quad gear. The boat numbers were gradually reduced between 1998 and 2007 to nine boats in 2007. When these quad gear trials were completed, the total capacity of net headrope was reduced by 10% to 395 m (216 fathoms) to account for a quad gear net efficiency increase. This aimed to retain total effective effort at levels observed historically. During this fleet restructure phase a second VFAS was approved in 2009 removing one more licence from the fishery.

Since 2007, active boat numbers in the fishery have remained at nine, fishing with a total headrope capacity of 376.73 m (206 fathoms). However, to date not all nine boats have towed the same size nets.

In 2011 nine boats operated towing a total of 376.73 m (206 fathoms) of net headrope. There were two different net headrope sizes towed, 10.97 m (6 fms) and 10.06 m (5.5 fms) because five of the nine boats cannot tow the 10.97 m nets. Boat numbers and net sizes for each boat have remained consistent since 2007. Total nominal effort for the 2011 season was 13,221 hours. The adjusted effort (to twin gear) was 20,532 hours, which is the lowest since 1968. Fishing effort in 2011 was at the expected level for the total landings because the king prawn abundance was low therefore only moderate effort was expended on this species. Usually effort on king prawns is focused towards the latter part of the season when their abundance peaks during late August and September. However because of low catch rates of king prawns this year effort was primarily applied onto the tiger prawns instead, which experience a very good abundance this season.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Level 4 - Direct survey/catch rate

Breeding stock levels: Adequate

Projected catch next season (2012):

175 (140-210) tonnes tiger prawns

The standardised catch per unit effort data from the fishery is an indicator of abundance, and can be used to monitor changes in stock levels from year to year. The average catch and catch rate is compared to a ten-year reference point (1989 to 1998) for each species. The tiger and king prawns stocks are also assessed each year using standardised recruitment and breeding stock surveys.

Catch assessment

The adjusted catch rate of 37.1 kg/hr for tiger prawn is much higher than the reference catch rate of 10 kg/hr. The high catch rates of tiger prawns reflect their high abundance because of favourable environmental conditions for this species. This was also reflected in an endeavour prawn catch rate of 6.4 kg/hr, which is above the reference point catch rate of 5.6 kg/hr. Although both tiger and endeavour prawns occupy similar inshore structured habitats the effort was focused on tiger prawns rather than endeavour prawns because tiger prawns are a much higher value. Therefore the endeavour prawn catch rate may not represent the actual abundance of this species because of the fleet fishing strategy focusing on tiger prawns. The season ceased according to the catch rate threshold of tiger prawns.

The adjusted catch rate 4.8 per kg/hr, for king prawns is below the reference catch rate level of 11.7 kg/hr. The king prawn total landings were below the acceptable catch range and there is some concern for the king prawn stock, however, fishing effort does not appear to be the cause of the decline in annual landings at current effort levels. Fishery-independent surveys are undertaken to measure the recruitment strength and logbook spatial and catch and effort information is used during the spawning phase to review the stock status and to understand the distribution of king prawns in the gulf.

The season commenced in early May, which was later than previous seasons and king prawns were fished conservatively because fishing in the northern area (key king prawn fishing grounds) was limited. In the early part of the season effort was reduced because of the later opening date and areas of small prawns were closed to fishing to ensure that size and quality were maintained. Also, fishing was restricted by an informal spatial closure on king prawns in the latter part of the season because of low abundance to maintain some spawning stock.

Survey assessment

The tiger and king prawn stocks are also assessed each year using standardised surveys, which permits variations to the management plan using flexible real-time arrangements within the season to optimise catch and size grades and ensure sustainability.

For tiger prawns, this process involves analysis of survey-based indices of recruitment and spawning stock, which are assessed against the spawning stock recruitment relationship.

The catch prediction for tiger prawns is based on the relationship between recruitment survey indices (early and late March and early April) and the season's landings (April–November of the same year). The projected tiger prawn catch range for 2011 was 480 to 720 tonnes. For the 2011 season the annual total landings were slightly above the prediction range. The tiger prawn breeding stock levels are maintained at adequate levels by monitoring the tiger prawn catch rates to determine when fishing should cease in the main tiger prawn fish grounds. This strategy maintains the spawning biomass of tiger prawns above the historically determined biological reference point. The present cut-off threshold catch rate is 25 kg/hr based on 6-fathom nets in quad gear configuration (which is reduced to 19 kg/hr after 1 November).

During 2011, tiger prawn catch rates were monitored from July to August and the central Tiger Prawn Spawning Area (TPSA) and Eastern Area closed on 11 August. Three standardised tiger prawn breeding stock surveys are carried out from August to October each year. The first two of three standardised tiger prawn breeding stock surveys carried out in August and September had an average quad gear CPUE of 61.7 kg/hr and 108.6 kg/hr in the spawning areas (Q1 and Q2 respectively). As there were low catch rates of king prawns in the Northern Area of the fishery and the catch rate of tiger prawns was well above the threshold of 25 kg/hr, part of the central TPSA west of the Heron line, was opened for fishing from 2 to 9 October inclusive. For this period of fishing the actual quad gear catch rates started at 140 kg/hr and declined to 60 kg/hr and the breeding stock level was maintained well above the threshold level. The August, September and October Q1 area surveys showed a quad gear CPUE of 63.4 kg/hr, 59.9 kg/hr and 52.0 kg/hr respectively with an average catch rate of 58.4 kg/hr overall. The spawning survey regime extends to the central Gulf (Q2 area) and the mean spawning indices for the three surveys were higher than in Q1 at 103 kg/hr. The tiger prawn spawning area and the eastern were then re-opened for fishing on 23 October and when fishing ceased in southern gulf the whole fishery was closed on 8 November. The tiger prawn catch rate when fishing ceased was 33 kg/hr, above the end-of-season catch rate threshold of 19 kg/hr however, it was considered appropriate to cease at this time as the fleet effort was concentrated within a small area maintaining a higher catch rate than if effort was spread into areas with lower catch rates.

The 2012 tiger prawn recruitment survey index was the lowest observed (13.3 kg/hr) since the inception of surveys with the next lowest in 2001 (13.9 kg/hr) after Cyclone Steve following a major perturbation from Cyclone Vance in March 1999. The spawning stock index in 2011 was high so there is no indication of recruitment overfishing occurring and therefore environmental effects will be examined to assess the cause of the low recruitment.

There is no formal stock assessment for endeavour prawns, a secondary target species whose distribution overlaps that of tiger prawns, and they are fished to varying levels depending on the abundance of (and hence the fishing effort applied to) the more valuable tiger prawns. The breeding stocks of endeavour prawns are considered to be at adequate levels because their distribution overlaps that of the tiger prawns and the tiger prawn closures also protect a significant portion of the endeavour prawn breeding stock each year. In addition, endeavour prawns are also considered to be more resilient to

fishing pressure due to their smaller size and lower catchability and less targeting than the tiger and king prawns.

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2011 the breeding stock indicators (catches within specified ranges) for tiger and endeavour prawns were met. The king prawns were below the target range, however there is a conservative harvesting strategy in place for this species. Low banana prawn landings recorded corresponded to the rainfall over the summer months.

Non-Retained Species

Bycatch species impact: **Low**

Bycatch levels for Exmouth Gulf are relatively low by tropical trawl fisheries standards, with few species of significance to other fishing sectors being taken. Trialing of secondary bycatch reduction devices continues (including square mesh cod-end nets) in order to reduce the volume of overall bycatch species retained in the trawls improving the quality of the prawn catch. In addition, all boats used hoppers (in-water catch sorting systems), which add another level of improvement for bycatch survival and product quality. Fishing adjusted effort in 2011 was the lowest seen since 1970.

The two performance measures for the fishery relate to (i) its impact on biodiversity through the take of non-target (bycatch) species, and (ii) its impact on associated species, e.g. dolphins, through the discarding of bycatch (provisioning). Analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas (even though abundances may vary), indicating that the performance indicator will be met. For provisioning, the indicator has been met due to the lower and more targeted trawl effort and implementation of BRDs in the fleet. Both actions have reduced the rate of discards relative to the pre-BRD period.

Protected species interaction: **Low**

While protected species including dugongs, turtles and sea snakes, occur in the general area, only sea snakes and occasionally turtles are encountered in the trawl catches. Both species are typically returned to the sea alive. Grids are now compulsory, which has largely eliminated the capture of any turtles or other large animals. In addition, secondary bycatch reduction devices (square mesh panels) were implemented in all nets in 2005. Twenty eight turtles were reported as being caught in nets during 2011 and all were returned back to the sea alive. There has been a focus on improved reporting of interaction with protected species by fishers. In 2011, 449 sea snakes were reported as captured and returned to the sea alive and 48 were dead. Twenty three sawfish and 4 syngnathids were also reported.

Ecosystem Effects

Food chain effects: **Low**

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

Habitat effects: **Low**

Historically, the fishery has impacted on some shallow water areas (less than 12 m in depth) containing sponge habitats, but the refocusing of the fishery into deeper waters to take larger prawns since the early 1980s has reduced this interaction. The trawling effort is now focused in the deeper central and north-western sectors of Exmouth Gulf. Owing to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little physical impact. Overall, the nature of this particular trawl fishery and the very tight controls on effort indicate that its environmental effect is now likely to be low.

Performance measures for habitat impact relate to the spatial extent of trawling within the licensed area of the Exmouth Gulf fishery. In 2011 the performance measure was met as the total area trawled, at approximately 335 square nautical miles (29%) per cent of Exmouth Gulf, was below the 40% level.

Social Effects

The estimated employment in the fishery for the year 2011 was 27 including skippers and other crew. Additional processing and support staff are also based in Exmouth Gulf and Fremantle. Within the Exmouth area, the fishery is one of the major regional employers contributing to the economic viability of the Exmouth township.

Economic Effects

Estimated annual value of major prawns for

2011: Level 4 - \$10 - 20 million (\$10.9 million)

Ex-vessel prices for prawns vary, depending on the type and quality of product and the market forces operating at any one time. In this fishery there is a high degree of vertical integration, with the fishing company, which own the boats undertaking direct marketing of the product into overseas markets. For this reason, the prices quoted for prawns can only be estimated, however prices are likely to be similar to those received for product from Shark Bay Prawn Managed Fishery. The total estimated value of the fishery includes byproduct (\$11.2 million). Estimated prices for prawns were as follows:

King prawns	\$11.50/kg
Tiger prawns	\$12.00/kg
Endeavour prawns	\$6.00/kg
Coral prawns	\$3.00/kg

Fishery Governance

Target catch range: 771 – 1,276 tonnes

Current fishing level: Acceptable

Under current fishing effort levels, the target catch range for major penaeids is 771–1,276 t so the total catch of 779 t is within the range. The long-term target catch ranges for individual species are king prawns 350–500 t, tiger prawns 250–550 t and endeavour prawns 120–300 t (noting that maximum or minimum catches do not occur for all species simultaneously). These overall and individual figures are generally based on a 10-year average (1989-1998). Tiger prawns were above the species range, however, the catch prediction was very high (480-720 t) indicating that the season landings could be above the target range. Endeavour prawns were within each species range but king prawns were well below the target catch range. The survey catch rates were indicating low abundance however, no index for catch prediction is yet available for this species but will be reviewed in 2012.

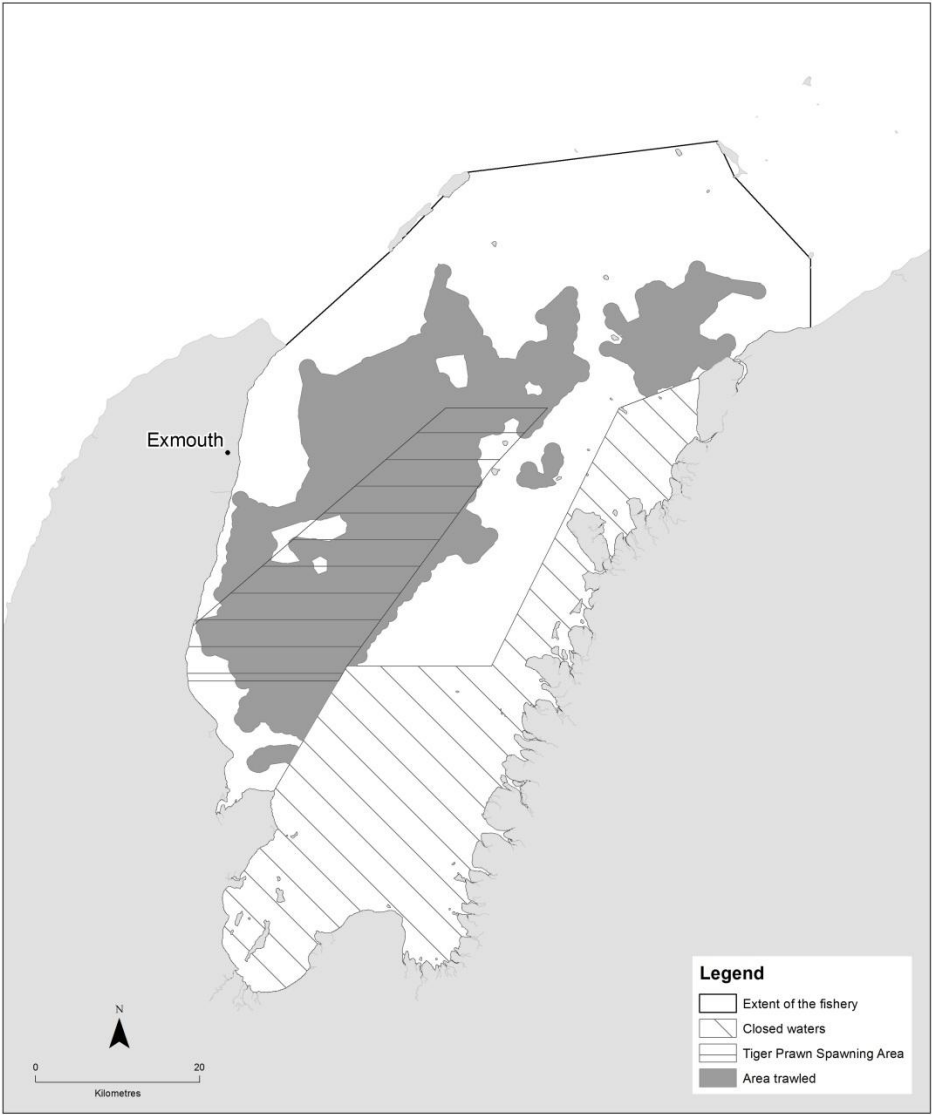
New management initiatives (2012)

The Department is progressing a management plan amendment in consultation with the licensee to incorporate quad trawl gear arrangements.

External Factors

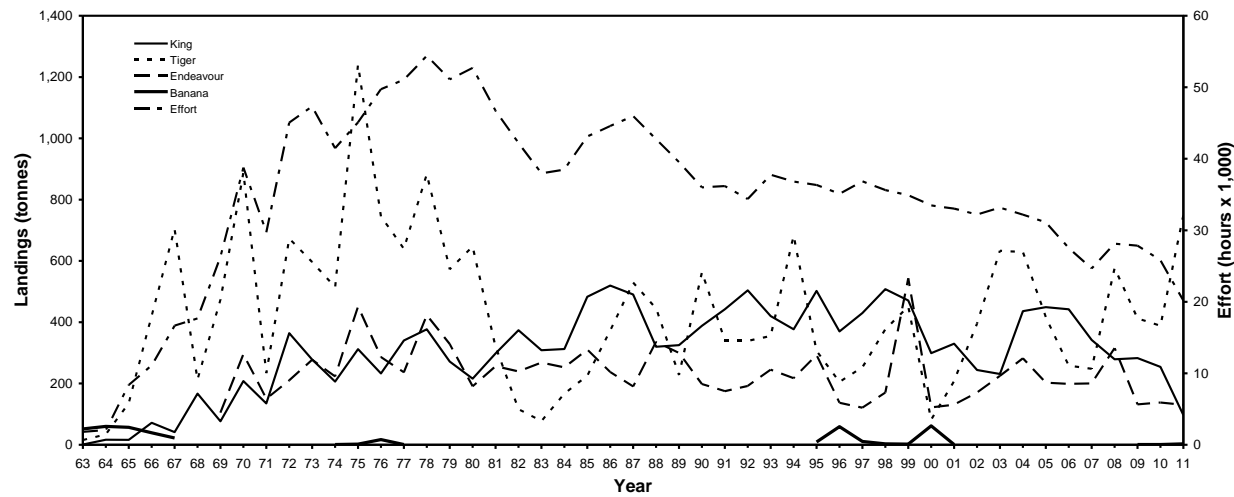
Increasing costs of fishing and lower returns due to the global economic climate and competition from imported and Australian aquacultured small prawns, has focussed fishing harvesting strategies on targeting larger prawns during efficient catch rate periods and shifting the emphasis to domestic markets rather than export markets. A slight increase in the price for prawns provided some increases in the value of the fishery in 2011.

Cyclones appear to have a significant effect on the productivity of Exmouth Gulf. Cyclone impacts can be either positive or negative. Early (December to January) cyclones can have a negative impact (high mortality) on small size prawns in the shallow nursery areas. The positive effect is that the water becomes turbid and prawn mortality reduces and prawns are triggered to move out into the trawl grounds. It is considered likely that there will be other environmental factors, yet to be fully investigated, that will affect the spawning stock – recruitment relationship. Environmental conditions were favourable for tiger and banana prawn species during the 2011 season with high summer rainfall (388 mm Dec 2010 to Mar 2011; 20-yr average 124 mm) and possibly warmer temperatures.



EXMOUTH GULF PRAWN FIGURE 1

The main boundaries of the Exmouth Gulf Prawn Fishery, extent of fishery closed waters, TPSA (Q1 and Q2), and area trawled in 2011.



EXMOUTH GULF PRAWN FIGURE 2

Exmouth Gulf Prawn Managed Fishery annual landings and adjusted effort (twin-gear), 1963 – 2011.

Gascoyne Demersal Scalefish Fishery Status Report

G. Jackson, R. Marriott, E. Lai and C. Lunow.

Main Features			
Status		Current Landings (2011)	
Stock level		Pink snapper:	
Pink snapper	Recovering	Commercial	237 t (2011)
Goldband snapper	Adequate	Recreational	31 t (2007)
Spangled emperor	Adequate	Charter	12 t (2011)
Fishing Level		Goldband snapper:	
Pink snapper	Acceptable	Commercial	53 t (2011)
Goldband snapper	Acceptable	Recreational	10-20 t (2007)
Spangled emperor		Charter	6 t (2011)
North Gascoyne	Unacceptable	Spangled emperor:	
South Gascoyne	Acceptable	Commercial	4 t (2011)
		Recreational	30 t (2007)
		Charter	6 t (2011)

Fishery Description

The Gascoyne Demersal Scalefish Fishery encompasses commercial and recreational (line) fishing for demersal scalefish in the continental shelf waters of the Gascoyne Coast Bioregion (Gascoyne Demersal Scalefish Fishery Figure 1).

Since 1 November 2010, the Gascoyne Demersal Scalefish Managed Fishery (GDSF) has incorporated the pre-existing pink snapper quota system from the Shark Bay Snapper Managed Fishery (SBSF) plus the previously open access area south of Coral Bay.

Commercial vessels in these waters historically focussed on the oceanic stock of pink snapper (*Pagrus auratus*) during the winter months. The GDSF licensed vessels fish throughout the year with mechanised handlines and, in addition to pink snapper, catch a range of other demersal species including goldband snapper (*Pristipomoides* spp., mainly *P. multidentis*), red emperor (*Lutjanus sebae*), emperors (Lethrinidae, includes spangled emperor, *Lethrinus nebulosus*, and redthroat emperor, *L. miniatus*), cods (Serranidae), ruby snapper (*Etelis carbunculus*), pearl perch (*Glaucosoma burgeri*), mulloway (*Argyrosomus japonicus*), amberjack (*Seriola dumerili*) and trevallies (Carangidae).

A limited number of licensed charter vessels and a large number of recreational vessels fish out of Denham, Carnarvon and around the Ningaloo area (Coral Bay, Tantabiddi and Exmouth) and catch a similar range of demersal species.

Governing legislation/fishing authority

Commercial

Gascoyne Demersal Scalefish Management Plan 2010

Gascoyne Demersal Scalefish Managed Fishery Licence

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

Recreational

Fish Resources Management Act 1994, Fish Resources

Management Regulations 1995 and subsidiary legislation

Consultation process

Commercial

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

Recreational

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

Boundaries

Commercial

The GDSF operates in the waters of the Indian Ocean and Shark Bay between latitudes 23°07'30"S and 26°30'S (Gascoyne Demersal Scalefish Fishery Figure 1). GDSF vessels are not permitted to fish in inner Shark Bay. No state-licensed commercial vessels are permitted to fish between 21°56' and 23°07'30"S ('Point Maud-Tantabiddi Well' closure). Management arrangements for the West Coast Demersal Scalefish Fishery (WCDSF) permit a limited number of commercial vessels to operate in waters up to the southern boundary of the GDSF (26°30'S).

Recreational

The recreational fishery (which includes activities by licensed charter vessels) operates in all Gascoyne waters with the exception of Sanctuary Zones, Marine Nature Reserves and Conservation Areas within the Ningaloo and Shark Bay Marine Parks.

Management arrangements

Commercial

The Gascoyne Demersal Scalefish Management Plan 2010 (the Plan) was implemented on 1 November 2010. The Plan superseded the Shark Bay Snapper Management Plan 1994 and provides a more effective management framework for the sustainable use of all demersal scalefish stocks in the Gascoyne Coast Bioregion. The 'open-access' wetline fishing operations previously undertaken in waters between 23°34'S and 23°07'30"S (Gascoyne Demersal Scalefish Fishery Figure 1) are also incorporated within the GDSF Management Plan (see Fisheries Management Paper No. 224 for further details).

Within the Gascoyne Demersal Scalefish Managed Fishery, pink snapper are managed through output controls based on an Individual Transferable Quota system. Pink snapper quota units operate from 1 September to 31 August ('quota-year'), with a total of 5,102 units in the fishery. There is a requirement to hold a minimum of 100 units of pink snapper to be able to operate within the fishery which has been carried over from the previous Shark Bay Snapper Management Plan.

Demersal scalefish other than pink snapper are currently managed using an interim effort cap of 30 days per 100 units of pink snapper quota which restricts total fishing effort and is applied as a non-transferable licence condition. A dedicated non pink snapper demersal scalefish entitlement system is being developed by the Department in consultation with WAFIC and licensees.

An Environmental Protection and Biodiversity Conservation Act assessment for the SBSF was first completed in 2003, and the fishery was re-accredited in 2009 for a further 5 years (next scheduled review in 2014).

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

Recreational

The recreational fishery (including charter vessels) is managed using maximum and minimum size limits, daily bag, trip and possession limits and limitations on the use of certain fishing gears. Since 2 March 2010, all persons fishing from a powered boat anywhere in the state have been

required to hold a Recreational Fishing from Boat Licence or fish in the company of a licence holder.

Research summary

Catch and effort monitoring for this fishery includes analyses of commercial 'daily/trip' returns for GDSF licensed vessels, catch-disposal records (only for pink snapper to monitor individual quotas), 'monthly' catch and effort returns for charter vessels, and recreational survey data (where available).

The commercial catch and effort data reported here covers all commercial line fishing within Gascoyne waters between 114°50'E and 26°30'S. The reporting season used for commercial catches is the pink snapper quota-year, i.e. September 1 2010 - August 31 2011 (referred to as 'season 2011'). Charter catches are reported for the calendar year. For recreational fishers, the most recent¹ survey information available of boat-based recreational fishing within the Gascoyne Coast Bioregion is used which was undertaken between April 2007 and March 2008 (this equates to the commercial 'season 2007').

Research undertaken by the Department of Fisheries on the retained species in each Bioregion is now focussed on selected indicator species. For demersal scalefish in the Gascoyne, these indicators have been selected to represent the inshore demersal suite (20-250 m) using a risk-based approach based on the relative vulnerability of the species/stock to fishing activities (DoF 2011²). In the Gascoyne Coast Bioregion, pink snapper, goldband snapper and spangled emperor (*Lethrinus nebulosus*) are the indicator species for the inshore demersal suite.

Pink snapper: Detailed research on the oceanic pink snapper stock and the associated SBSF was undertaken throughout the 1980s and early 1990s. Commercial catches are sampled throughout the year to provide representative catch-at-age data. An integrated stock assessment model has been used to determine stock status since 2003 and is updated every 3 years (most recently in 2012). A Western Australian Marine Science Institute (WAMSI) project investigated the relationships between pink snapper stocks from Shark Bay to the South Australian border based on genetics and otolith chemistry.

Goldband snapper: Comprehensive research on goldband snapper commenced in 2007 as part of a Gascoyne Integrated Fisheries Management (IFM) project. A 'weight of evidence' based assessment has been completed and externally reviewed (Marriott et al in press). Monitoring of commercial catches and age structure is continuing and further research is planned to refine estimates of the key biological parameters.

Spangled emperor: Comprehensive research on spangled emperor commenced in 2007 also as part of the Gascoyne IFM project. A 'weight of evidence' based assessment has

¹ Results of the Integrated Survey of Boat-based Recreational Fishing 2011_12 will be available in late 2012.

² DOF 2011 Resource Assessment Framework (RAF) for Finfish Resources in Western Australia. Fisheries Occasional Publication No. 85, Department of Fisheries, Perth.

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been completed and externally reviewed (Marriott et al in press). Limited monitoring of recreational catches landed at fishing tournaments is on-going.

Retained Species

Commercial landings (season 2011):

Total	374 tonnes
Pink snapper	237 tonnes
Goldband snapper	53 tonnes
Spangled emperor	4 tonnes
Other species	81 tonnes

The total commercial catch of 374 t taken in the Gascoyne Coast Bioregion in 2011 included 237 t of pink snapper (oceanic stock, TACC = 277 t), plus 138 t of other species including 53 t of goldband snapper, 4 t of spangled emperor and 81 t of other scalefish species (Gascoyne Demersal Scalefish Table 1). This is significantly lower than the total of 477 t taken by this fishery last season mostly due to the significant decrease in the catch of goldband snapper (105 t in 2010).

Recreational catch estimate (includes charter sector):

Pink snapper	ca. 40 tonnes
Goldband snapper	c.a. 15-25 tonnes
Spangled emperor	ca. 30-40 tonnes

In 2011 the recreational catch of pink snapper (oceanic stock) reported by licensed charter boats was 12 t (similar to catch in 2010, significantly lower than the 22 t taken in 2007). In 2007/08, an estimated 31 t of pink snapper (oceanic stock) was taken by recreational vessels fishing in Gascoyne waters (excluding inner gulfs of Shark Bay). The total catch of this stock of pink snapper taken by recreational and charter vessels in the Gascoyne is therefore assumed to be approximately 40 tonnes.

The recreational catch of goldband snapper reported by charter boats in 2011 was 6 t (similar to 2010, compared to 8 t in 2007). The recreational catch of goldband snapper in 2007/08 is estimated to have been between 10-20 t making the total catch for these sectors in the Gascoyne to be between 15-25 tonnes.

The recreational catch of spangled emperor reported by charter boats in 2011 was 6 t (similar to 2010, no information on catch in 2007). In 2007/08, an estimated 30 t of spangled emperor was taken by recreational vessels fishing in Gascoyne waters. The total catch of spangled emperor taken by recreational and charter vessels in the Gascoyne is therefore assumed to be approximately 30-40 tonnes.

Fishing effort/access level

Commercial

At the start of the season there were 55 licences with pink snapper quota although only 17 vessels actively participated in fishing (19 in 2010). These vessels (all are required to hold a minimum of 100 units of pink snapper quota to be able to operate in the waters of the GDSF) fished for a total of 793 days in waters between 23°34'S and 26°30'S between

September 1 2010 and August 31 2011. The level of effort targeted at pink snapper varies on a seasonal basis, historically peaking in June–July, when the oceanic stock aggregates to spawn. Pink snapper catch rates are assessed annually using 'standard boat days', i.e. days fished by quota-holding vessels that caught more than 4 t each of pink snapper by line during the period June–July. Vessels that met these criteria fished for 280 boat days during June–July in 2011 (similar to 2010).

Recreational

Total recreational boat fishing effort (fisher days) across the entire Gascoyne in 2011 was assumed to be similar to that estimated from the last recreational fishing survey (April 2007 - March 2008), i.e. ca. 240,000 fisher days.

Stock Assessment

Assessment complete:

Pink snapper	Yes
Goldband snapper	Yes
Spangled emperor	Yes

Assessment level and method:

Pink snapper	Level 2 - Catch Rates (annual)
	Level 5 - Composite Assessment (2011)
Goldband snapper	Level 1 - Catch (annual)
	Level 3 - Fishing Mortality (2010)
Spangled emperor	Level 1 - Catch (annual)
	Level 3 - Fishing Mortality (2010)

Breeding stock levels:

Pink snapper	Recovering
Goldband snapper	Adequate
Spangled emperor	Adequate

Pink snapper: An integrated stock assessment model was developed for this stock in 2003 which indicated that the spawning biomass of the oceanic stock was at a depleted level (< target level in 2002-2003). The most recent assessment using this method (completed in 2012) indicated that the spawning biomass in 2011 was above the threshold level (30% of the unexploited spawning biomass). The model estimated that at 2011 harvest levels (total annual catch ca. 300 t), the target level (40% of the unexploited spawning biomass) would be reached by 2014-2015. The next assessment is scheduled to be completed in 2014.

Prior to the development of the integrated assessment model, the breeding stock was assessed using a pink snapper catch rate based on catch and effort information from the peak of the spawning season (June–July) only. It is recognised that the use of catch rate as an index of pink snapper abundance must be treated with caution, due to the aggregating behaviour of the stock during the winter spawning period.

This indicator was used in the original EPBC Act assessment of the SBSF with an inaugural trigger level set at a minimum of 500 kg pink snapper/standard boat day. Since the reductions in quota were implemented in the mid 2000s, the pink snapper catch rate (GDSF vessels fishing in June–July

only) has fluctuated around 550 kg/day. The 2011 season it has continued this trend at 564 kg pink snapper/standard boat day (see also box below).

The current performance measure for the Gascoyne Demersal Scalefish Fishery is that the pink snapper catch rate for the peak months (June–July) should not fall below a minimum trigger level of 500 kg pink snapper/standard boat day. Catch rates had a slight downwards trend through the 1990s but the early 2000s saw a clear decline reaching a low of 450 kg pink snapper/standard boat day in 2004. Since that time (TACC was reduced significantly in 2004 and reduced again in 2007), catch rates have increased to an average value of about 550 kg/day with yearly fluctuations. In 2011 the catch rate was 564 kg pink snapper/standard boat day, above the minimum trigger level (500 kg pink snapper/standard boat day).

Goldband snapper: Historical catch rate data from the SBSF were found to be uninformative for use as an index of relative abundance for this species. Several more years of daily trip logbook data (implemented in January 2008) will provide the minimum basis of a time series of catch rates for examining trends in relative stock biomass. A ‘weight of evidence’ approach, based on an assessment of fishing mortality (F), has been used to assess the stock. Sufficient data from sampling the commercial fishing catches in both the 2006 and 2008 quota years were available for this analysis. Estimates of F for both years were within the target range, indicating that fishing was not having an unacceptable impact on the age structure of the population at that time. The completed ‘weight of evidence’ assessment has now been externally reviewed and will be made available as a Fisheries Research Report in late 2012 (Marriott et al. in press).

The approximately 50% reduction in the commercial catch in 2011 is explained by a reduction in the level of effort targeting this species. The total goldband snapper catch is now well below the sustainable limit recommended for this species in this bioregion (100–120 t, see Marriott et al. in press for details). Breeding stock levels and fishing level are currently assessed as adequate.

Spangled emperor: Commercial catch rate data for spangled emperor were found to be uninformative as an index of abundance. A ‘weight of evidence’ approach, based on an assessment of fishing mortality, was used to assess stock status based on data collected primarily in 2007. Estimates of fishing mortality (F) indicated that in the South Gascoyne, F was close to the target level while in the North Gascoyne, F was above the limit level, suggesting that localised over-fishing was occurring north of Point Maud. Relatively few individual spangled emperor older than 10 years old were sampled from the North Gascoyne in 2007, indicating that older fish had been removed by fishing, at least from areas outside of sanctuary zones of the Ningaloo Marine Park. That F exceeded the limit level indicated, given the available evidence, that the current level of fishing on the spangled emperor population in the North Gascoyne exceeds sustainable levels. The spangled emperor breeding stock is estimated to be at an acceptable level for the bioregion overall noting significant reductions in the relative numbers of older (breeding age) spangled emperor in the North

Gascoyne due to localised depletions. The completed ‘weight of evidence’ assessment has now been externally reviewed and will be made available as a Fisheries Research Report in late 2012 (Marriott et al. in press).

Non-Retained Species

Bycatch species impact

Negligible

The commercial catch consists of a large number of demersal species of medium to high market value; therefore there are few species captured by the fishery that are not retained.

Commercial operators must return any sharks caught and are not permitted to use wire trace, in order to minimise interactions with sharks.

Protected species interaction

Negligible

As line fishing is highly selective, interactions with protected species by commercial, charter and recreational fishers in the GDSF are low. Commercial GDSF and charter fishers are required to record protected species interactions in their logbooks. During 2011, commercial fishers in the GDSF caught one grey nurse shark, which was released alive. The charter fishery in this bioregion reported no interactions.

Ecosystem Effects

Food chain effects

Low

Pink snapper are generalist feeders and just one of a number of such species inhabiting the continental shelf waters in this Bioregion. Food chain effects due to fishing for pink snapper are considered to be low because the quota system restricts GDSF catches to a relatively small percentage of the total biomass. The juvenile components of the stock are likely subject to large, mostly-environmentally driven fluctuations in abundance even in the absence of fishing, resulting in significant variability in annual recruitment strength. A recent study (Hall and Wise, 2011)¹ of finfish community structure in this bioregion found no evidence of material changes.

Habitat effects

Negligible

The nature of the fishery, targeting aggregations of adult pink snapper and other demersal scalefish using hooks and lines, means that the commercial fishery has virtually no direct impact on benthic habitats.

¹ Hall, N.G. & Wise, B.S. (2011). Development of an ecosystem approach to the monitoring and management of Western Australian fisheries FRDC Report 2005/063. Fisheries Research Report 215 Department of Fisheries, Western Australia. 112pp.

Social Effects

The pattern of fishing by GDSF vessels in 2011 was similar to previous years and reflects the focus on pink snapper during the peak season and fishing deeper water for other species at other times of the year.

In 2011, 11 vessels fished for more than 10 days during the peak season with average crew of 2-3. Commercial fishing and associated fish processing are important sources of local employment in Denham and Carnarvon.

Shark Bay and Ningaloo are popular recreational fishing destinations and both locations are major tourist attractions especially during the winter months and school holidays.

Economic Effects

Estimated annual value (commercial sector) for

2011: Level 2 - \$1 - 5 million

The gross value of production (GVP) of the commercial component of the Gascoyne Demersal Scalefish Fishery was in the range \$1-5 million in 2011. While a dollar value is difficult to assign to recreational and charter catches at this stage, the availability of demersal target species underpins the local recreational fishing-based tourism industry and generates significant income for the regional economy.

Fishery Governance

Commercial:

Current effort level Pink snapper (season 2011):

Acceptable

Current catch level Goldband (season 2011):

Acceptable

Target catch (and effort) range:

Pink snapper 277 tonnes/380-540 days

Goldband snapper 50-120 tonnes (preliminary)

In 2011, GDSF vessels with pink snapper quota required 419 boat days to catch 237 t of pink snapper (oceanic stock, TACC = 277 t).

The average catch rate at 564 kg pink snapper/boat day during the peak season for the 2011 was above the performance measure (500 kg/standard boat day). This catch rate-based performance measure will be re-assessed when sufficient higher resolution (daily/trip catch and effort returns) data are available, likely as part of the next EPBC Act fishery review export accreditation review (due in September 2014). The catch of Goldband snapper in 2011 was within the preliminary acceptable range.

Recreational:

Current effort level (2007/08):

Pink snapper Acceptable

Goldband snapper Acceptable

Spangled emperor

Unacceptable (North Gascoyne)

Acceptable (South Gascoyne)

Estimates of fishing mortality (based on data from 2007/08) indicate localised depletion of spangled emperor is occurring north of Point Maud outside of the sanctuary zones.

New management initiatives (2011/12)

As noted previously, the GDSF Management Plan 2010 was implemented on 1 November 2010, superseding the Shark Bay Snapper Management Plan 1994. The Plan provides the Department with the ability to manage all demersal scalefish stocks, whereas the Shark Bay Snapper Management Plan 1994 had the legal capacity to regulate only the take of pink snapper. The Plan also incorporated the last unregulated 'open access' line fishery in the Bioregion in south of Coral Bay, resulting in all commercial line fishers in the southern Gascoyne operating under a consistent set of management arrangements.

While the first phase of the Plan has been implemented, and includes a formal pink snapper entitlement system (in the form of individual transferable quota) it still requires a second form of entitlement to be introduced to more explicitly regulate the take of other demersal scalefish. The development of an entitlement framework with the capacity to regulate catches of other scalefish, in particular goldband snapper, that can work in combination with the existing ITQ system for pink snapper is currently underway.

A statewide recreational boat fishing licence was introduced in March 2010. A statewide integrated recreational fishing survey (included a phone diary survey based on the database of licensed boat fishers) was carried out between January 2011 and February 2012. Results of this study that will include estimates of recreational catches of the key species will be available in late 2012.

Integrated Fisheries Management (IFM) processes in the Gascoyne are likely to commence in late 2012 including consideration of sectoral catches of demersal scalefish and other relevant issues in the Bioregion.

External Factors

Under the Offshore Constitutional Settlement, commercial vessels licensed by the Commonwealth may operate in state waters outside the 200 m isobath as part of the Western Deepwater Trawl Fishery (WDWTF). In the 2008/09 season total effort in this fishery was 482 hours of trawling with ruby snapper making up the majority (28 tonnes) of the scalefish catch (Wilson et al. [eds] 2010)¹. Recent information on catches of pink snapper taken or returned by WDWTF vessels fishing in waters >200 m off the Gascoyne coast is not available (last reported catch of pink snapper was <0.5 t in 2006).

Climate change has the potential to impact fish stocks in range of ways including, with temperate species such as pink snapper, affecting spawning patterns and influencing their

¹ Wilson DT, Curtotti R and Begg GA (eds) (2010) Fishery status reports 2009: status of fish stocks and fisheries managed by the Australian Government, Australian Bureau of Agricultural and Resource Economics - Bureau of Rural Sciences, Canberra.

geographic distribution (latitude shift). A review of the impacts and responses to marine climate change in Australia has been undertaken by CSIRO (see www.oceanclimatechange.org.au). In addition, a 3-year FRDC-funded project is currently assessing the effects of climate change on key fisheries in Western Australia. The key species that will be considered in relation to the consequences of climate change as part of this project include

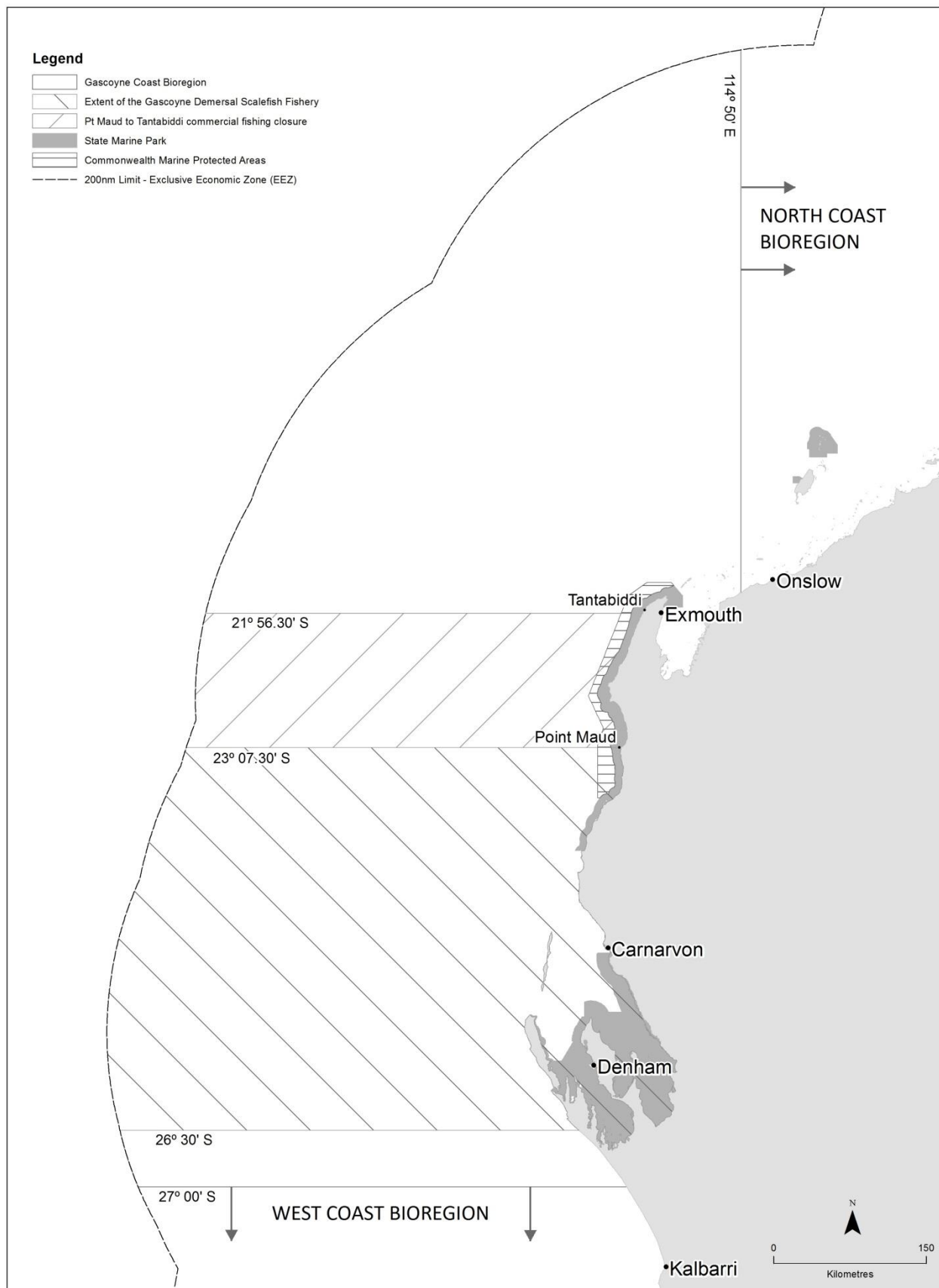
pink snapper, goldband snapper and spangled emperor. A recent collaborative study with CSIRO used modelling to investigate the potential influence of long-term increases in water temperatures and cyclone activity on spangled emperor in the Ningaloo Marine Park.

GASCOYNE DEMERSAL SCALEFISH FISHERY TABLE 1

Total commercial catches of demersal scalefish species other than pink snapper taken in Gascoyne waters between 2001/02 and 2010/11 (excludes mackerels, sharks and tunas). Units are tonnes.

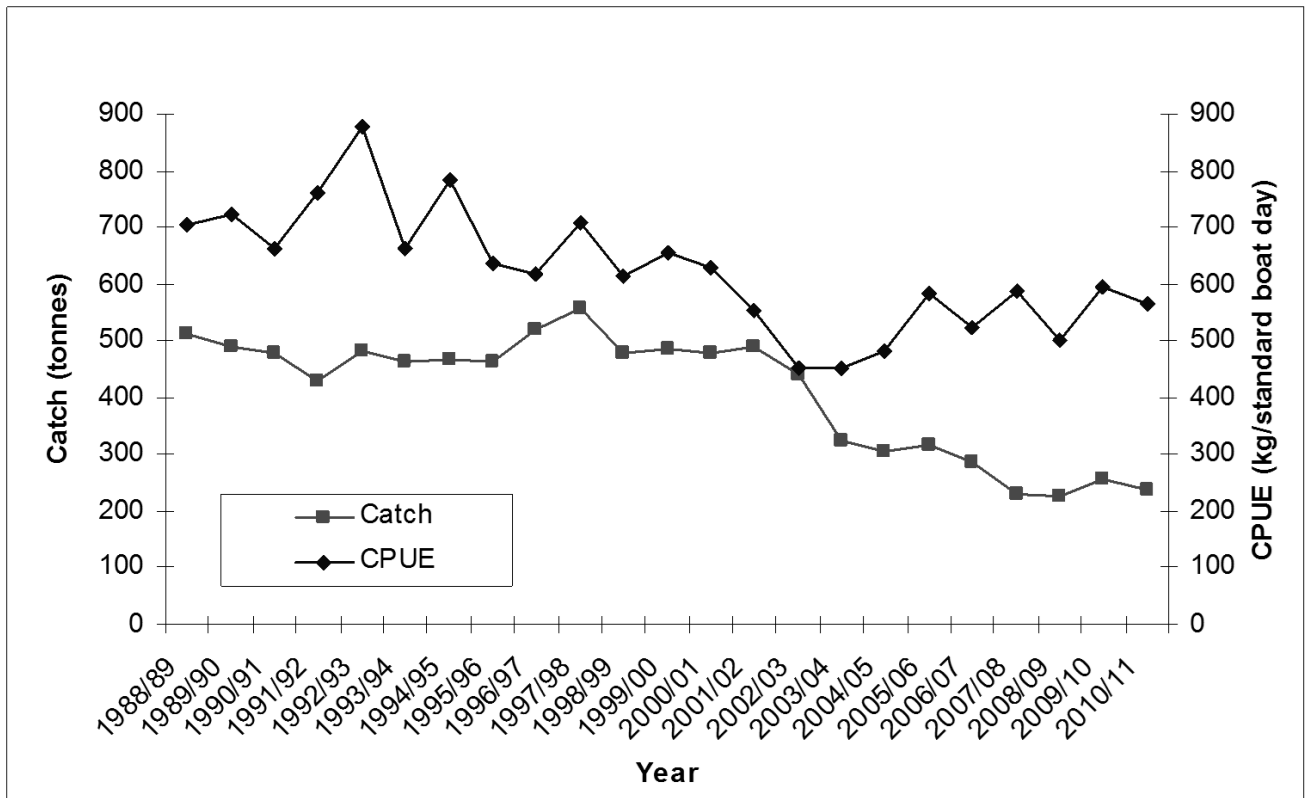
Species	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Goldband snapper	110.0	310.7	250.4	239.8	105.8	107.2	121.1	143.8	104.6	53.2
Red emperor	21.3	18.6	21.3	18.5	19.4	17.0	12.8	11.7	9.8	8.2
Spangled emperor	23.1	20.4	15.2	13.5	18.1	7.0	7.0	3.3	3.8	3.7
other emperors	25.7	25.8	37.4	31.8	29.2	34.3	26.8	13.8	9.2	10.4
Cods	29.7	38.0	39.2	27.9	21.9	21.5	15.0	9.5	13.4	11.4
Other	85.9	90.5	95.4	82.0	78.1	77.1	65.8	64.8	72.9	50.7
Total	295.7	504.0	458.9	413.5	272.5	264.1	248.5	246.9	213.7	137.5

GASCOYNE COAST BIOREGION



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 1

Waters of Gascoyne Coast Bioregion including Gascoyne Demersal Scalefish Fishery and 'Point Maud to Tantabiddi Well' fishing closure. Commercial line fishing in waters between 26°30'S and 27 °00'S has been managed as part of West Coast Demersal Scalefish Fishery since January 2008.



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 2

Gascoyne pink snapper catch and catch per unit effort by season from 1988/89 to 2010/11. Units are kg whole weight of pink snapper per standard boat day. The CPUE for vessels line fishing for pink snapper in June-July (peak season) is incorporated in the stock assessment model used for the oceanic pink snapper stock.

Inner Shark Bay Scalefish Fishery Status Report

G. Jackson, J. Norriss and C. Lunow

Main Features

Status

Stock level:

Whiting	Adequate
Mullet	Adequate
Tailor	Adequate
Yellowfin bream	Adequate
Pink snapper	Eastern Gulf – Adequate
	Denham Sound – Adequate
	Freycinet Estuary – Recovering

Fishing Level:

Whiting	Acceptable
Mullet	Acceptable
Tailor	Acceptable
Yellowfin bream	Acceptable
Pink snapper	Eastern Gulf – Acceptable
	Denham Sound – Acceptable
	Freycinet Estuary – Acceptable

Current Landings

Commercial (2011)

Whiting	105 t
Mullet	108 t
Tailor	16 t
Yellowfin bream	9 t
Pink snapper	2 t

Recreational (Pink snapper only)

Eastern Gulf	4 t (2010)
Charter	0.5 t (2011)
Denham Sound	6 t (2010)
Charter	0.5 t (2011)
Freycinet	1.5 t (2010)
Charter	nil (2011)

Fishery Description

The Inner Shark Bay Scalefish Fishery encompasses commercial and recreational fishing for scalefish species within the waters of the Eastern Gulf, Denham Sound and Freycinet Estuary in inner Shark Bay (Inner Shark Bay Fishery Figure 1). This includes the activities of the Shark Bay Beach Seine and Mesh Net Managed Fishery (SBBSMNF) and the Inner Shark Bay Recreational Fishery.

The SBBSMNF operates from Denham and uses a combination of beach seine and haul net gears to mainly take four species/groups: whiting (*Sillago schomburgkii* and *S. analis*), sea mullet (*Mugil cephalus*), tailor (*Pomatomus saltatrix*) and yellowfin bream (*Acanthopagrus latus*).

Most recreational fishing is boat-based using rod & line or handline. The key recreational species are pink snapper (*Pagrus auratus*), black snapper (grass or blue-lined emperor, *Lethrinus laticaudis*), western butterflyfish (*Pentapodus vitta*), whiting (*Sillago* spp.), Queensland school mackerel (*Scomberomorus queenslandicus*), tailor, blackspot tuskfish (bluebone, *Choerodon schoenleinii*) and estuary cod (slimy cod or goldspotted rockcod, *Epinephelus coioides*). A limited number of licensed charter vessels operate out of Denham (mostly fishing in the oceanic waters off Cape Inscription) and Monkey Mia.

Governing legislation/fishing authority

Commercial

Shark Bay Beach Seine and Mesh Net Management Plan 1992

Shark Bay Beach Seine and Mesh Net Managed Fishery Licence

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation

Consultation process

Commercial

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

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues (e.g. Shark Bay Inner Gulf Pink Snapper Working Group, convenes every 3 years).

Boundaries

The areas covered by this report are shown in Inner Shark Bay Fishery Figure 1. Fishing is not permitted in the Hamelin Pool Nature Reserve or in sanctuary zones, recreational zones or special purpose zones within the Shark Bay Marine Park.

Management arrangements

Commercial

The SBBSMNF is managed through input controls in the form of limited entry and gear restrictions (e.g. vessel size, net length and mesh size). A unit in the fishery comprises one primary vessel, a maximum of three netting dinghies and a maximum fishing team of three individual fishers.

Commercial line fishing for pink snapper and other species has not been permitted in these waters since 1996 (see 'Gascoyne Demersal Scalefish Fishery').

Recreational

For most species, the recreational fishery is managed using the normal combination of daily bag, possession, size and gear limits. For pink snapper more complex arrangements are used within the Eastern Gulf, Denham Sound and Freycinet Estuary (Inner Shark Bay Fishery Figure 1). These stocks are managed separately with explicit Total Allowable Catch (TAC) targets. In 2010, the TACs for pink snapper were as follows:

Eastern Gulf	15 tonnes (approx. 12 tonnes recreational, 3 tonnes commercial)
Denham Sound	15 tonnes (approx. 12 tonnes recreational, 3 tonnes commercial)
Freycinet Estuary	5 tonnes (approx. 1,400 fish, i.e. 1,050 recreational and 350 commercial)

Research summary

The stocks of pink snapper within the inner gulfs have been the focus of a comprehensive research program since 1996/97. Since 2002, integrated stock assessment models have been used to separately assess the status of the Eastern Gulf, Denham Sound and Freycinet Estuary stocks, and to determine appropriate levels of TAC. These assessments are updated every 3 years.

Estimates of recreational catch and effort have been derived from 'on-site' recreational fishing surveys involving interviews with boat crews returning to the Monkey Mia, Denham, and Nanga boat ramps. Surveys were undertaken each year between 1998 and 2010 (no surveys were conducted in 1999 and 2009).

Catches of pink snapper taken by licensed commercial and charter vessels are derived from compulsory monthly catch returns. The status of the four SBBSMNF target species (whiting, sea mullet, tailor, yellowfin bream) is monitored each year using data from commercial catch returns coupled with the extensive scientific knowledge gained from research dating back to the 1960s. Performance indicators for the SBBSMNF in the form of acceptable catch ranges and CPUE trigger levels were determined as part of an ESD risk-based assessment that was undertaken in 2002-03 for Departmental purposes.

Research on pink snapper in the inner gulfs is now limited to a monitoring level and involves using daily egg production method (DEPM) surveys to estimate spawning biomass every 3-5 years. At the most recent meeting of the Shark Bay Inner Gulf Pink Snapper Working Group (September 2011), the Department committed to completing a DEPM survey in each of the three areas to enable the stock assessments to be updated prior to the next scheduled meeting (2014).

Retained Species

Commercial landings (season 2011):

Whiting	105 tonnes
Mullet	108 tonnes
Tailor	16 tonnes
Yellowfin bream	9 tonnes
Pink snapper	2 tonnes

The total commercial catch taken by SBBSMNF licensed vessels in 2011 was 250 t (similar to 2010). This comprised 105 t of whiting, 108 t of sea mullet, 16 t of tailor, 9 t of yellowfin bream and 12 t of other mixed scalefish species that included 2 t of pink snapper (taken as bycatch in net fishing gears).

Recreational catch estimates (including charter, 2011)

Pink snapper	Eastern Gulf ca. 4 tonnes
	Denham Sound ca. 6 tonnes
	Freycinet Estuary ca. 1.5 tonnes
Black snapper	ca. 10 tonnes

As a direct result of management intervention, including the introduction of TAC-based management in 2003, recreational catches of pink snapper have decreased significantly since 1998.

Based on results of the most recent recreational fishing survey in 2010, the estimated recreational catch of pink snapper was approximately 4 tonnes in the Eastern Gulf, approximately 6 tonnes in Denham Sound and approximately 1 tonne in the Freycinet Estuary. The estimated recreational catch of black snapper in 2010 was approximately 10 tonnes (all areas combined).

In 2011, approximately 0.5 t of pink snapper was taken both in Denham Sound and the Eastern Gulf by licensed charter vessels; no charter boat catches were reported from the Freycinet Estuary. A total catch of <0.5 t of black snapper (all three areas combined) was reported by charter vessels in 2011.

Fishing effort/access level

Commercial

In 2011, of the 12 SBBSMNF licenses, only six vessels were actively involved in fishing (similar to 2010).

Fishing effort in the SBBSMNF again declined slightly in 2011 (986 boat days) compared with 2010 (1,041 boat days) and 2009 (1,118 boat days).

Recreational

In 2010, boat-based recreational fishing effort in the inner gulfs was estimated at approximately 37,000 boat fisher hours (compared to an estimated 33,000 fisher hours in 2007).

Stock Assessment

Assessment complete

Whiting	Yes
Mullet	Yes
Tailor	Yes
Yellowfin bream	Yes
Pink snapper	Yes
Black snapper	Yes

Assessment level and method:

Whiting/Mullet/Tailor/Yellowfin bream

Level 2 - Catch, Catch Rate

Pink snapper

Level 5 - Composite Assessment (2011)

Black snapper Level 3 - Fishing Mortality (2005)

Level 1 - Catch (2010)

Breeding stock levels

Whiting	Adequate
Mullet	Adequate
Tailor	Adequate
Yellowfin bream	Adequate
Pink snapper	Eastern Gulf - Adequate Denham Sound - Adequate Freycinet - Recovering

Black snapper Adequate

Whiting, Mullet, Tailor, Yellowfin bream: Assessment of the four main SBBSMNF target species is based on annual analysis of the commercial catch and effort data. A target range of annual catch and a CPUE trigger level have been determined for the fishery overall and for each species separately (Inner Shark Bay Fishery Table 1).

The total catch (all species) was 250 tonnes in 2011 and was within the target range (235–335 tonnes). The overall CPUE of 253 kg/boat day (all species) was similar to the long-term average since 1990 (230 kg/boat day). The catch and CPUE for whiting in 2011 (105 tonnes, 107 kg/boat day), mullet (108 tonnes, 109 kg/boat day) and yellowfin bream (9 tonnes, 9 kg/boat day) were all within the respective target (catch) ranges and above the minimum (CPUE) trigger levels. The tailor catch (16 tonnes) was again below the target range and the CPUE (17 kg/boat day) also below the minimum trigger level. While some level of reduction in natural abundance cannot be discounted, the recent low landings for tailor are mostly attributable to local processing restrictions.

Pink snapper: DEPM surveys that directly estimate pink snapper spawning biomass were conducted annually in the Eastern Gulf, Denham Sound and Freycinet Estuary during the period 1997-2004 and periodically since. Most recently, DEPM surveys were conducted in the Eastern Gulf in 2009 and in Denham Sound and Freycinet Estuary in 2010. Research trawl surveys, to monitor variation in juvenile

recruitment, have been conducted each year since 1996.

Integrated assessment models have been used to assess the status of the three stocks in relation to the management target (40% of the unexploited spawning biomass) since 2002. The most recent assessments (2011) estimated the spawning biomass of pink snapper was above the target level (40%) in both the Eastern Gulf and Denham Sound but while improving was still below the threshold level (30%) in the Freycinet Estuary.

Black snapper: Based on age-structure data collected in 2005, fishing mortality (F) was estimated to be around the threshold level (F=M, natural mortality). More recent information on F for this species is not available but there is no information from recent catch data that would suggest the situation has changed.

Non-Retained Species

Bycatch species impact **Low**

Bycatch is minimal in the SBBSMNF because netting operations selectively target specific schools of fish. Based on experience, fishers can determine the species and size of the school, and the size of individual fish within the school, before deploying the net. Fish are readily observed in the very shallow near-shore waters of Shark Bay. Non-target species and under-sized fish are avoided in most cases.

Protected species interaction **Negligible**

As nets are actively set and hauled, if any protected species such as dugongs, dolphins or marine turtles are caught (rarely) they are immediately released.

Ecosystem Effects

Food chain effects **Low**

The overall catch levels in the fishery have been relatively stable over several decades, despite a long-term reduction in effort, suggesting that recruitment of the main target species has not been significantly affected by fishing mortality. The total biomass of the key target species appears sufficient to maintain trophic function in these waters.

Habitat effects **Negligible**

Seine nets are set and hauled over shallow sand banks, including intertidal areas. Sand habitats are naturally dynamic environments with resident infauna adapted to cope with regular physical disturbances. Combined with the low frequency of fishing in any one location, this indicates that the fishery is unlikely to have a lasting effect on the habitat.

Social Effects

Commercial

Currently around 20 fishers are employed in the SBBSMNF based on six managed fishery licenses actually operating. Fishing and associated fish processing is an important source of local employment - the fishery, although relatively small-scale, makes a significant contribution to the Denham economy and community.

Recreational

Shark Bay is a very popular tourist destination, especially during the winter months and school holidays: data indicate that approximately 30% of all visitors participate in recreational fishing during their stay.

Economic Effects

Estimated annual value (commercial sector) for 2011 **Level 2 - \$1 - 5 million**

Commercial

The gross value of production (GVP) of the SBBSMNMF in 2011 was estimated in the range \$1-5 million.

Recreational

While a dollar value is difficult to assign to recreational and charter catches, the availability of quality fishing underpins the tourism industry and generates significant income for the regional economy.

Fishery Governance

Commercial

Current effort level (2011): **Acceptable**

Target catch range (2011):

All species (ex Pink snapper) **235–335 tonnes**

Pink snapper **Eastern Gulf 3 tonnes**
Denham Sound 3 tonnes
Freycinet 1.2 tonnes

Total fishing effort in SBBSMNMF declined to 986 boat days in 2011 (1,041 boat days in 2010 and 1,118 in 2009).

The total commercial catch (ex. pink snapper) in 2011 at 250 t was within the acceptable target range (235–335 t). At this time, this fishery is considered to present a low risk to the sustainability of the finfish and other ecological resources of inner Shark Bay, and as a consequence is a low research/management priority.

Commercial catches of pink snapper taken as bycatch by SBBSMNMF vessels in 2011 were either nil or significantly below their allocation within the respective pink snapper TACs (2 tonnes in Denham Sound, nil catch in Eastern Gulf and Freycinet Estuary).

Recreational

Target catch range (2011):

Pink snapper **Eastern Gulf 12 tonnes**
Denham Sound 12 tonnes
Freycinet Estuary 3.8 tonnes

Recreational catches of pink snapper were assumed to be similar to those estimated in 2010 (no survey undertaken in 2011) and therefore within the respective TACs in each area.

In 2011, a total of 478 applications were received for Freycinet Estuary management quota tags with a total of 944 tags (total available 1,050) allocated to recreational fishers.

New management initiatives (2011/12)

As an outcome of the 'Wetline Review' (see Fisheries Management Paper No. 224 for details), a management plan will be developed for a Gascoyne Inshore Net Fishery. The Plan will incorporate the existing SBBSMNF, the Exmouth Gulf Beach Seine Fishery and commercial net fishing in the Carnarvon area as separate zones under a single management plan.

Using the information from the recreational fishing from boat licence introduced in 2010, a statewide integrated recreational fishing survey (included a phone diary survey based on the database of licensed boat fishers) was carried out between January 2011 and February 2012. This study will generate estimates of the recreational catches of key species within the Gascoyne region which will be available in late 2012.

In October 2011, the Shark Bay Inner Gulf Pink Snapper Working Group met to discuss recent research data and provide suggestions on management for the next three year period 2012-2014. Given the stock status is above the 40% breeding stock target limit, and as the annual recreational catch estimate was below the 12 tonne target the working group recommended an increase in the recreational bag limit for inner gulf pink snapper. The Department is currently considering the Working Group's advice in light of the recommendations from the statewide review of recreational rules.

Integrated Fisheries Management (IFM) issues in the Gascoyne is likely to commence in late 2012 and Consideration of sector catches of demersal scalefish will include consideration of the inner Shark Bay Fishery as well as other demersal scalefish fisheries in the Bioregion.

External Factors

The inner Shark Bay environment is particularly stable as a result of its typically low-rainfall, arid environment but is occasionally affected by irregular flood events such as occurred in the Gascoyne and Wooramel Rivers in late 2010 and again in early 2011. The impact of these events on key target species in inner Shark Bay remains to be fully determined but the abundances of some target species tend to be relatively stable, with fishery production mostly determined by levels of fishing effort. Other species including pink snapper, yellowfin bream and possibly tailor appear to be influenced by environmentally driven variations in recruitment.

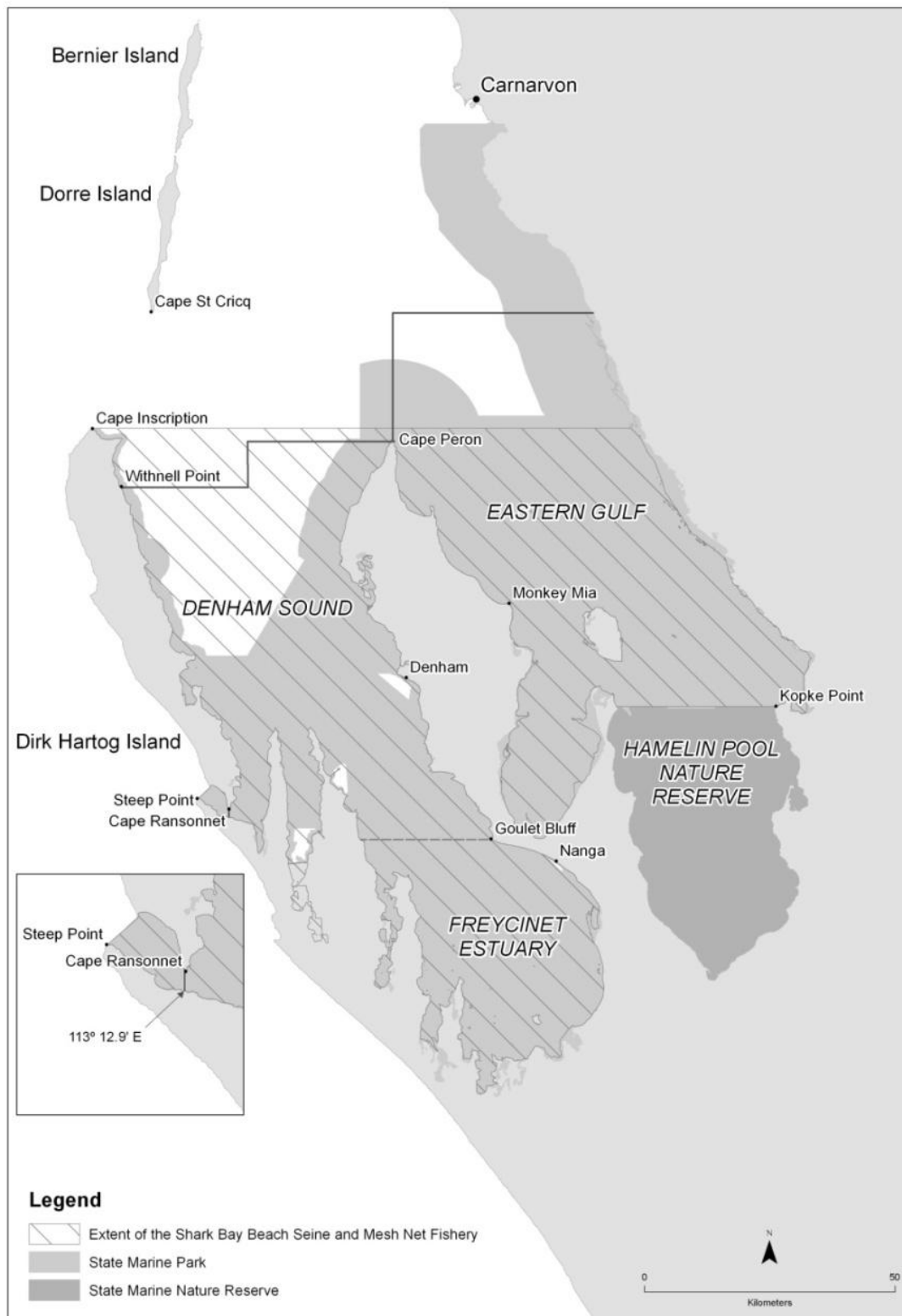
Climate change has the potential to impact fish stocks in range of ways including, with temperate species such as pink snapper, affecting spawning patterns and influencing their geographic distribution (latitude shift). A review of the impacts and responses to marine climate change in Australia has been undertaken by CSIRO (see www.oceanclimatechange.org.au). A 3-year FRDC-funded project has recently commenced that will assess the effects of climate change on key fisheries in Western Australia. The key fishery species that will be considered in relation to the consequences of climate change as part of this project include pink snapper and tailor.

INNER SHARK BAY SCALEFISH FISHERY TABLE 1

Annual catch and acceptable catch range (tonnes) (upper), and annual CPUE and minimum trigger level (kg/boat day) (lower) for key species taken by Shark Bay Beach Seine and Mesh Net Managed Fishery vessels for the period 2002-2011.

Species	Acceptable catch range	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Whiting	93-127	100	107	119	116	113	102	117	112	116	105
Mullet	77-144	136	149	143	85	62	91	107	104	95	108
Tailor	25-40	26	28	24	19	21	23	23	17	16	16
Bream	7-15	17	24	27	27	23	14	8	8	10	9

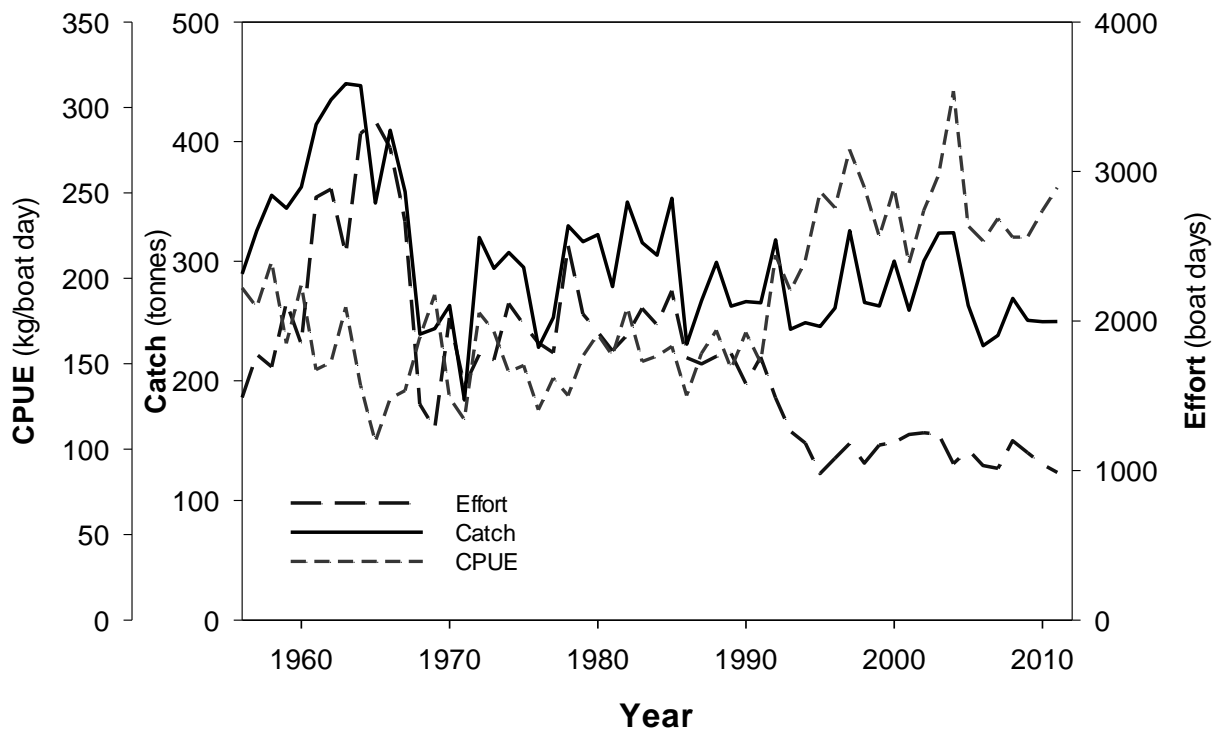
Species	Trigger level	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Whiting	75	80	86	114	102	110	100	98	100	112	107
Mullet	62	108	120	137	74	60	90	89	93	92	109
Tailor	21	21	22	23	17	20	22	19	15	15	17
Bream	5	14	19	26	23	22	14	6	7	10	9



INNER SHARK BAY SCALEFISH FISHERY FIGURE 1

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

Shark Bay Beach Seine and Mesh Net Total Catch



INNER SHARK BAY SCALEFISH FISHERY FIGURE 2

The total annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2011.

Gascoyne Coast Blue Swimmer Crab Fishery Status Report

D. Johnston, D. Harris, C. Syers and C. Lunow.

Main Features

Status		Current Landings	
Stock level		Commercial catch	890 t
Shark Bay	Under review	Shark Bay trap fleet	496 t
Exmouth	Adequate	Shark Bay trawl fleet	364 t
		Exmouth Gulf trawl fleet	30 t
Fishing Level			
Shark Bay	Under Review	Recreational catch	Minimal

Fishery Description

The blue swimmer crab (*Portunus armatus*) is found along the entire Western Australian (WA) coast, in a wide range of inshore and continental shelf areas, from the inter-tidal zone to at least 50 m in depth. However, the majority of the commercially and recreationally-fished stock, is concentrated in the coastal embayments and estuaries between Geographe Bay in the south west and Port Hedland in the north.

Blue swimmer crabs are targeted commercially using a variety of fishing gear, but most dedicated crab fishers in WA now use purpose-designed crab traps. Operators in the Shark Bay Crab (Interim) Managed Fishery are only permitted to use 'hourglass' traps. Each of the State's prawn and scallop trawl fisheries that operate in this region may also retain crabs. Recreational crab fishers in the Gascoyne bioregion mainly use drop nets or scoop nets.

Crabbing activity in the Gascoyne Coast bioregion is centered in the embayments of Shark Bay and Exmouth Gulf. The Shark Bay Crab (Interim) Managed Fishery has developed into the largest crab fishery in WA.

Governing legislation/fishing authority

Commercial

Shark Bay Crab Fishery (Interim) Management Plan 2005

Exceptions to the *Fish Traps Prohibition Notice 1990* and *Fish Traps Restrictions Notice 1994*

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

Shark Bay Prawn Management Plan 1993

Shark Bay Scallop Management Plan 1994

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Order – Shark Bay Interim Managed Fishery only)

Recreational

Fish Resources Management Act 1994; *Fish Resources Management Regulations 1995* and subsidiary legislation.

Consultation process

Commercial

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

Recreational

Recreational consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department continues to undertake direct consultation with the community on specific issues

Boundaries

The Shark Bay Crab Interim Managed Fishery covers the waters of Shark Bay north of Cape Inscription, to Bernier and Dorre Islands and Quobba Point (Gascoyne Coast Blue Swimmer Crab Figure 1). In addition, two fishers with long-standing histories of trapping crabs in Shark Bay are permitted to fish in the waters of Shark Bay south of Cape Inscription.

The boundaries of the Shark Bay Prawn, Shark Bay Scallop and Exmouth Gulf Prawn Managed Fisheries, which also retain blue swimmer crabs, are described in the relevant status reports specific to the trawl fisheries elsewhere within this document.

Management arrangements

Commercial access to blue swimmer crab stocks in WA is governed by a series of separate management arrangements provided for under the legislative framework of the *Fish Resources Management Act 1994*. Individual fisheries are managed under an input control system, primarily through the regulation of licence and trap numbers or length of headrope of trawl net. Supplementary controls cover what species can be retained, any associated minimum size limits, gear specifications, and area, seasonal and daily time restrictions. The principal management tool employed to ensure adequate

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breeding stock involves having minimum size limits well above the size at sexual maturity. Male blue swimmer crabs in Shark Bay become sexually mature at 115 mm carapace width, while females become sexually mature below 100 mm carapace width. Setting the commercial minimum size at 135 mm carapace width is designed to ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

There are five crab trap licences in Shark Bay under the Shark Bay Crab Fishery (Interim) Management Plan 2005 which sets the number of traps that can be fished, fishery specific spatial closures, gear specifications and other controls. These licences are consolidated onto three active vessels. Two permit holders, who have a long standing history of crab fishing south of Cape Peron (south of the existing waters of the Shark Bay Crab Interim Managed Fishery [SBCIMF]), have a Fishing Boat Licence (FBL) condition that allows them to fish in these waters but with no more than 200 traps. At no time, however, may they each use more than 300 traps in total across all of the waters of Shark Bay.

Management controls for the trawl fisheries that retain blue swimmer crabs in the Gascoyne Coast bioregion, namely the Shark Bay Prawn, Shark Bay Scallop and Exmouth Gulf Prawn Managed Fisheries, are based on limited entry, seasonal and area closures, and gear controls including bycatch reduction devices (grids) and these are fully described in the relevant status reports within this document. The Department of Fisheries' vessel monitoring system (VMS) continues to monitor the activities of all trawlers in these fleets.

A third comprehensive ESD assessment of the Shark Bay fishery was completed in June 2011. The Federal Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) approved the fishery to export product for a further five years until September 2016, subject to several conditions and recommendations - for details refer to: <http://www.environment.gov.au/coasts/fisheries/wa/shark-bay/index.html>.

Recreational fishing for blue swimmer crabs in WA is managed through a series of input and output controls. As with commercial fishing, the principal management tool employed to sustain an adequate breeding stock is a minimum size limit well above the size at sexual maturity. A minimum legal size limit of 127 mm carapace width applies in the waters of the Gascoyne Coast bioregion, along with a bag limit of 20 crabs per person or 40 crabs per boat. Restrictions also govern gear types that can be used to take blue swimmer crabs.

Research summary

Data for the assessment of blue swimmer crab stocks in the Gascoyne bioregion are obtained from trap fishers' statutory monthly catch and effort returns and voluntary daily logbooks, and trawl fisher's statutory daily logbooks. Department of Fisheries' research staff also conduct quarterly catch monitoring surveys aboard commercial crab trap vessels in Shark Bay, and a fishery-independent trawl survey that covers some of the commercial crab habitat is conducted annually during late November/early December.

Some base-line information on the biology and ecology of blue swimmer crabs has been generated by a number of Fisheries Research and Development Corporation (FRDC)-funded projects conducted by the Department of Fisheries and Murdoch University over the past decade. An FRDC project completed in early 2005 produced a preliminary stock assessment of the Shark Bay blue swimmer crab fishery.

An external scientific review of the available blue swimmer crab research data for Shark Bay was conducted in May 2011. The review highlighted current stock trends in the fishery and gaps in the current knowledge. An accurate assessment of sustainable catch levels could not be provided due to insufficient scientific data. As a result of this uncertainty, management options for the commercial trap and trawl sectors are being considered until a more robust stock assessment can be completed. An FRDC project (FRDC 2012/015) to assess the stock status of crabs in Shark Bay was submitted in 2011 and funding has recently been approved. This fishery-independent research program will commence in July 2012 and run for three years.

Retained Species

Commercial landings (season 2010/11):

	890 tonnes (total)
Shark Bay trap fleet	496 tonnes
Shark Bay trawl fleet	364 tonnes
Exmouth Gulf	30 tonnes

The total commercial catch for the Gascoyne bioregion during 2010/11 was 890 t, representing a slight increase on the 2009/10 catch of 888 t. This catch accounted for 82% of the state commercial blue swimmer crab catch of 1087 t for 2010/11 (refer to West Coast Blue Swimmer Crab Figure 1 in the West Coast Blue Swimmer crab Fishery Report).

The annual catch from the Shark Bay crab trap fishery for 2010/11 was 496 t, a 7% decrease on the 2009/10 catch of 529 t (Gascoyne Coast Blue Swimmer Crab Figure 2, 3). Landings from the Shark Bay trawl fleet were 364 t in 2010/11, an 11% increase on the 2009/10 catch of 323 t.

A total of 30 t of blue swimmer crabs was landed in the Exmouth Gulf region during 2010/11, a 173% increase on the previous year's catch of 11 t (Gascoyne Coast Blue Swimmer Crab Figure 2). All of the crab catch was landed as by-product from prawn trawlers, with no commercial trap fishing undertaken in Exmouth Gulf during 2010/11.

Recreational catch:

Gascoyne Bioregion	< 1 % of total
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A recreational boat-ramp survey monitoring crabbing in the Gascoyne Coast bioregion was carried out during 1998/99. The survey provided a recreational blue swimmer catch estimate of approximately 1 tonne, representing less than 1% of the total catch. Most of the recreational catch was taken in the inner gulfs of Shark Bay, in and around the townships of Denham and Monkey Mia. A subsequent recreational fishing survey was conducted in the Gascoyne region between March 2007 and March 2008, and analysis of the collected data is expected to be published in the near future.

Information on recreational blue swimmer catches in the inner gulfs of Shark Bay has also been derived from recreational surveys targeting pink snapper conducted in 2000/01, 2001/02, 2005/06, 2006/07 and 2007/08. While the surveys were restricted to boat fishers only who used boat ramps in Monkey Mia, Denham and Nanga, the limited data that was collected also suggested that the recreational crab catch in the lower gulfs was minimal compared with the take by commercial fishers operating in the same area. The surveys provided recreational catch estimates of between 0.3-1.9 t of blue swimmer crabs for the gulf regions.

A small amount of recreational crabbing also occurs in Exmouth Gulf.

Fishing effort/access level

Effort in the Shark Bay Crab Interim Managed Fishery decreased during 2010/11, as operators continued to maximize profitability by capitalizing on peak catch periods. Shark Bay crab trap fishers reported a total of 284,400 traplifts for 2010/11 (Gascoyne Coast Blue Swimmer Crab Figure 3) – a 19% decrease on the 352,550 traplifts reported for the previous year.

Effort in the Shark Bay Prawn, Shark Bay Scallop and Exmouth Gulf Prawn Managed Fisheries, are described in the relevant status reports elsewhere within this document.

Stock Assessment

Assessment complete:

Shark Bay: Yes

Assessment level and method:

Level 3 - Catch rate/Size Distributions

Breeding stock levels:

Shark Bay: Adequate

Shark Bay: The Shark Bay Crab Fishery (trap and trawl sectors) has developed rapidly in the last 10 years to become Australia's highest producing blue swimmer crab fishery, with peak landings in 2010 of 828 t valued at over AU\$6 million. During the developmental phase of the commercial trap fishery, catches grew steadily in line with increases in fisher knowledge, gear development and fishing effort, from 87 t (1998) to 564 t (2005). In 2005, the trap fishery transitioned to interim managed status and trap catches have stabilized at around 500 t. During 2010/11, the mean trap catch rate of blue swimmer crabs was 1.74 kg/traplift, a 16% increase on the 2009/10 catch rate of 1.50 kg/traplift (Gascoyne Coast Blue Swimmer Crab Figure 3). The Shark Bay prawn fishery has taken crabs since inception. The level of retained catch was relatively low up until 2001 (89 t), but has since increased steadily to 338 t in 2010.

Conflicting evidence exists as to the sustainability of current total harvest levels in the data collected in the Shark Bay crab trap fishery. Linear relationships of nominal and standardized effort against commercial catch for the trap fleet over the past decade suggest the Shark Bay crab stock is yet to show signs of excessive fishing effort, and that fluctuations in catch are dependent on changes in effort and environmental conditions. Conversely, potential signs of high exploitation include:

standardised catch rates of crabs from fishery-independent trawl surveys decreasing in the last three years; a decrease in mean standardized carapace widths of crabs from both commercial trap monitoring surveys and fishery-independent trawl surveys; a reduction in the proportion of extra large male crabs in the commercial catch; and a downward trend in the standardized commercial trap catch rate in the Eastern Gulf. Concern also exists over the level of latent effort in the fishery, with the trap sector currently operating at 70-80% of its potential effort and the capacity for further increases in crab landings by the trawl fleet.

It is noted here that after the completion of the 2010/11 season in July 2011, the relative abundance of all size classes of crabs in Shark Bay declined significantly. The reasons for this unexpected and substantial decline are yet to be fully understood but may be linked to several adverse extreme environmental events (sustained low salinity associated with intensive flooding and very warm waters up to 4-5°C above average associated with a very strong La Niña event) that occurred during the summer of 2010/11. This decline has already had a significant impact on the 2011/12 fishing season and full details will be provided in the 2012/13 Report.

Exmouth Gulf: Catch and effort on blue swimmer crabs in the Exmouth Gulf prawn fishery has been relatively stable, and the stocks are considered to be at acceptable levels.

The minimum legal size at first capture (127 mm carapace width for recreational fishers; 135 mm carapace width for commercial fishers based on industry agreement) for crab fisheries in the Gascoyne Coast Bioregion is set well above the size at first maturity (95 – 115 mm carapace width) of the resident stocks. Consequently, breeding stock levels are expected to be adequate to maintain stocks in all current fishing areas under normal environmental conditions.

The breeding stocks in the Gascoyne Coast bioregion are also supported by the influence of the warmer waters that occur at these latitudes which extends the spawning period over the whole year, than, whereas spawning is restricted to the late spring and early summer months on the lower West Coast.

The performance measure for the Shark Bay fishery requires that the breeding stocks be maintained. The breeding stock is measured as adult crab abundance (catch per unit effort - CPUE). The CPUE in the Shark Bay fishery for 2010/11 was 1.74 kg/trap lift – well above the performance measure of 1.0 kg/trap lift. This level of breeding stock has proven adequate to support ongoing recruitment to the fishery. However, extreme adverse environmental events over the summer of 2010/11 have had a negative impact on stock levels during the second half of 2011 and into 2012.

Non-Retained Species

Bycatch species impact

Negligible

Hourglass traps are purpose-designed to minimise the capture of undersized blue swimmer crabs and non-target species and are therefore an inefficient way to capture fish, the majority of which are able to escape through the entrance gaps when the pot is soaking or being hauled.

Small numbers of fish are infrequently captured in crab pots, but the fishers are not permitted to retain them. The low

GASCOYNE COAST BIOREGION

number of fish caught and returned by crab fishers is considered to pose a negligible risk to these stocks.

Impacts from discarded bycatch from trawl fisheries that retain crabs as a by-product is dealt with in those sections of this report specific to the trawl fisheries.

Protected species interaction **Negligible**

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

Ecosystem Effects

Food chain effects **Low**

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

Habitat effects **Negligible**

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

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

Social Effects

During 2010/11, approximately 15 people were employed as skippers and crew on vessels fishing for blue swimmer crabs in the Gascoyne Coast bioregion. Additional employment for some 30-35 workers has been created in Carnarvon through the development of post-harvest processing of the crab catch.

Economic Effects

Estimated annual value (to fishers) for 2010/11

Level 3 - \$5 - 10 million (\$5.0 million)

Blue swimmer crab landings from the Gascoyne Coast bioregion during 2010/11 were worth \$5.0 million, a 24% increase on the \$4.04 million generated during 2009/10.

The economic value of commercial blue swimmer crab fishing to the State of Western Australia for the 2010/11 financial year was estimated to be \$6.35 million – an 18% increase on the estimated \$5.37 million generated in 2009/10.

The average beach price for green crabs in the Gascoyne fisheries for the year was around \$5-5.80/kg.

While the majority of the product was sold through local and inter-state markets, several Shark Bay fishers have been developing markets in Asia.

Fishery Governance

Target catch (or effort) range:

Shark Bay: Under Development

A review of these blue swimmer crab fisheries is being undertaken and target catch ranges will be set.

Current fishing (or effort) level: Shark Bay - N/A

Conflicting evidence exists as to the sustainability of current total harvest and effort levels in the data collected in the Shark Bay crab trap fishery. While there is sufficient biomass and productivity within the blue swimmer crab stock in Shark Bay to sustain a significant commercial fishery, the current challenge for the research and management of this fishery is to clarify the causes for the recent decline, and establish the appropriate harvest strategy to ensure the future sustainability of the stock.

With the termination of the Exmouth Gulf Developing Crab Fishery and only a moderate retention of crabs from the Exmouth Gulf trawl fleet, the current level of effort in Exmouth Gulf is considered acceptable.

New management initiatives (2011/12)

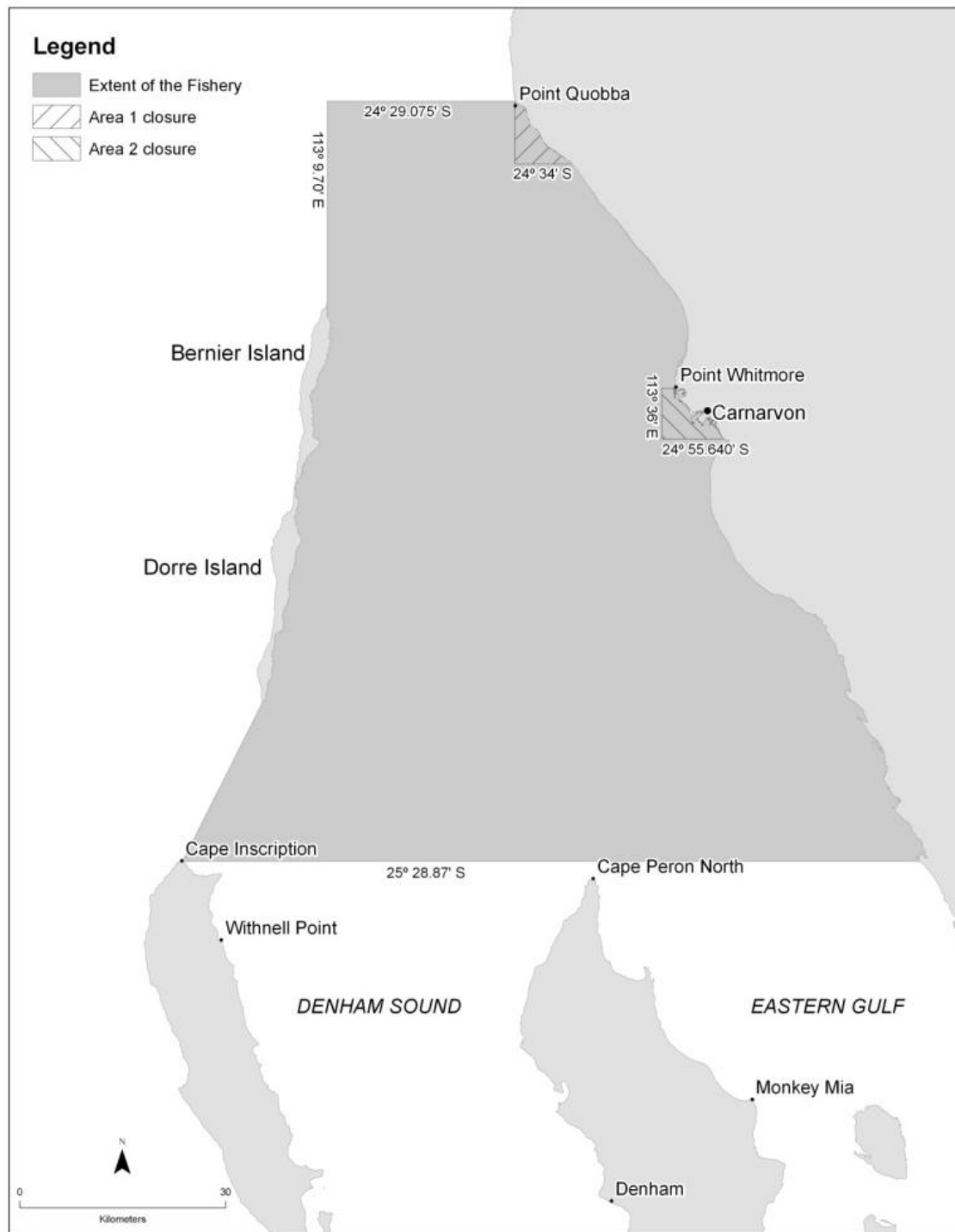
The Shark Bay Crab Interim Management Plan was extended to 31 August 2013 to provide more time to resolve a number of issues related to resource sharing between the Shark Bay crab trap and Shark Bay prawn and scallop trawl fisheries. Joint commercial industry meetings were held in 2012 to consider possible catch share allocations between crab trap and trawl fishers in Shark Bay. The meetings identified a need for an independent workgroup to provide advice on those specific catch share allocations which the Department of Fisheries is now looking to engage.

To address the reduction in stocks following the environmental perturbations in late 2011 a voluntary no take of crabs was negotiated between the Department of Fisheries and the Trap and trawl fishers taking effect on 24 April 2012. The results of regular research trawl and trap surveys will be used to reassess the stock condition and performance measures are being drawn up to determine when stocks reach a suitable level to support commercial fishing again. Appropriate management action will be considered when the fishery resumes including catch and/or effort controls. Recreational fishing has not been restricted during this voluntary commercial closure due to the very low impact of that sector on the stock.

External Factors

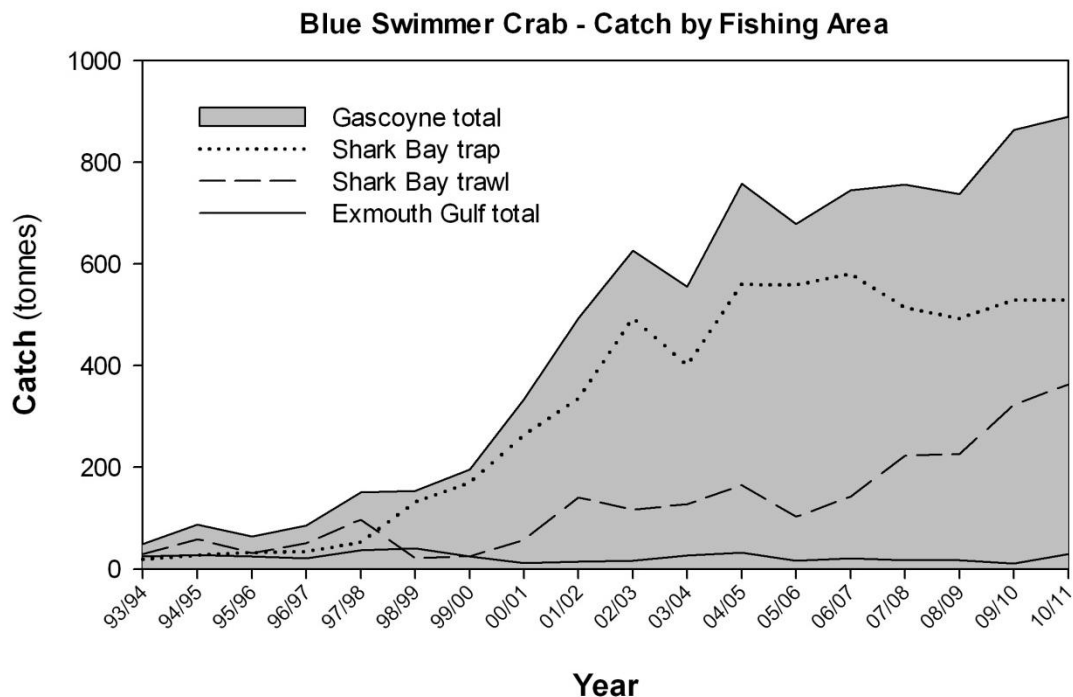
Levels of recruitment to many of the crab fisheries fluctuate considerably. While the causes of these variations are not fully understood, it is considered most likely due to environmental influences on spawning success and larval survival through to recruitment. The relationship between environmental factors, recruitment and catch is being further evaluated as data becomes available.

The negative effects on the crab stocks from the marine heatwave (very warm waters up to 4-5°C above average associated with a very strong La Niña event) combined with the flood events that occurred during the summer of 2010/11 are currently being examined.



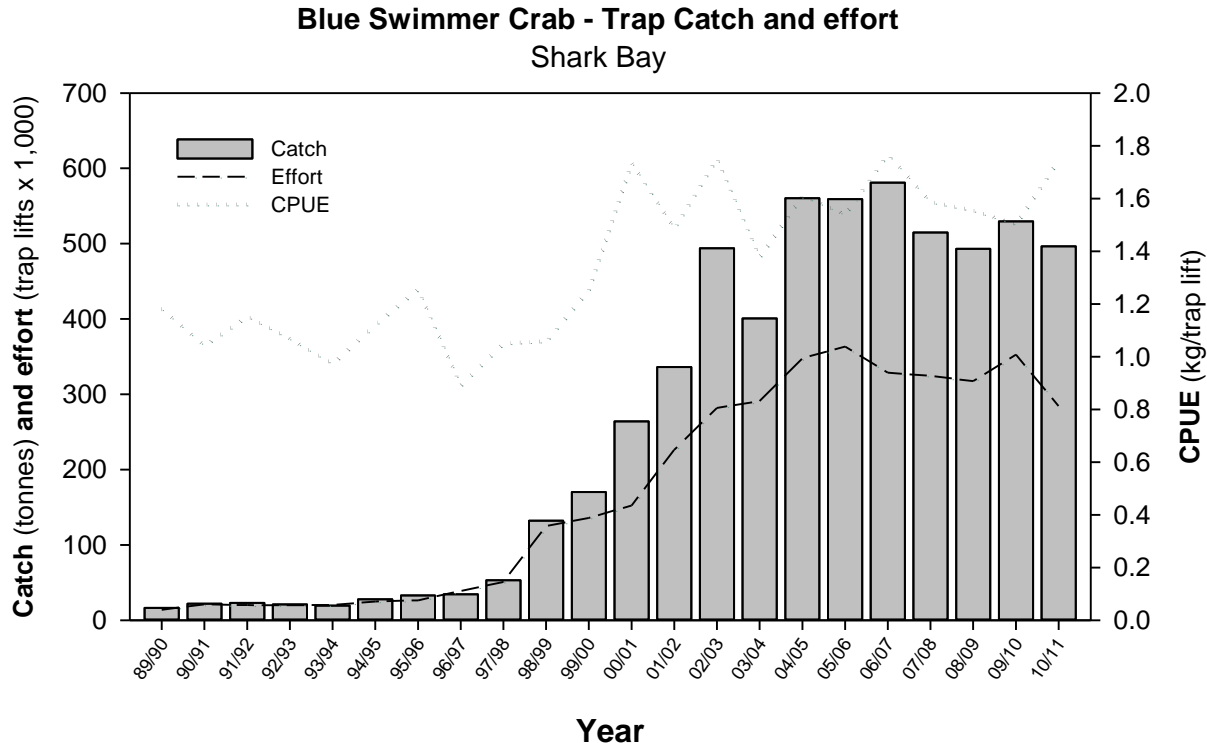
GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 1

Extent of the Shark Bay Crab (Interim) Managed Fishery. Two additional 200-trap exemptions allow for fishing in the western and eastern gulfs south of Cape Peron.



GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 2

Commercial catch history for the blue swimmer crab (*Portunus armatus*) fisheries in the Gascoyne Coast bioregion of Western Australia since 1993/94.



GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab trap catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in Shark Bay since 1989/90.

AQUACULTURE

Regional Research and Development Overview

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

A local aquaculture sector is emerging, focusing on the production of aquarium species, including coral and live

rock. This developing sector is regulated according to the policy entitled *The Aquaculture of Coral, Live Rocks and Associated Products*.

A start-up project is investigating the production of artemia (brine shrimp) and a small-scale project is growing limited quantities of diadromous and marine species for local markets.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education services in the Gascoyne Coast Bioregion are delivered by Fisheries and Marine Officers (FMOs), Community Education Officers (CEOs) and associated management and administrative support staff based at District Offices in Denham, Carnarvon and Exmouth. During 2010/11 the three district offices supported a total of eleven FMO positions allocated to deliver services to several client groups including commercial and recreational fisheries, marine parks, pearling and aquaculture operations and fish habitat protection areas. The region covers approximately 2700 kilometres of the Western Australian (WA) coastline, some 13% of the WA coast. The various coastal landscapes represent some of the most remote, isolated, pristine and dangerous marine and terrestrial environments in the State.

A significant aspect of the regions work is the provision of compliance services to the State's Marine Parks. The Gascoyne Coast Bioregion has two of WA's most iconic and significant Marine Parks, Ningaloo Marine Park and the associated Commonwealth Marine Park, Shark Bay Marine Park and the associated World Heritage Area. These two Marine Parks occupy just over 70% of the Gascoyne Coast Bioregion. In partnership with the Department of Environment and Conservation (DEC), FMOs monitor and deliver compliance and education programs covering some 30 Sanctuary Zones and Marine Managed Areas and other protected areas.

FMOs undertake regular land, air and sea patrols using a compliance delivery model supported by a risk assessment process and associated operational planning framework. Throughout the bioregion they employ specially equipped four-wheel-drive vehicles, quad bikes and small towable vessels. They also make use of sophisticated surveillance, mapping and GPS equipment to assist in evidence gathering. This includes high-powered telescopes and photographic mapping technology. A high visibility Recreational Fishing Mobile Patrol has been added to the Gascoyne pool of resources. This dedicated education and enforcement unit patrols the coast from Onslow through to Kalbarri.

FMOs at Exmouth make extensive use of the 13-metre Patrol Vessel (PV) the PV *Edwards* to conduct compliance activities throughout the Gascoyne bioregion. FMOs in

Denham use an 8 metre PV and in Carnarvon a 7.3-metre rigid inflatable boat is used to conduct at-sea inspections in Shark Bay and within the Southern aspects of the Ningaloo Marine Park and Commonwealth Marine Park. In all 3 Districts FMOs spend approximately 100 days a year at sea on patrol duties. Large patrol vessels (greater than 20 m in length) also assist FMOs at various times of the year for offshore patrols, especially in the Shark Bay Prawn and Scallop Fisheries; this accounted for 12 days of at-sea patrols in 2010/11. FMOs also conduct aerial surveillance, dive inspections, at-sea and on-land catch, licence, gear and marine safety inspections, and attend community events as well as school education programs.

Management of the Shark Bay Crab Fishery is an emerging issue for the region. The fishery is the largest in Australia and requires management across a number of separate managed fisheries, including the prawn, scallop and crab fishery itself. The floods of December 2010 and February 2011 had an impact on the Carnarvon and Shark Bay areas and also appear to be having an affect on crab numbers. Further research by the DoF will assist in planning future management and compliance strategies.

The sustainability of the Shark Bay Snapper Managed Fishery, which has become the Gascoyne Demersal Scalefish Fishery, continues to be a high priority and major management challenge. The monitoring of commercial catch quota via the "Catch and Disposal Record" (CDR) process remains a pivotal part of the management process, as does the inspection of catch landed ashore in accordance with the CDRs. Recreational snapper tags in the Freycinet Estuary area continue to be another positive method for managing the pink snapper recovery in this area. Ensuring fair and equitable access to the fishery for both commercial and recreational fishers whilst ensuring the sustainability of the species remains a high priority for the Gascoyne Management team and FMOs in the region.

The continuing recovery of the Shark Bay Inner Gulf pink snapper stocks has been supported by the efforts of the Department's staff in the Gascoyne Coast Bioregion and the officers of the Denham District in particular.

FMOs continue to support and maintain important and long-term relationships with the community through their

GASCOYNE COAST BIOREGION

participation in community events and the coordination of educational and interpretive activities during peak periods utilising Community Education Officers (CEOs) throughout the bioregion. These peak periods commence in late March and finish in early October. During this peak season, fishing competitions like the *Carnarfin*, *Shark Bay Fishing Fiesta* and *Gamex*; and community events such as the *Whale Shark Festival* and *Gascoyne Expo* provide high exposure community education opportunities for FMOs and CEOs. FMOs make a substantial contribution to the pre-season preparations of the Shark Bay and Exmouth trawl fleets by providing advice, pre-season briefings and inspections of vessels, fishing and safety equipment.

The Department's satellite-based vessel monitoring system (VMS) continues to be a central compliance and management tool enabling positional surveillance and monitoring of commercial vessels and provides an important safety tool for fishers in case of emergency. The VMS allows for fishery-specific management plan closures to be monitored remotely by triggering an alarm should a boundary be crossed or an unauthorized activity be detected. FMOs can program their inspection regimes and apply their investigation methods more efficiently by using the facilities provided by VMS. The expansion of the VMS into other fisheries such as the Gascoyne Demersal Scalefish and mackerel fisheries has ensured that a higher and more effective rate of compliance is achieved.

Activities during 2010/11

During 2010/11 FMOs delivered a total of 6,944 hours of "in-field" compliance activity (Gascoyne Coast Compliance Table 1 which excludes Gascoyne pearling compliance activities which are reported in the North Coast Bioregion), (Gascoyne Coast Compliance Patrol Hours Figure 1). The total budgeted hours for compliance were not delivered by FMOs in the region during 2010/11. This was due again to staff shortages for significant periods of time during the year. It has been demonstrated in previous years that the ongoing positive effects of a stable FMO work group have resulted in a better working relationship between fishers and FMOs, especially commercial fishers, however previous efforts might be at risk because of the ongoing issue of staff shortages. Commercial and recreational fishers alike continue to provide positive feedback that the routine attendance of familiar FMOs in their workplace and recreational fishing locations has led to a better understanding and knowledge of the regulations and a higher rate of compliance.

In delivering compliance services to the Gascoyne, FMOs under the management of the Compliance Manager make use of a risk assessment and intelligence analysis-driven model to compliance planning and prioritization. All the existing Operational Compliance Plans (OCP) were reviewed and updated during the 2010/11 year using this model. Several other OCPs were completed, including the Gascoyne/Pilbara Recreational Fishing plan focussing effort on Onslow and the Commonwealth Ningaloo Marine Park. This continues to be the model for delivering compliance across the agency and continues to provide the most effective and efficient method for a planned and measurable approach to compliance delivery.

The OCP's deliver agreed outcomes and provide a more accountable and realistic process for budget creation and the actual services that are to be delivered.

OCPs have been operating for several years now in the Exmouth Gulf Prawn Fishery, Shark Bay Prawn Fishery, Shark Bay Scallop Fishery, Shark Bay Crab Interim Managed Fishery, Gascoyne Aquaculture and Pearling Fishery, and, for the management of the Ningaloo Marine Park, Shark Bay Marine Park and Commonwealth Ningaloo Marine Park. A more targeted effective and relevant compliance service in terms of both cost and activities was delivered using this planning and delivery process.

FMOs delivered compliance activities directed at commercial fisheries mostly through pre-season inspections, catch inspections and quota monitoring, as well as at-sea inspections and investigations resulting from suspected breaches detected via the VMS and intelligence led operations. FMO effort was again directed at building stronger relationships with industry through higher levels of contact both at sea and in port. The number of suspected breaches of closed waters detected through the VMS and other monitoring methods has remained at a moderately high level in 2010/11. However, compliance overall is assessed as being at an acceptable level across all the fisheries except for the Shark Bay Prawn Fishery where issues regarding VMS compliance remain an ongoing concern. Compliance staff assess that the commercial fishing industry continues to demonstrate a positive approach to complying with regulations and playing their part to ensure the sustainability of their fisheries. A total of 8 infringement warnings and 5 infringement notices were issued and 4 prosecutions were instigated from a total of 206 field contacts with commercial fishers. Field contacts were lower than 2009/10 because of the previously highlighted staff shortages.

The monitoring of marine park activities with respect to recreational fisheries has divided the recreational fishing compliance program from a stand-alone program into two distinct programs, one with a marine park focus. FMOs increased their compliance activities in relation to both Ningaloo Marine Park and Shark Bay Marine Park in line with the increased importance and focus of government on marine parks across the State. The number of infringement warnings (72) was significantly lower than in previous years, however infringement notices issued (180) increased. No prosecutions were instigated. This was achieved from a total of 11,810 recreational fishing field contacts, which reflects the increased importance placed on recreational fishing and marine parks in general across the Gascoyne. Recreational fisher contacts were approximately 20% higher than in 2009/10.

Three Recreational Fishing Mobile Patrols from outside the region were again active in the Gascoyne in 2010/11. "Mobile 1" provides a dedicated mobile recreational fishing patrol using specialized remote-area-equipped vehicles and surveillance equipment. "Mobile 1" patrols operated mainly in the Denham and Carnarvon Districts, working in a coordinated approach with District Officers to provide greater coverage and improved compliance outcomes. The focus for this unit was again on education and enforcing management arrangements for Shark Bay Inner Gulf pink snapper and the Gnarrloo Bay area. Two Mobile Patrols from the Metro Region patrolled the Gascoyne Region increasing the effective contact rate at the peak of the season.

Initiatives in 2011/12

For the 2011/12-year a number of initiatives across the Gascoyne Bioregion have been planned. These include: -

- Address the management and compliance aspects associated with the Shark Bay Crab Fishery;
- Continue to focus on a more Intelligence based and Tactical approach to compliance delivery, especially in marine parks and recreational fishing;
- Improve the level of FMOs investigation and prosecution skills and experience;
- Increase effort in terms of education and enforcement in the Onslow and Eastern Exmouth Gulf area;
- Improve recruitment and retention practises to attract and retain staff in the Gascoyne;
- Complete construction of new Denham Fisheries and DEC building.

GASCOYNE COAST COMPLIANCE TABLE 1

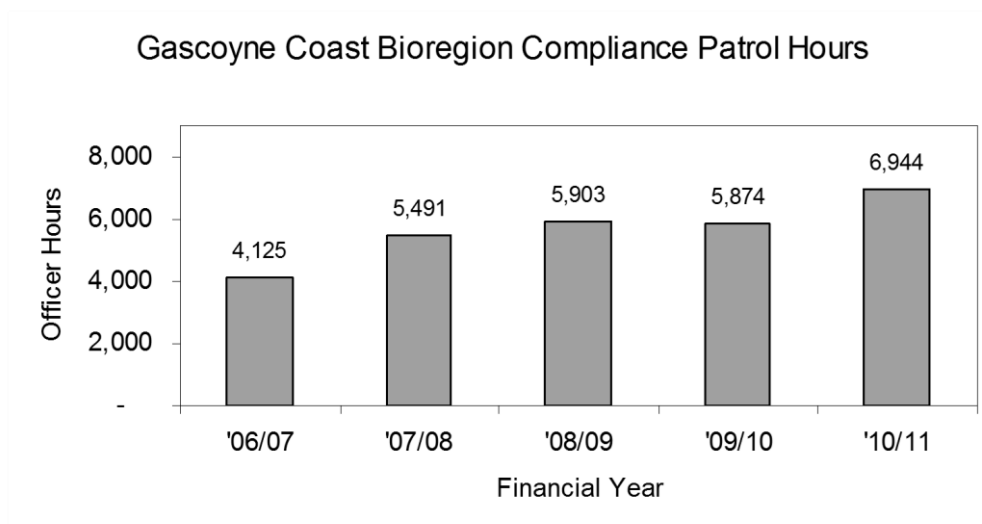
Summary of compliance and educative contacts and detected offences within the Gascoyne coast bioregion during the 2010/11 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	6,944 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	206
Infringement warnings	8
Infringement notices	5
Prosecutions	4
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	11,810
Infringement warnings	72
Infringement notices	180
Prosecutions	0
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field Contacts by Fisheries & Marine Officers	529
Fishwatch reports**	6
VMS (Vessel Days)****	7,829

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

**This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors.

**** VMS (Vessel Days) represents the number of vessel days recorded in this bioregion. That is, a count for each day that each vessel was polled within the bioregion.

**GASCOYNE COAST COMPLIANCE FIGURE 1**

“On Patrol” Officer Hours showing the level of compliance patrol activity delivered to the Gascoyne coast bioregion over the previous 5 years. The 10/11 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. (The totals exclude time spent on other compliance related tasks e.g. travel time between patrol areas, preparation and planning time etc.).

NORTH COAST BIOREGION

ABOUT THE BIOREGION

The oceanography of the North Coast bioregion includes waters of Pacific origin that enter through the Indonesian archipelago bringing warm, low salinity waters polewards via the Indonesian Throughflow and Holloway Current which flow seasonally and interact with Indian Ocean waters. The Integrated Marine and Coastal Regionalisation for Australia (IMCRA V 4.0) scheme divides this bioregion into 8 meso-scale regions: Pilbara inshore, Pilbara offshore, North West Shelf, Eighty Mile Beach, Canning, King Sound, Oceanic Shoals and Kimberley.

Ocean temperatures range between 22°C and 33°C, with localised higher temperatures in coastal waters, particularly along the Pilbara coastline. Fish stocks in the North Coast bioregion are entirely tropical, with most having an Indo-Pacific distribution extending eastward through Indonesia to the Indian subcontinent and Arabian Gulf regions.

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

Significant river run-off and associated coastal productivity can be associated with cyclone events, with run-off ceasing during winter. The entire north coastal region is subject to very high evaporation rates (3 metres per year), although the Pilbara coastline is more arid than the Kimberley, due to its lower cyclone frequency.

The second significant influence on coastal waters is the extreme tidal regime, related to the wide continental shelf. Spring tides range from up to 11 metres along the Kimberley section of the coast down to around 2 metres in the west Pilbara.

As a result of these factors, the generally tropical low-nutrient offshore waters can, in the few locations with rivers, be significantly influenced by rainfall run-off and tidal mixing to generate varying water quality in different sections of the North Coast Bioregion. Along the Kimberley coastline, waters are turbid and relatively productive, while the Pilbara coast with its lower run-off and lesser tidal influence has the clear waters more typical of the tropics.

The coastal geography of the various sections of the coastline also differs. The Kimberley coast is highly indented, with bays and estuaries backed by a hinterland of high relief. Broad tidal mudflats and soft sediments with fringing mangroves are typical of this area. The eastern Pilbara coast is more exposed than the Kimberley, with few islands and extensive inter-tidal 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. Near-shore 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.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

One of the principal commercial fisheries in the North Coast bioregion focuses on tropical finfish, particularly the high-value emperors, snappers and cods that are taken by the Pilbara Fish Trawl Fishery and the Pilbara and Northern Demersal trap fisheries. The typical catch is in the order of 3,000 t annually, making these fisheries, at an estimated annual value of around \$12 million, the most valuable finfish sector in the state.

Another significant commercial fishery in this bioregion is based on the collection of pearl oysters (*Pinctada maxima*) for use in the aquaculture production of pearls (see below). These are collected from the fishing grounds primarily off the Eighty Mile Beach, with smaller catches being taken around the Lacepede Islands (north of Broome).

The North Coast Bioregion also has a number of small, limited-entry trawl fisheries for prawns, producing about 700 t annually, valued at around \$10 million.

A number of other finfish fisheries operated in the region including surface trolling for Spanish mackerel, demersal line fishing, near-shore beach seining and gillnetting for barramundi/threadfin salmon and shark.

Recreational fishing is experiencing significant growth in the North Coast Bioregion, with a distinct seasonal peak in winter when the local population is swollen by significant numbers of metropolitan and inter-state tourists travelling through the area and visiting, in particular, the Onslow, Dampier Archipelago and Broome sections of the coastline. This has been added to by the increased recreational fishing by those involved in the construction or operation of major developments in this region. Owing to the high tidal range, much of the angling activity is boat-based, with beach fishing limited to periods of flood tides and high water.

The numerous creek systems, mangroves and rivers, and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reef systems and continental shelf waters provide species of major recreational interest including saddletail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish.

Aquaculture development in the north coast bioregion is dominated by the production of pearls from the species *P. maxima*. 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 King Sound. Pearl farm sites are located mainly along the Kimberley coast, particularly in the Buccaneer Archipelago, in Roebuck Bay and at the Montebello Islands.

Developing marine aquaculture initiatives in this region include growing trochus and barramundi. A focus of

NORTH COAST BIOREGION

aquaculture development is provided by the Department of Fisheries' Broome Tropical Aquaculture Park, which houses a commercial pearl oyster hatchery, an indigenous-owned multi-species hatchery and the Kimberley Training Institute aquaculture training facility.

ECOSYSTEM MANAGEMENT

Extensive fisheries closures in coastal and most offshore waters have been introduced to manage finfish trawling by Australian vessels (North Coast Ecosystem Management Figure 1). However, trawling is still permitted in a number of locations (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 Commonwealth Government 'Guidelines for the Ecologically Sustainable Management of Fisheries' under the Environment Protection and Biodiversity Conservation Act 1999. The extent of these areas means that 41% of the entire shelf region of the North Coast Bioregion could be classified as a marine protected area with an IUCN category of IV (as per Dudley, 2008¹; North Coast Ecosystem Management Table 1).

In addition to these habitat related marine protected area closures, the bioregion has a number of other marine protected areas including the Montebello and Barrow Islands and the Rowley Shoals 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, Peron Peninsula and the wreck of the Kunmunya Samson II (Delambre Reef) (see North Coast Ecosystem Management Figure 2). The proposed Dampier Archipelago marine conservation reserves are still under consideration by Government.

The Department of Fisheries has also participated in the marine conservation reserve planning process in this region. This has resulted in the recent establishment of the Camden Sound Marine Park. The Department has recently received funding to establish baseline and ongoing monitoring and research to underpin ecosystem management of this area. There is considerable interest in developing further marine protected areas within the Kimberley region, and the State Government has announced funding of a further marine protected area at Eighty Mile Beach. The Department continues to work closely with relevant agencies and stakeholders to develop strategies to minimize environmental effects in the marine environment including the Kimberley Science and Conservation Strategy with DEC.

The Commonwealth Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) has also undertaken a Marine Bioregional Planning process for Commonwealth waters between Shark Bay and the Northern Territory border. The federal minister for the environment has recently announced

the final reserve network proposed for the north-west which spans the North Coast and Gascoyne bioregions.

Marine habitats within the North Coast Bioregion of Western Australia are experiencing increasing pressure through a range of activities but most notably as a result of increased resource development activity that is occurring in the area.

The Department continues to engage with the Environmental Protection Authority through the environmental impact assessment process by providing advice on individual development proposals, which if implemented, have the potential to have an adverse impact on the marine environment. These include new (and upgraded) port developments in the Pilbara region, as well as offshore and nearshore oil and gas extraction projects in the Kimberley and Pilbara region. Major developments recently assessed for which the Department has played a key role include the Gorgon Gas Development at Barrow Island, and the proposed Kimberley LNG processing site.

The increase in international shipping movement and dredging activity associated with resource development in the Northern region is considered to present a high risk to the marine environment because of the potential for the introduction of non-indigenous marine organisms (including animals, plants, pathogens and diseases) into WA's coastal environment.

The recent Montara oil spill that occurred in this region highlights the potential risks to this area from oil and gas production. The outcome of this incident on fishery resources and assets may not be known for some time.

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets using the EBFM framework

Under the Integrated Marine and Coastal Regionalisation for Australia scheme, the bioregion has been divided into the bioregion has been divided into 8 meso-scale regions: Pilbara inshore, Pilbara offshore, North West Shelf, Eighty Mile Beach, Canning, King Sound, Oceanic Shoals and Kimberley Gulf (IMCRA, V 4.0, 2006). While this sub-regional 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), in the North Coast these meso-scales have been combined into two marine based ecosystems Pilbara (Pilbara and NW Shelf, eighty Mile Beach), Kimberley (Canning, Kimberley) and a Nearshore/estuarine ecosystem.

In terms of ecological assets, the Department has recognised the following ecological values for the IMCRA regions within the North Coast Bioregion:

- Ecosystem structure and biodiversity;
- Captured fish species
- Protected species (direct impact – capture or interaction);
- Benthic habitats; and
- External impacts.

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

For some issues a finer level of division of the IMCRA ecosystems is used by the Department. This relates to recent management initiatives necessary to recognise different suites of exploited fish and invertebrates across the continental shelf. These sub-components are defined by depth contours (Nearshore 0-20m; Inshore 20-250m; Offshore >250m; Pelagic). The full set of ecological assets identified for assessment and in some cases ongoing monitoring are presented in North Coast Ecosystem Management Figure 3.

Risk Assessment of Bioregional Level Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined in North Coast Ecosystem Management Figure 3 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (North Coast Ecosystem Management Table 2) provides an overview and cumulative assessment of the current risks to the ecological assets of the North Coast Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department's Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

Summary of Monitoring and Assessment of Ecosystem Assets

The Department of Fisheries continues to provide advice to the Environmental Protection Authority on development proposals, which, if implemented, have the potential to impact on the aquatic environment. The Department is working closely with the Commonwealth Government and other jurisdictions to develop and implement the National System for the Prevention and Management of Marine Pest Incursions that will minimise the biosecurity risks associated with increased shipping in the Pilbara and Kimberley regions. Within WA, this will be achieved through the Fish Resources

Management Act 1994 and the Biosecurity and Agriculture Management Act 2007. Associated regulations and subsidiary legislation are currently being developed.

The Department of Fisheries' Research Division's Biodiversity and Biosecurity Branch has recently completed a pilot project aimed at establishing resource condition monitoring protocols for the Pilbara and Kimberley. The project focussed on an extensive survey of the research literature relating to the coastal and marine environments in the Pilbara and Kimberley. The review of the literature has highlighted those areas of research that are lacking from the region. These knowledge gaps ranged in scope from fine scale life history trait studies of particular species; to large-scale oceanographic studies to identify major ocean current dynamics, and oceanic primary production from plankton.

The vast and remote coastline of the region dictates that remote sensing (satellite imagery and aerial photography) will be the primary tool for resource condition monitoring. The project concentrated on developing remote sensing as a monitoring tool, and developing a suite of resource condition indicators that accurately portray the health of the numerous marine and coastal environments, and set bench marks for which to assess environmental change, within the Pilbara and Kimberley.

The Department has been provided with funds for an ongoing monitoring program in the Camden Sound Marine Park. Further initiatives are being developed as part of the broader Kimberly Science and Conservation strategy.

The Biodiversity and Biosecurity branch have implemented a series of biosecurity related projects during 2011 – 2012. All projects aim to detect the presence of introduced marine pests (IMPs) using a suite of tools including ongoing background monitoring and large-scale port monitoring. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. Two large-scale, nationally approved, surveys have been implemented for the Ports of Dampier and Port Hedland that have informed the Department of the status of IMPs in those Ports. Background monitoring programs are also continuing within Dampier and Port Hedland Ports waters with assistance from the Dampier Port Authority and Port Hedland Port Authority. Further detail may be found in the Introduced Pests Status Report at the end of this chapter. This work complements introduced aquatic organism incursion and fish kill incident response programs already in place in this bioregion.

NORTH COAST ECOSYSTEM MANAGEMENT TABLE 1

The areas and proportions of the North Coast Bioregion making up State Waters and continental shelf waters where habitats are protected from the physical disturbance of trawl fishing. The areas, 200 m depth which are formally closed to trawling would be equivalent to meet category IV of the IUCN criteria for classification as marine protected areas. The area effectively protected covers those areas of the shelf < 200 m depth where state managed trawling doesn't occur.

Total Area of Shelf	Area of shelf equivalent to IUCN marine protected area category IV (%)	Maximum area of actual trawling activity	Total area of habitat effectively protected (%)
98600 sq nm	40700 sq nm (41%)	10500 sq nm	88100 sq nm (89%)

NORTH COAST ECOSYSTEM MANAGEMENT TABLE 2
RISK LEVELS FOR EACH NORTH COAST ASSET.

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level (bioregional) components. Negligible, Low and Moderate values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by '(non-fishing)', this indicates that all, or the majority of the risk value, was not generated by fishing activities but by some external factor including those activities which are managed by other government agencies (State or Federal).

Ecosystem Structure and Biodiversity

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Nearshore/ Estuarine	Marine	LOW (non fishing)	With the onshore developments that are proposed in this area, while some specific areas may be locally impacted, these still only pose a low risk to the overall nearshore/estuarine ecosystem of this bioregion.
Pilbara	Marine	LOW	Given the large areas closed to both trawling and to all commercial fishing, there is only a low risk that the level of fishing in this region is changing the community structure at a regional level to an unacceptable level. A recent study by Hall and Wise (2011) ¹ found no change in community structure of commercially captured finfish over the past 30 years consistent with a significant trophic impact. A proposal to further examine recovery of this area from the impacts of Taiwanese fishing that occurred in the 1980s is currently under development.
Kimberley	Marine	LOW (non fishing)	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 negligible risk that the ecosystem will be altered measurably. A recent study by Hall and Wise (2011) ¹ found no change in community structure of commercially captured finfish over the past 30 years consistent with a significant trophic impact. A significant level of planning has been undertaken to study this region as part of the Kimberley Science Plan.

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.

Captured fish species

Fish species	Aquatic zone	Risk	Status and Current Activities
Finfish	Nearshore/ Estuarine	MODERATE	The barramundi and threadfin salmon stocks are considered to be at acceptable levels.
	Shelf demersal	MODERATE	The current status of demersal finfish stocks captured by the Pilbara trawl fishery requires a review. A research survey is underway to assist determine if the recent low catch rates are due to changes to trawl gear or to localized depletion.
	Pelagic	MODERATE	The Spanish mackerel stock in this region is at acceptable levels and there are few other pelagic fish that are impacted.
Crustaceans	Nearshore/ Estuarine	LOW	There is a small amount of fishing for mud crabs and blue swimmer crabs in some estuarine and inshore areas.
	Shelf	MODERATE	There are a number of separate prawn stocks and fisheries within this bioregion that each have 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	Pearls	LOW	The pearl oyster fishery only targets a very small section of the stock both spatially and the available size range. Recent catches have been well below the quota levels due to low market demand but are beginning to increase again,

Protected species

Protected fish species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Non fish	NEGLECTIBLE	Crocodiles are occasionally captured in nets but are released alive. Sea snakes and occasionally turtles are encountered in the trawl catches and both of these species are typically returned to the sea alive. Grids are now compulsory, which has largely eliminated the capture of any turtle or other large animal. The number of turtles captured now is very low and most of these are returned alive. Turtle captures and their status at release are monitored and reported.
	Mammals	MODERATE	Dolphins are captured by the Pilbara trawl fishery, but dolphin excluder devices have reduced this incidence to acceptable levels with further refinements in net design currently being trialled.
Protected 'Fish' Species	Fish	LOW	The sawfish (Pristidae), spartooth shark (Glyphis glyphis) or the northern river shark (Glyphis garricki), are captured in small numbers by net fishing in small regions of the Kimberley region.

Benthic habitat

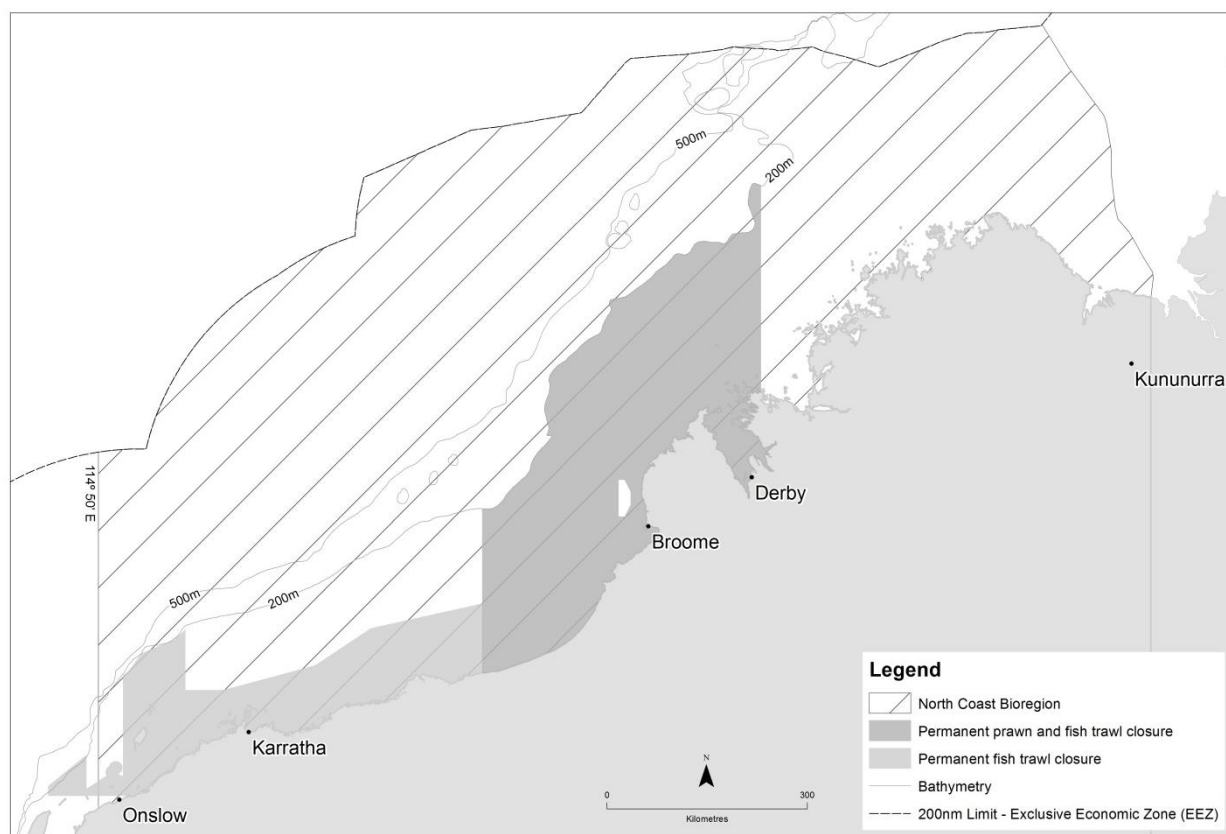
Benthic Habitat	Category	Risk	Status and Current Activities
Estuaries/ Nearshore		LOW (non Fishing)	The main risks to nearshore habitats come from oil and gas developments.

NORTH COAST BIOREGION

Benthic Habitat	Category	Risk	Status and Current Activities
Pilbara		MODERATE	This bioregion has fish trawling but this activity is tightly constrained. The large area permanently closed to trawling and the relatively small area where trawling actually occurs indicates that the habitat in this region is appropriately managed.
Kimberley		LOW (Non Fishing)	Except for some small areas where prawn trawlers operate for short periods each year, most of this region is closed to trawling. These activities may be examined as part of the proposed Camden Sound marine park. The most likely potential impacts to the habitat in this area are from oil and gas infrastructure and operations.

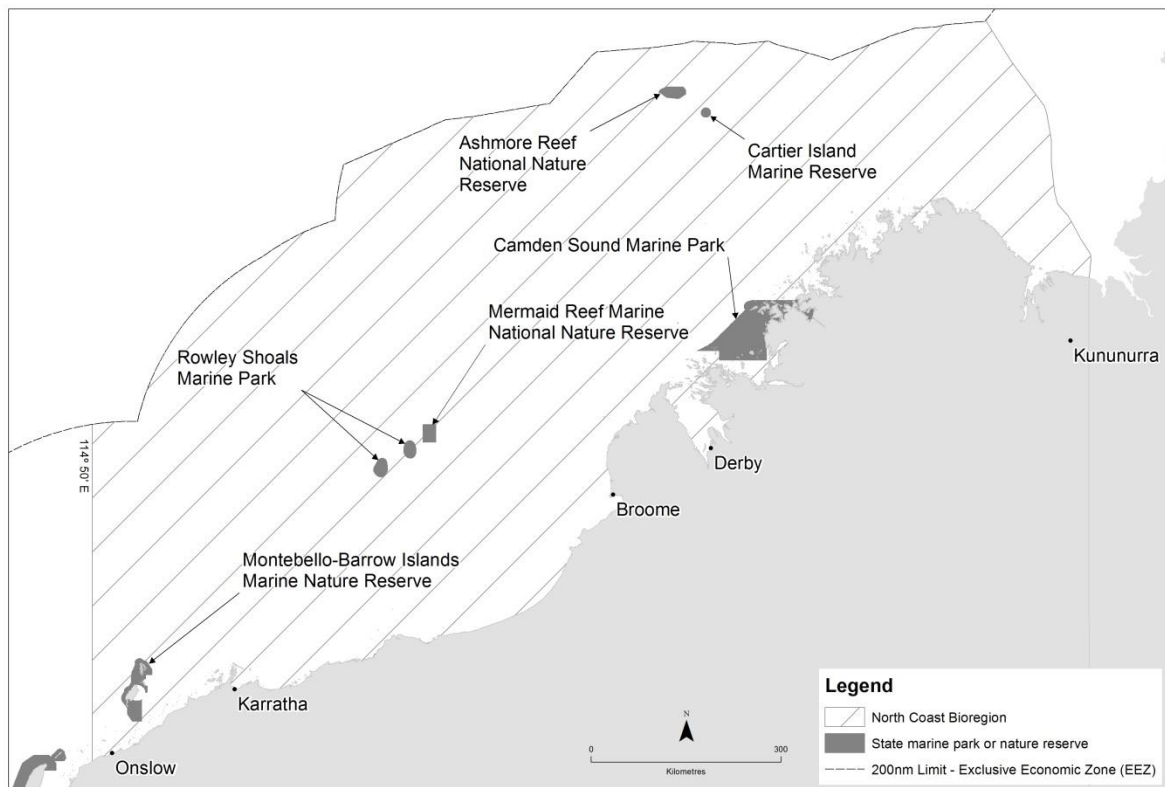
External Drivers (NON FISHING)

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	HIGH	The extremely high level of international shipping that operates in this region poses a high risk that an introduced pest may be introduced. The department has implemented a targeted IMP monitoring and inspection program. The extent and findings of monitoring activities in this bioregion are detailed in the Introduced Pests Status Report at the end of this chapter.
Climate	LOW	This area is predicted to have relatively minor impacts from climate change, especially in the coming decade compared to more southerly locations. Projects to examine potential impacts are planned.



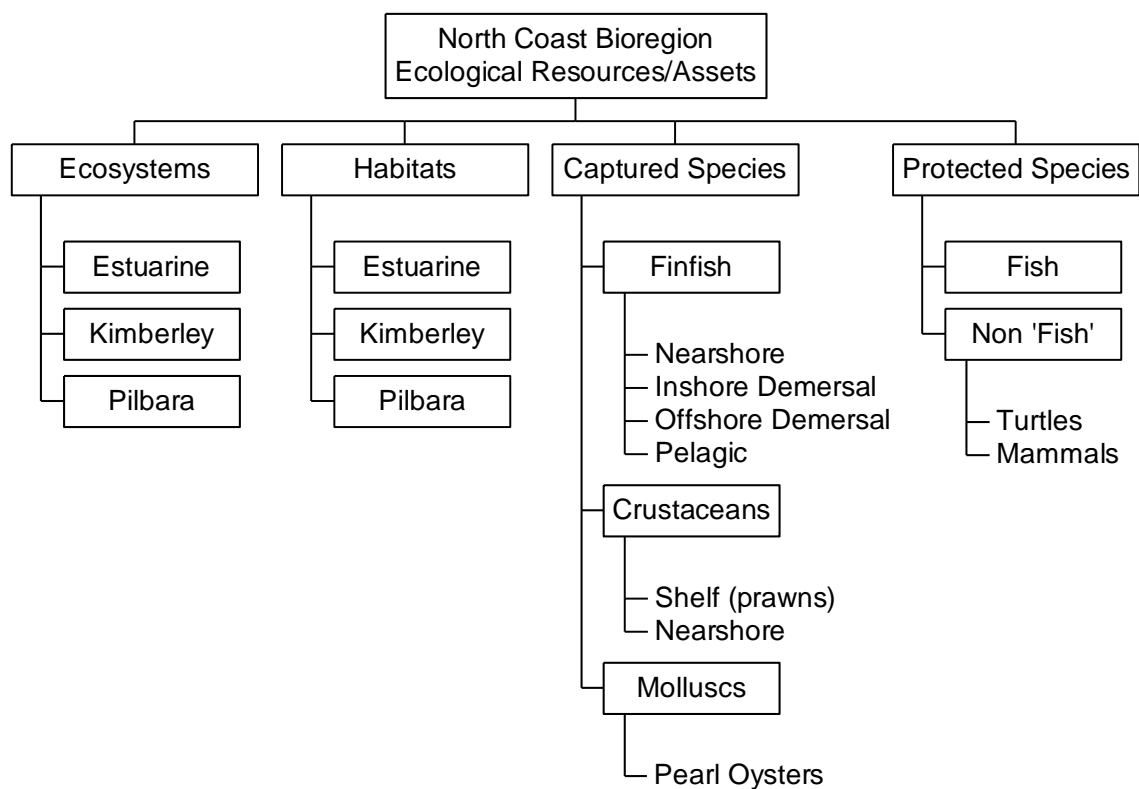
NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 1

Map showing areas permanently closed to trawling by WA state managed fisheries in the North Coast bioregion.



NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 2

Map showing current areas of protected fish habitat in the North Coast bioregion.



NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 3

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

INTRODUCED PESTS STATUS REPORT

Regional Monitoring and Research Update

The introduction and spread of marine pests in WA waters poses a serious threat to native biodiversity and can have widespread effects on both our economy and health. To this end the Marine Biosecurity Research group are actively involved in developing and implementing targeted marine pest monitoring and research programs in two ports in the North Coast bioregion. The aim is to detect the presence of introduced marine pests (IMPs) using a suite of tools. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. The Marine Biosecurity Research group previously completed large-scale marine pest monitoring programs in Dampier and Port Hedland ports in early 2011. These biennial programs adhered to the Australian Marine Pest Monitoring Guidelines and have been endorsed by the Commonwealth. In recognition of the risks IMPs pose to WA ports DoF have

developed complementary monitoring to occur every alternate year to National monitoring. These surveys are scheduled for mid 2012. This supplementary monitoring is a smaller more focussed version of the national approach designed to target select high risk sites in each port between the larger surveillance trips.

In addition the Marine Biosecurity Research group, with financial and *in-kind* assistance from Dampier and Port Hedland Port Authorities and stakeholders, are using *in-situ* sampling arrays to aid in the early detection of marine pests in both ports.

Through this combined surveillance the species that have been detected in this region are reported in Introduced Pests Table 1.

INTRODUCED PESTS TABLE 1

Introduced marine species detected in this bioregion.

Common name	Scientific name	Type of organism	IMS/IMP listing
	<i>Theora fragilis</i>	Mollusc	Introduced species
	<i>Didemnum perlucidum</i>	Ascidian	Introduced species – likely pest

FISHERIES

North Coast Prawn Managed Fisheries Status Report

E. Sporer, M. Kangas, M Shanks and L Pickles.

Main Features

Status		Current Landings	
Stock level	Adequate	Onslow:	16 t
		Nickol Bay:	178 t
Fishing level	Acceptable	Broome:	5 t
		Kimberley:	155 t

Fishery Description

There are four prawn fisheries that operate in the north coast bioregion, all using otter trawls. These fisheries extend northward from the north eastern boundary of the Exmouth Gulf Prawn Fishery to 126° 58' east longitude (Cape Londonderry – boundary of the Northern Prawn Fishery).

The Onslow (OPMF) and Nickol Bay (NBPMF) Prawn Managed Fisheries operate along the western part of the North-West Shelf. The OPMF targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) whereas the NBPMF primarily targets banana prawns (*Penaeus merguensis*).

The Broome Prawn Managed Fishery (BPMF) operates in a designated trawl zone off Broome and targets western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species).

The Kimberley Prawn Managed Fishery (KPMF) operates off the north of the state between Koolan Island and Cape Londonderry. It predominantly targets banana prawns (*Penaeus merguensis*) but also catches tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and western king prawns (*Penaeus latisulcatus*).

Governing legislation/fishing authority

Onslow Prawn Fishery Management Plan 1991

Onslow Prawn Managed Fishery Licence

Nickol Bay Prawn Fishery Management Plan 1991

Nickol Bay Prawn Managed Fishery Licence

Broome Prawn Managed Fishery Management Plan 1999

Broome Prawn Managed Fishery Licence

Kimberley Prawn Fishery Management Plan 1993

Kimberley Prawn Managed Fishery Licence

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

Consultation process

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

Boundaries

The boundaries of the OPMF are ‘*all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114°39.9' on the landward side of the 200 m depth isobath*’. The fishery is divided into three parts with associated size management fish grounds (SMFGs) and nursery areas as follows: Area 1, incorporating the Ashburton SMFG; Area 2, incorporating the Mangrove Island and Weld Island SMFGs and Coolgra Point Nursery; and Area 3, incorporating the Fortescue SMFG (Northern Prawn Figure 1).

The boundaries of the NBPMF are ‘*all the waters of the Indian Ocean and Nickol Bay between 116°45' east longitude and 120° east longitude on the landward side of the 200 m isobath*’. The NBPMF incorporates the Nickol Bay, Extended Nickol Bay, Depuch and De Grey SMFGs. (Northern Prawn Figure 2).

The boundaries of the BPMF are ‘*all Western Australian waters of the Indian Ocean lying east of 120° east longitude and west of 123°45' east longitude on the landward side of the 200 m isobath*’. The actual trawl area is contained within a delineated small area north west of Broome as shown in Northern Prawn Figure 3.

The boundaries of the KPMF are ‘*all Western Australian waters of the Indian Ocean lying east of 123°45' east longitude and west of 126°58' east longitude*’. It abuts the western boundary of the Commonwealth Northern Prawn Fishery (NPF). The KPF has four inshore closures and two SMFGs in place (Northern Prawn Figure 4).

NORTH COAST BIOREGION

Management arrangements

Management of all the north coast prawn fisheries is based on input controls including limited entry, seasonal and area closures, and gear controls including bycatch reduction devices. The Department's Vessel Monitoring System (VMS) monitors the activities of all boats. Fish Escape Devices are mandatory in all trawl nets.

OPMF: The management arrangements in the OPMF involve using a standardised net headrope allocation whereby each Managed Fishery Licence (MFL) has an equal allocation of net headrope length in each Area. However, there are different net sizes permitted between Areas. Area 1 boats are authorised to use two trawl nets each having a maximum headrope length of 10.98 metres (6 fathoms). These boats operate under an exemption to fish with larger size nets. In Areas 2 and 3 a maximum headrope length of 29.27 metres (16 fathoms) is permitted in either twin or quad gear configuration. Trawl net headrope amalgamation between MFLs has been permitted in the OPMF consistent with other trawl fisheries. The fleet is composed of trawlers up to 23 metres in length. Additionally, the fishery is exempt from the 375 boat unit rule.

Different licence classes apply to the OPMF, allowing boats to trawl in specific zones. These classes are listed below, with figures in brackets indicating number of licensed boats:

Class A	Areas 1, 2 and 3 (four MFLs)
Class B	Areas 2 and 3 (three MFLs)
Class C	Area 2 (11MFLs, that are also Exmouth Gulf Prawn MFLs)
Class D	Area 3 (12 MFLs that are also Nickol Bay prawn MFLs)

The approved season arrangements during 2011 for the various areas in the OPMF were as follows:

Areas 1, 2, 3	24 April – 12 October
Fortescue SMFG	25 May – 12 August
Ashburton SMFG	25 May – 15 July
Weld Island SFMG	25 May– 12 August
Mangrove Island SFMG	25 May –12th October

Moon closures were implemented this season on a voluntary basis. The moon closure period was three days around each full moon during the fishing season across all areas.

NBPMF: The management arrangements in the NBPMF provide for authorised boats to tow any combination of standard otter trawl nets provided that the total headrope length does not exceed 29.27 metres (16 fathoms). Each licence has an equal allocation of headrope length and the maximum total headrope length for the entire fleet is 409.78 metres (224 fathoms). The 2011 season opened on 17 March and closed on 1 November with subsidiary openings and closings of SMFG's. The specific SMFG openings were as follows:

Nickol Bay	22 May – 1 September
(Day fishing only 22 May – 5 June)	
Extended Nickol Bay SMFG	22May –1 November
Depuch SMFG	22May – 1September
(Day fishing only 20 May – 5 June)	

De Grey SMFG

22May – 1 November

BPMF: The BPMF management arrangements provide for the use of standard otter trawl nets not exceeding 73.16 metres (40 fathoms) in either twin or quad gear configuration. Each licence has an equal allocation and the maximum total headrope length for the entire fleet is 365.8 metres (200 fathoms).

The Fishery opened on 19 May and officially closed on 5 September, providing for 110 fishing nights. Only one boat entered the BPMF fishery during the season to assess if commercial fishing was viable and to inform the other operators of the abundance of king prawns available. The boat fished a limited time then left the fishery. The king prawn catch rates were considered relatively low and given the current economic conditions and high cost of fishing, other operators did not send boats to the Broome fishery to undertake commercial fishing in 2011.

KPMF: The KPMF Management Plan permits the use of two otter trawl nets where the total headrope length does not exceed 58.5metres (32 fathoms).

There are 124 boats licenced to fish in the KPMF and at 30 June 2011, 31 of these also held an NPF licence.

Seasonal dates for the KPMF are generally aligned with those of the adjacent NPF. This strategy aims to prevent large shifts of fishing effort into the KPMF. A total allowable effort cap system is in place that restricts the number of fishing days to a total of 1500 days, with 600 and 900 boat days allocated to the first and second part of the season respectively.

The 2011 season opened on 1 April with a mid-season closure commencing on 27 May. The fishery re-opened on 1 August, with a final season closure on 30 November. A comprehensive Ecologically Sustainable Development (ESD) assessment of these fisheries has been undertaken to identify any potential sustainability risks requiring direct management action. The only issue identified through this process related to the breeding stock levels of target species (e.g. banana, tiger and king prawns). Boxed text in this status report provides the annual assessment of performance for this issue. The SEWPaC (formerly DEWHA) completed the reassessment of the NBPMF, OPMF, KPFM and BPMF trawl fisheries and export approval has been granted until 20 August 2015 for all fisheries under the one approval.

Research summary

Research programs are focused to underpin the sustainable management of these small fisheries involving stock monitoring and assessment utilising information from daily logbooks and processor unloads. For the NBPMF and KPMF rainfall records are also used to update the rainfall-catch relationship for banana prawns. In the OPMF a field-based consultative process is normally undertaken whereby industry and the Departments' Research Division decide on the extent of an area to be fished within the areas that are officially opened, and to limit the fishing of small size prawns. For 2011 this did not occur because only one boat fished and the late opening date and market prices mitigated the risk of taking small size prawns. For the BPMF a depletion analysis is undertaken when sufficient fishing activity occurs which assists in the assessment of the king prawn stocks within the permitted fishing area. Due to insufficient effort in 2011 the depletion analysis could not be undertaken.

Retained Species

Commercial production (season 2011):

Onslow:	16 tonnes
Nickol Bay:	178 tonnes
Broome:	5 tonnes
Kimberley:	155 tonnes

Landings

OPMF: The total landings of major penaeids for the 2011 season were 16 t, comprising 1 t of king prawns, 14 t of tiger prawns, <1 t of endeavour prawns and <1 t of banana prawns. Tiger prawn landings in 2011 were low but within the target catch range and at the expected level given the low effort in this fishery. King and endeavour prawn landings were extremely low and below the target catch range (Northern Prawn Figure 5). Recorded landings of by-product species in the OPMF included <1 t of bugs (*Thenus australiensis* and *parindicus*) and <1 t of blue swimmer crabs (*Portunus amartus*). No other byproduct species landings were recorded this year.

NBPMF: The total landings of major penaeids for the 2011 season were 178 t comprised 174 t of banana prawns, 4 t of tiger prawns and less than 1 t of king and endeavour prawns combined (Northern Prawn Figure 6). The recorded landings of banana prawns in 2011 were below the projected catch range (205 to 310 t) but within the target catch range. Recorded byproduct landings for 2011 were extremely low with < 1 t of blue swimmer crabs (*Portunus amartus*), bugs (*Thenus australiensis* and *parindicus*) and squid combined the only species recorded.

BPMF: Recorded landings for target species were very low at 5 t for king prawns and <1 t of coral prawns. No byproduct species was recorded in 2011 (Northern Prawn Figure 7).

KPMF: The total recorded landings in the KPMF were 155 t, comprising 145 t of banana prawns, 7 t of tiger prawns and 3 t of endeavour prawns (Northern Prawn Figure 8). Banana prawn landings were below their target catch range (200-450 t) and the projected catch range (310 to 460 t) calculated using the relationship between summer rainfall and catches. Both tiger and endeavour prawns were slightly below their target catch ranges. Fishing occurred in both fishing periods for 2011 but effort was still low, possibly reducing total catches for these species. Negligible quantities of byproduct were reported.

Recreational component: Nil

Fishing effort/access level

OPMF: One boat fished in 2011 with a total of 60 boat days, a decrease compared to the 97 days recorded in 2010. This effort is extremely low compared to the days fished between 2000 and 2005 inclusive (mean of 726 days) and the second lowest effort ever recorded in this fishery. However, the actual fishing effort since 2007 is not directly comparable due to the amalgamation of headrope for the boat that fished. In Area 1, this boat was exempted to fish with larger nets using a total net headrope length of 18 fathoms (four 4.5-fathom nets) instead of the permitted 16 fathoms total net headrope length. This required the amalgamation of net

allocations from two boats, licensed to fish all areas, onto one boat, resulting in a reduction of net headrope length from 32 fathoms to 18 fathoms for fuel efficiency.

NBPMF: Five boats fished during the 2011 season for an aggregated total of 253 boat days. This is the highest effort recorded since 2006 reflecting the increased banana prawn abundance this season.

BPMF: Only fifteen nights of fishing effort was expended by one boat in this fishery in 2011.

KPMF: Ten boats operated in the fishery during 2011. The total number of days fished was 200 days well under the total days (1500) allocated to fish and the lowest since 1990 when effort estimates were first made.

Stock Assessment

Assessment complete: Yes

Assessment level and method: Level 1 - Catch
(Rainfall-catch relationship for NBPMF and KPMF for banana prawns,

Depletion analysis for BPMF - when appropriate)

Breeding stock levels: Adequate

Projected catch next season (2012):

NBPMF: 165 t banana prawns

KPMF: 260 t banana prawns

For the northern prawn fishery stocks, their short life cycle, high fecundity and dispersed nature prevent fishing from depleting breeding biomass to unacceptable levels. Historical catch levels from periods where it is known that recruitment was not affected by fishing effort have been used as the basis for calculating target catch ranges. These catch ranges are used as an indicator of breeding stock adequacy.

The low annual landings of prawns in general are still a feature in these northern fisheries and these low catches are in part due to low effort caused by the current economic conditions including, high fuel and equipment prices and low market prices and variable market conditions. Catches of banana prawns are highly variable and related to the amount of rainfall recorded in the region with consecutive high rainfall years providing the optimal conditions for banana prawn recruitment.

OPMF: The 2011 season tiger prawn landings (16 t) were lower compared to 2010. The effort in this fishery since 2006 inclusive has been very low with a maximum three boats fishing in any one year but in most of these years only one boat fished. The low overall landing for 2011 is mainly due to low effort. Most of the season's catch was taken from Area 1 where tiger prawns are mainly caught. Generally boats search in other areas of the fishery (Areas 2 and 3), however, because of the high catch rates of tiger prawns in Area 1 there was little incentive to search for prawns and byproduct in these other areas in the current economic environment. Although the landings were below the average landings (the mean reference landings range for 1987 to 1995 is 61 t) these tiger prawn catches were taken at efficient catch rates. The total catch of tiger prawns, taking into account the level of effort, indicates adequate breeding stock.

NORTH COAST BIOREGION

King prawn catch (1 t) remains low compared to the mean catch of 33 t for 1985 to 2009. Since the early 2000's, there has been a decline in king prawn abundance in this fishery and since 2006, the decline in effort may also be contributing to the low catches. There were extremely low landings of banana prawns this season. Generally there is a positive correlation between early seasonal rainfall and the catch of banana prawns. However, this generally requires a few consecutive years of rainfall to provide a stock build-up.

NBPMF: The landing of banana prawns (174 t) in 2011 is within the target catch range but below the predicted catch range. The tiger prawn landings were at the lower end of the target range, whereas, the king and endeavour prawns were below the target range.

The catch projection for banana prawns in Nickol Bay is based on the summer rainfall level between December and March (Northern Prawn Figure 9). The total rainfall between December 2011 and March 2012 (at Roebourne) was 258 mm and the predicted catch for 2012 is around 165 t with a range of 130–200 t of banana prawns.

BPMF: Very low fishing effort reflecting the low king prawn landings of 5 t, taken in this fishery during 2011 so no stock assessment was completed. The king prawn catch rates at 33 kg/hr were in line with historical catch rates in this fishery, however, because of high fishing costs it was not economically viable to continue fishing.

KPMF: Banana prawns were below the target catch range (200 to 450 t) and both tiger and endeavour prawns were below their target ranges. Effort levels were at historic low levels and the low tiger and endeavour prawn landings are likely to be effort related.

The relationship between the early season rainfall and catches of banana prawns (the dominant species taken in this area) is based on the rainfall in Kalumburu and Derby in January and February (451 mm). The predicted catch of banana prawns in 2012 is 260 t, with a range of 210 to 315 t. The 2011 catch was well below the expected catch given the high level of rainfall. This may be due to the reduced levels of fishing effort, which was the lowest recorded.

The main performance measures for the OPMF, NBPMF and KPMF relate to maintenance of breeding stocks for each of the major target prawn species. In 2011 the breeding stock indicators in the OPMF (catches within specified ranges, as set out in the 'Fishery Governance' section) for tiger prawns were met whereas king, banana and endeavour prawns were below the target catch range due to low effort. Environmental conditions i.e. summer rainfall was relatively high, however and it was not expected to benefit banana prawn production this year because the breeding stock was low the previous year, therefore, available prawn abundance was expected to be low.

The breeding stock indicator for banana and tiger prawns in the NBPMF was met and the landings were within the target catch range. Banana prawns were below the projected range. There were low recorded king prawn landings, therefore, they were below the target ranges. This is likely to be a result of limited targeting of this species this year.

An assessment of breeding stock could not be made for the BPMF due to very low fishing effort.

The breeding stock indicators in KPMF (catches within specified ranges) for banana, tiger and endeavour prawns were below the target range and the projected range for banana prawns. This may be due to record low levels of effort.

Non-Retained Species

Bycatch species impact:

Low

Bycatch from the northern prawn fisheries is typical of tropical trawl fisheries (i.e. from 2:1 up to about 5:1 relative to the target species), but the effort levels and spatial coverage are too low to impact bycatch species' populations. The introduction of fish escapement devices (FEDs) within all the nets towed by each vessel has reduced this risk even further. The NBPMF and KPMF fishery operates predominantly by specifically targeting schools of banana prawns. This targeting results in relatively low effort and minimal bycatch compared with other trawl fisheries. The impact on bycatch in the BPMF was negligible due to very low effort. All trawl nets have grids to exclude large fish and protected species.

Protected species interaction:

OPMF:

Low

NBPMF, BPMF, KPMF:

Negligible

The northern prawn fisheries have previously caught the occasional turtle and sea snakes and the overall low effort level and targeted coverage suggest that such interactions would not have been significant. Bycatch reduction devices ('grids') and FEDs are now fully implemented minimising the capture of large animals including turtles. No turtles or sea snakes were reported as caught in the OPMF in 2011. For the NBPMF six sea snakes were reported as caught but released alive and no turtle captures. For the KPMF there were no reported turtle captures but thirty sea snakes were reported of which 14 were released alive. One sawfish was reported as caught and released alive. For the BPMF two turtles were captured but returned to the sea alive whilst eighteen sea snakes were reported as dead.

Ecosystem Effects

Food chain effects:

Low

For all the northern prawn fisheries and in particular the OPMF and BPMF the limited spatial coverage of the fisheries and low levels of effort and catch, it is unlikely to have any significant ecological consequences. In addition for the NBPMF and the KPMF, the highly variable nature of banana prawn recruitment, positively related to cyclonic rainfall, any food chain impacts from fishing are likely to be minimal.

Habitat effects:**BPMF:** Negligible**OPMF, NBPMF, KPMF:** Low

In 2011 the area fished in all four fisheries was less than 1-3% of the overall fishery (Northern Prawn Figures 1-4). The fisheries are generally restricted to clean sand and mud bottoms, where trawling has minimal long-term physical impact.

Social Effects

Estimated employment in these fisheries for 2011 was 50 to 70 including skippers and other crew with additional people involved in local processing.

Economic Effects**Estimated annual value (to fishers) for 2011:****OPMF/NBPF/BPMF:****Level 2 - \$1 - 5 million (\$1.7 million)****KPMF:** **Level 2 - \$1 - 5 million (\$1.3 million)****Fishery Governance****OPMF Target catch range:** **60 – 180 tonnes****Current fishing level:** **Acceptable**

Under normal effort levels and previous environmental conditions, the target ranges of prawn catches, based on the catches of the 1990s, are as follows:

King prawns	10 – 55 t
Tiger prawns	10 – 120 t
Endeavour prawns	5 – 20 t
Banana prawns	2 – 90 t

NBPMF Target catch range: **90 – 300 tonnes****Current fishing level:** **Acceptable**

Banana prawns	40 – 220 t
King prawns	20 – 70 t
Tiger prawns	2 – 40 t

BPMF Target catch range: **55 – 260 tonnes****Current fishing level:** **Acceptable**

Under current effort levels and previous environmental conditions, the target ranges of prawn catches are as follows:

King prawns	35 – 170 t
Coral prawns	20 – 90 t

For king prawns the target range is based on the catches of the 1990s, while for coral prawns it is based on the seven-year range (1996 – 2002) since catches were first recorded.

KPMF Target catch range: **240 – 500 tonnes****Current fishing level:** **Acceptable**

Under current effort levels and previous environmental conditions, the target ranges of prawn catches, based on the catches of the 1990s, are as follows:

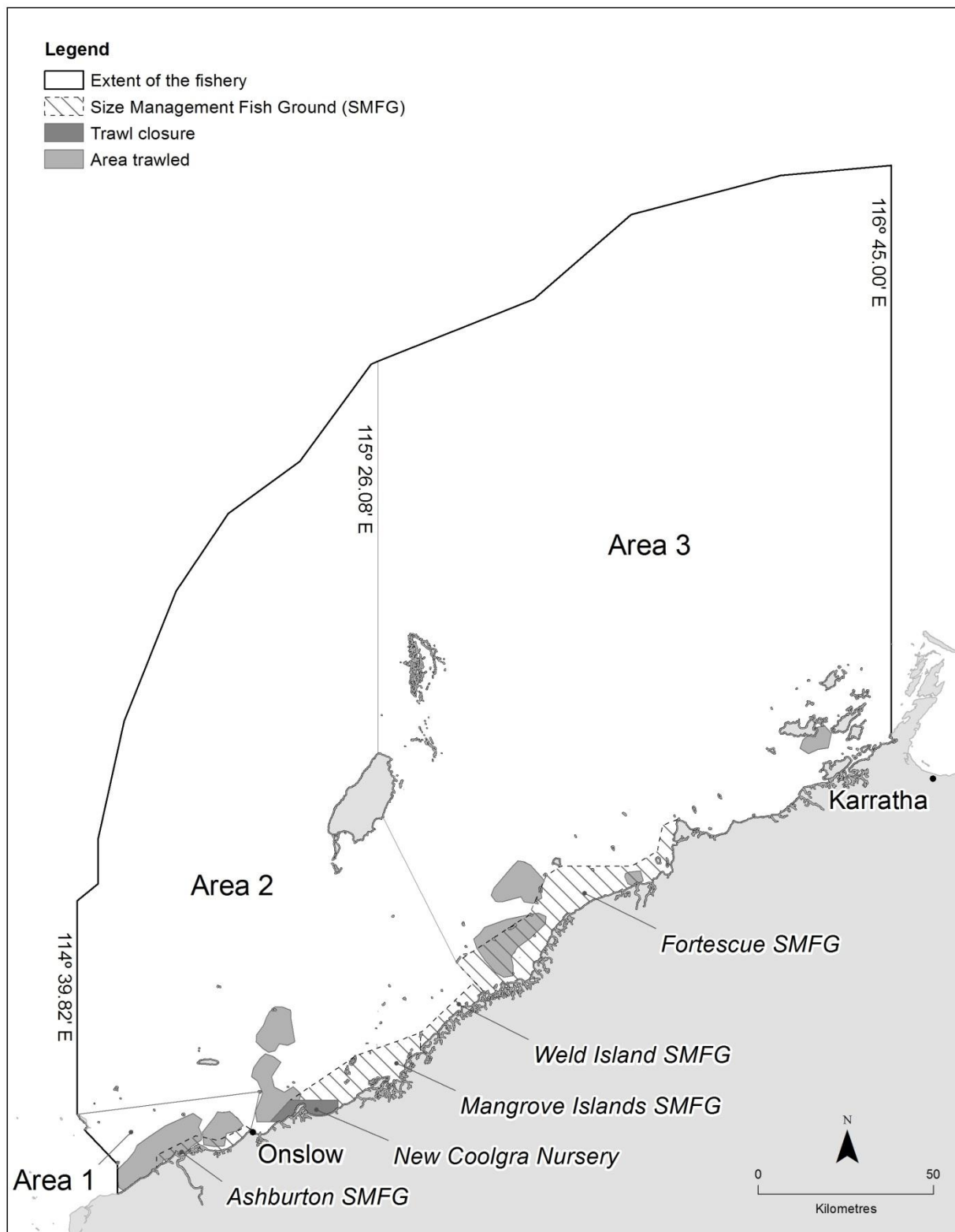
Banana prawns	200 – 450 t
Tiger prawns	15 – 60 t
Endeavour prawns	7 – 80 t

The overall target range for all species combined is different from the aggregate of the individual species ranges shown above. This is because the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species. Effort is now a considered a factor when reviewing target catch ranges in these northern fisheries.

New management initiatives (2012): **None****External Factors**

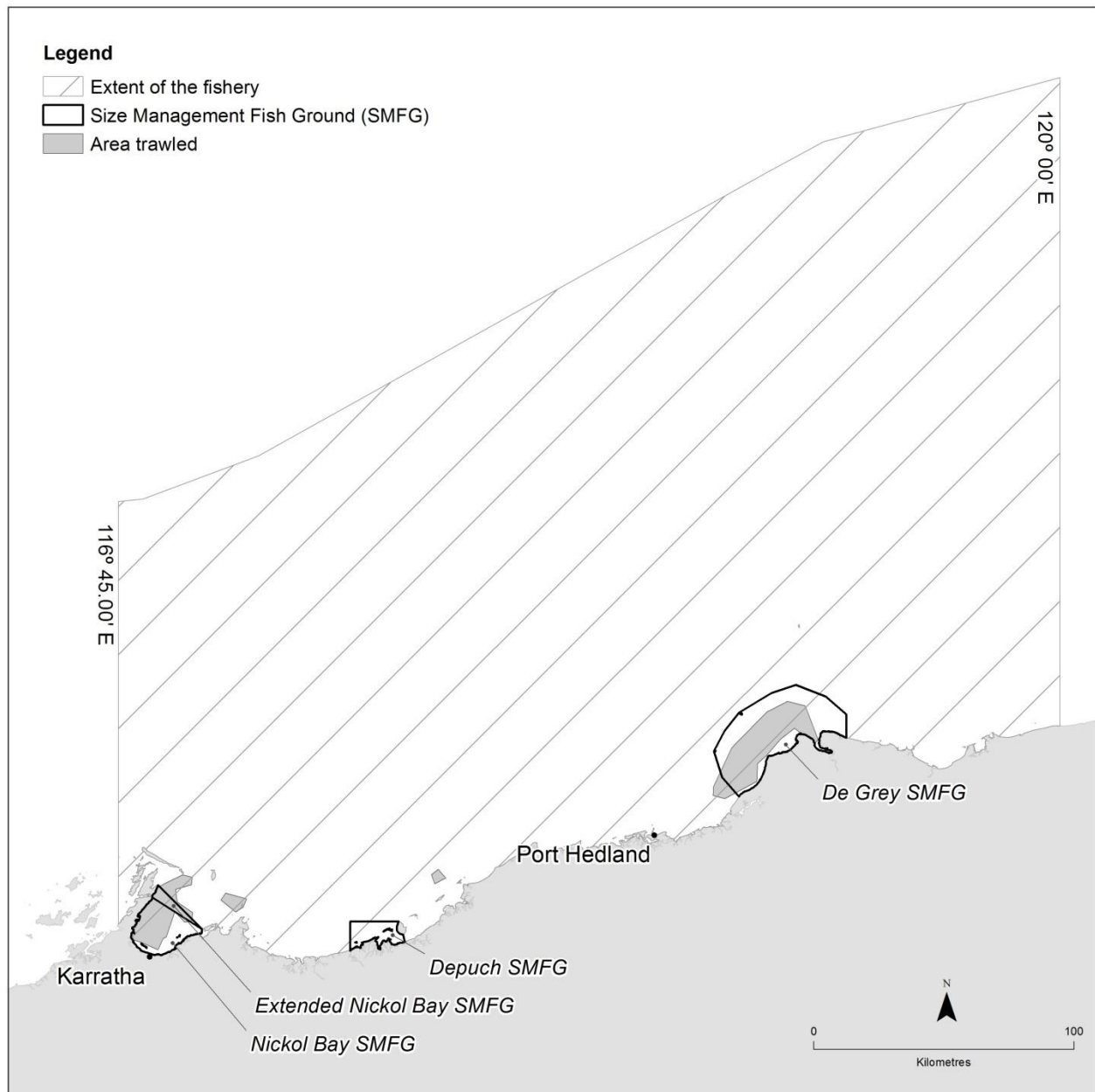
Banana prawns are rainfall dependent and can be highly variable annually in the KPMF, NBPMF and for the OPMF where banana prawns may be in some years be taken predominantly off the mouth of the Ashburton River. Due to high costs of fishing and low prawn prices, some boats in these fisheries are choosing not to fish in years of relatively low banana prawn catches. There is also competition for boat crew with the oil and gas resource sector.

In the BPMF one factor influencing catches is the timing of the season which is set by the mid-season closure for the Northern Prawn Fishery, and, since the permitted fishing area is small, in some years the timing of prawn recruitment and the prawn migration patterns may not result in significant abundances in the permitted fishing area. The success of this fishery also depends on how the limited fishing season coincides with the king prawn recruitment and catchability, which is strongly influenced by the lunar period.



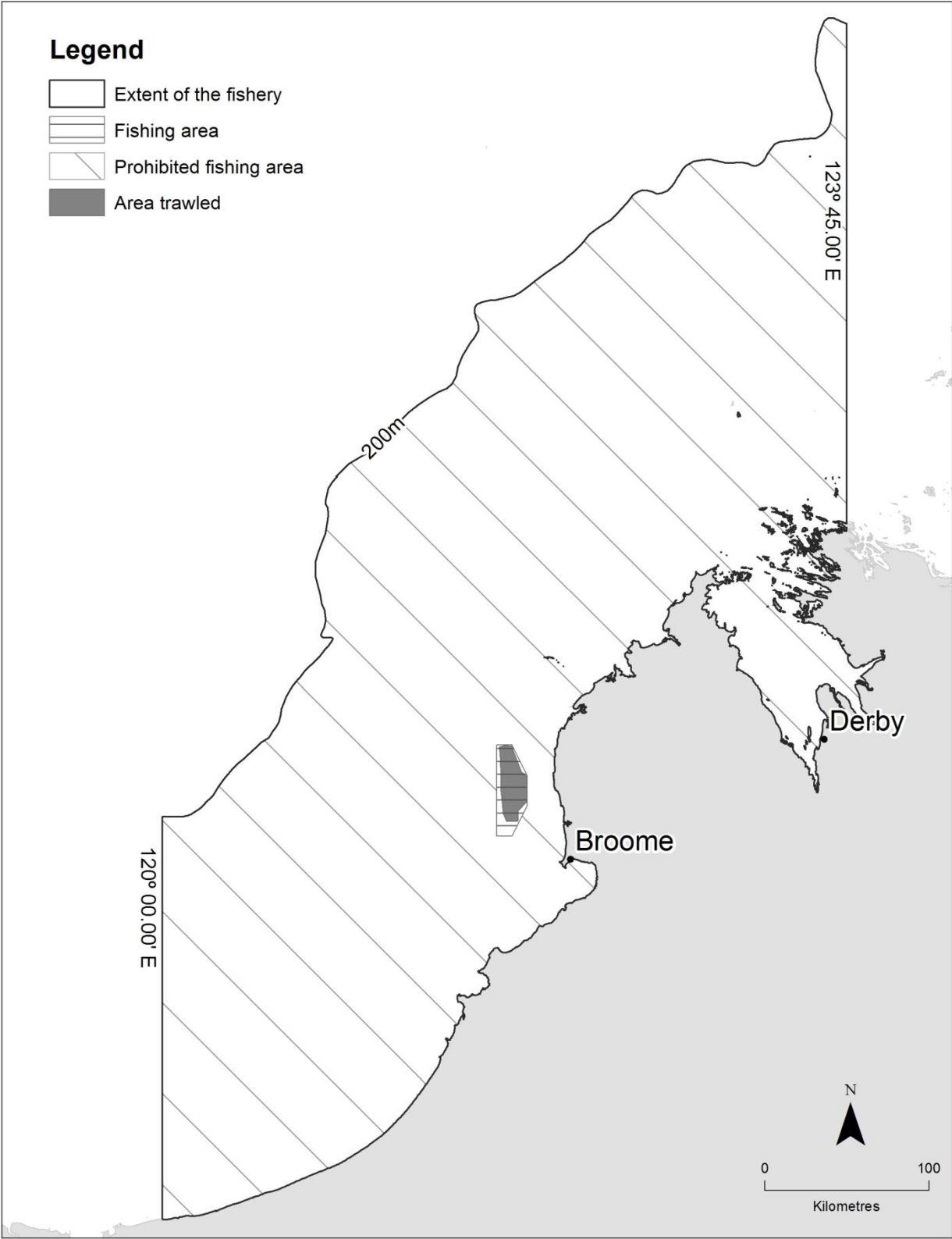
NORTHERN PRAWN FIGURE 1

Boundaries of the Onslow Prawn Managed Fishery indicating trawl closures and size management fish grounds and area trawled in 2011.



NORTHERN PRAWN FIGURE 2

Boundaries of the Nickol Bay Prawn Managed Fishery indicating nursery areas and size management fish grounds and areas trawled in 2011.



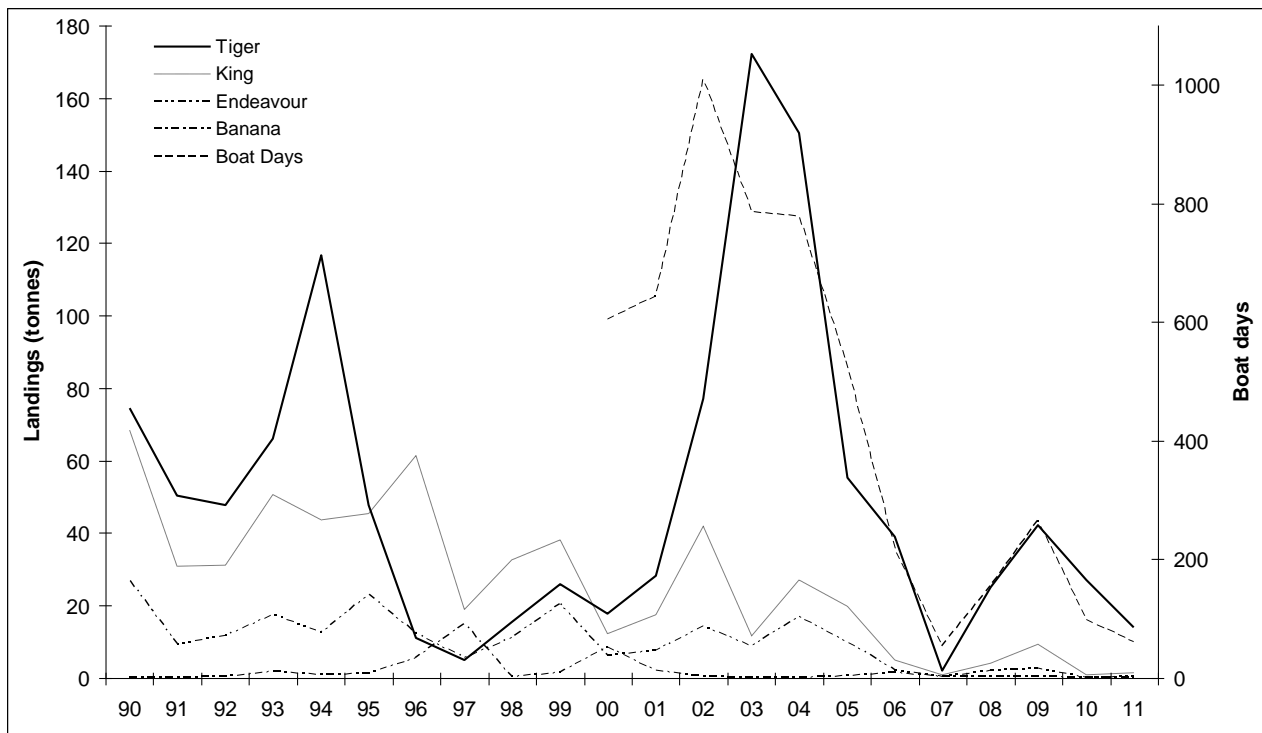
NORTHERN PRAWN FIGURE 3

Boundaries of the Broome Prawn Managed Fishery indicating area trawled in 2011.



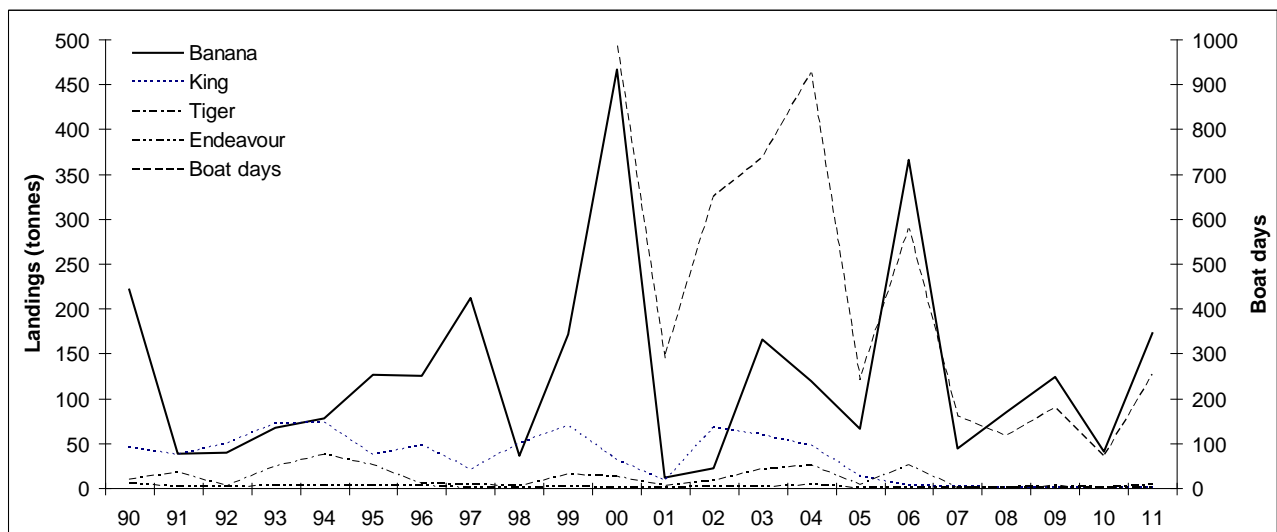
NORTHERN PRAWN FIGURE 4

Areas fished in the Kimberley Prawn Managed Fishery in 2011, Size Management Fish Grounds and the inshore trawl closures.



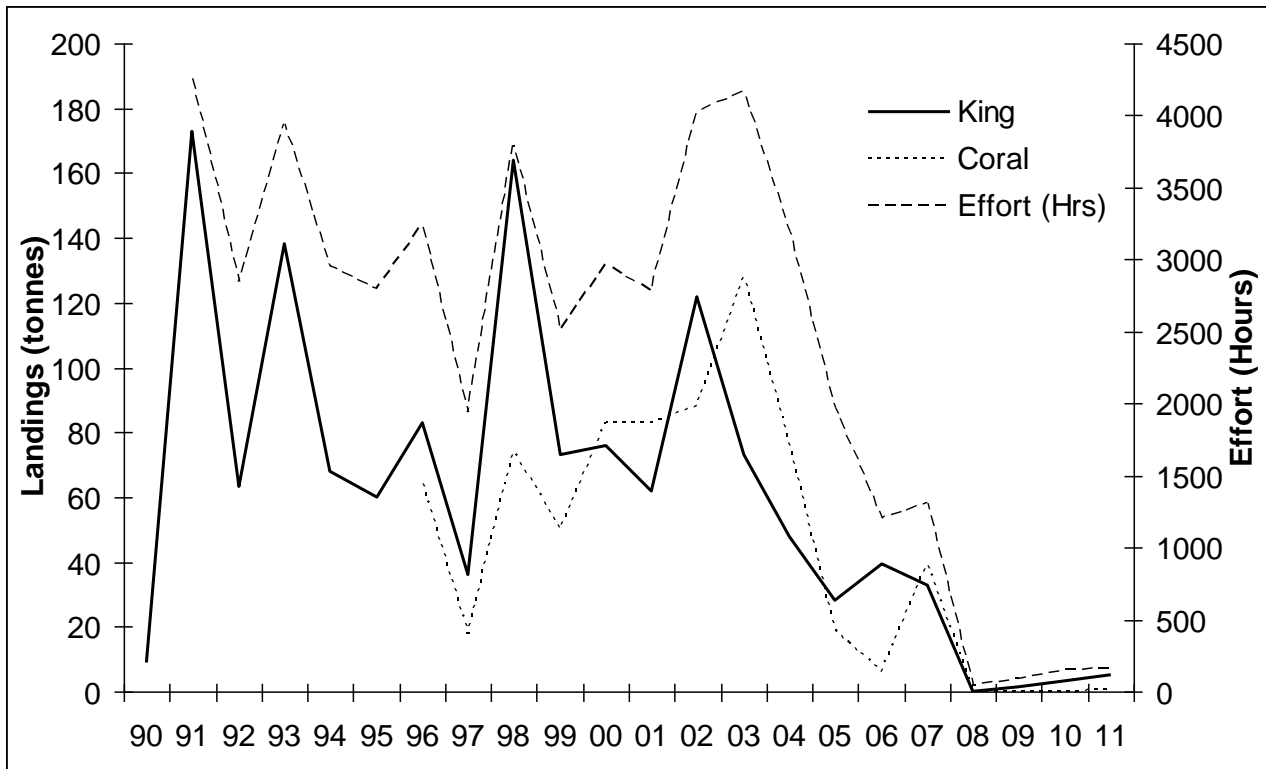
NORTHERN PRAWN FIGURE 5

Annual landings and number of boat days (from 2000) for the Onslow Prawn Managed Fishery, 1990 – 2011.

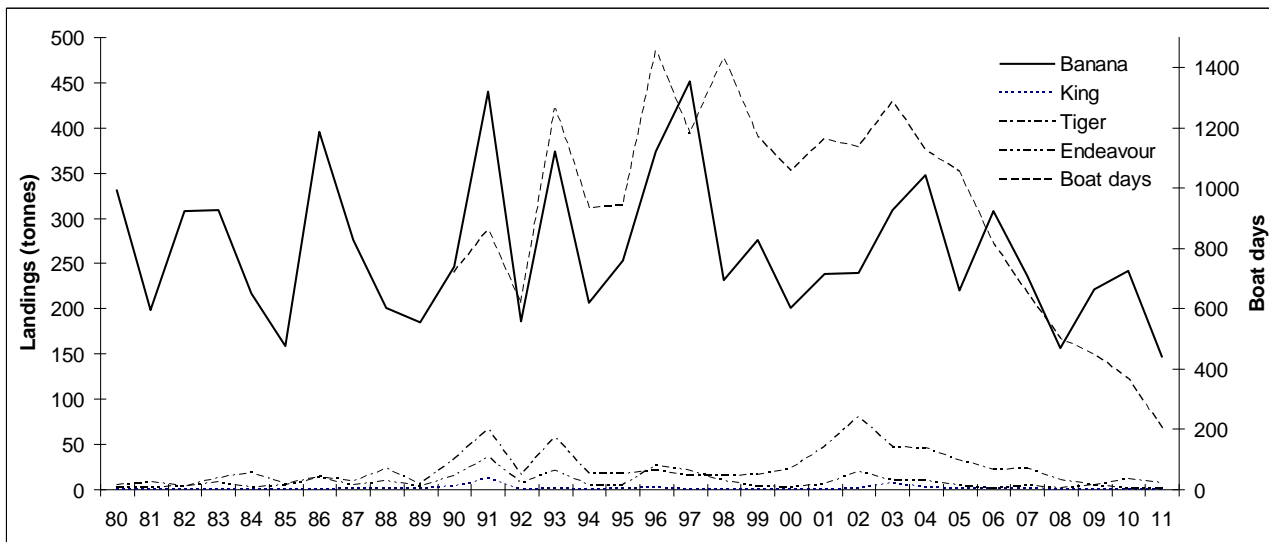


NORTHERN PRAWN FIGURE 6

Annual landings and boat days (from 2000) for the Nickol Bay Prawn Managed Fishery, 1990 – 2011.

**NORTHERN PRAWN FIGURE 7**

Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1990 – 2011.

**NORTHERN PRAWN FIGURE 8**

Annual landings and number of boat days (from 1990) for the Kimberley Prawn Managed Fishery, 1980 – 2011.

North Coast Nearshore and Estuarine Fishery Status Report

S.J. Newman, G. Mitsopoulos, B. Rome, R. McAuley, R. Mason and P. Carter

Main Features

Status		Current Landings	
Stock levels	Acceptable	Total	110.5 t
		Barramundi	28.5 t
Fishing Levels	Acceptable	Threadfin	74.2 t
		Recreational	2-10% of total (last estimate 2000)
		Charter	< 6 t (barramundi and threadfin)

Fishery Description

Commercial

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) operates in the nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129°E) to the top of Eighty Mile Beach, south of Broome (19°S). It encompasses the taking of any fish by means of gillnet in inshore waters and the taking of barramundi (*Lates calcarifer*) by any means.

The other species taken by the fishery are predominantly king threadfin (*Polydactylus macrochir*) and blue threadfin (*Eleutheronema tetradactylum*). The main areas of operation for the fishery are the river systems and tidal creek systems of the Cambridge Gulf, the Ria coast of the northern Kimberley, King Sound, Roebuck Bay and the northern end of Eighty Mile Beach to 19°S.

Recreational

Recreational fishing activities are concentrated around key population centres, with a seasonal peak in activity during the dry season (winter months).

Governing legislation/fishing authority

Commercial

Kimberley Gillnet and Barramundi Managed Fishery Management Plan 1989

Kimberley Gillnet and Barramundi Managed Fishery Licence.

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation.

Consultation processes

Commercial

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

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues. There is also an annual Broome Consultative Forum.

Boundaries

Commercial

The waters of the KGBF are defined as 'all Western Australian waters lying north of 19° south latitude and west of 129° east longitude and within three nautical miles seaward of the high water mark of the mainland of Western Australia and the waters of King Sound south of 16°21.47' south latitude. The principal fishing areas from the Broome coast to Cambridge Gulf in the KGBF are illustrated in Kimberley Gillnet Figure 1.

Recreational

The North Coast Bioregion, which encompasses the Pilbara and Kimberley regions, extends from the Ashburton River south of Onslow to the WA/NT border (all land and water north of 21°46'S latitude and east of 114°50'E longitude).

Management arrangements

Commercial

The KGBF is managed primarily through input controls in the form of limited entry, seasonal and spatial area closures and gear restrictions. Access to the KGBF is limited to seven licences.

There is a closed season in which fishing is prohibited in the KGBF. In the southern KGBF (west of Cunningham Point, 123°08.23' E longitude) the closure extends from 1 December to 31 January the following year, while in the northern section of the KGBF (east of Cunningham Point) the closure extends from 1 November to 31 January the following year. There are also limits on the length of net and mesh sizes to be used in the fishery.

There are four principal fishing areas within the KGBF: Cambridge Gulf (including Ord River), Kimberley coast (six small river systems), King Sound and the Broome coast (Roebuck Bay).

NORTH COAST BIOREGION

There are commercial fishing area closures around major town sites and recreationally important fishing locations, namely Broome Jetty to Crab Creek, Jacks Creek, Yardogarra Creek, Thangoo Creek, Cape Bossut to False Cape Bossut, Derby Jetty, the Fitzroy River and all its creeks and tributaries south of 17°27' S, Whistle Creek and Admiral Bay, and the lower Ord River upstream of Adolphus Island.

Recreational

As a precautionary measure to ensure that breeding stock levels of barramundi are maintained, special fishing rules are in place for three key fishing areas: Fitzroy River area and King Sound (bag and possession limit of 2 fish, maximum size limit of 800mm); Broome area (bag limit of 1 fish, possession limit of 2 fish); and the Ord River area (bag and possession limit of 1 fish, maximum size limit of 800mm). Fish species in the North Coast Bioregion are assigned to a number of risk categories for the purposes of recreational fisheries management. The bag and size limits are species-specific (e.g. Barramundi) or species group specific (e.g. mullet). Recreational set and haul netting is prohibited in all waters of the North Coast Bioregion with the exception of haul netting in the waters of the Dampier Archipelago (between Cape Preston and Cape Lambert) with the following restrictions: haul nets must not exceed 30 metres in length; mullet are the only species to be retained and all other species must be returned to the water.

Research summary

Monthly catch and effort data from the commercial fishery are used to assess the status of barramundi and threadfin populations targeted by this fishery. This status report is compiled annually and provided to industry and regional management.

The biological characteristics required for fisheries management for both the threadfin species have been completed (Pember et al. 2005)¹. These data may be used to provide a stock assessment of threadfin in the KGBF and Pilbara in the future. The bycatch of elasmobranchs in the KGBF and the previous Pilbara Coast fishing area was examined during 2002 and 2003 (McAuley et al. 2005)². The stock structure of both threadfin species was defined in FRDC Project 2007/032 (Welch et al. 2010)³.

¹ Pember, M.B., Newman, S.J., Hesp, S.A., Young, G.C., Skepper, C.L., Hall, N.G. and Potter, I.C. 2005. Biological parameters for managing the fisheries for Blue and King Threadfins, Estuary Rockcod, Malabar Grouper and Mangrove Jack in north-western Australia. Final Report to the Fisheries Research and Development Corporation (FRDC) on Project No. 2002/003. Centre for Fish and Fisheries Research, Murdoch University, Murdoch, Western Australia, Australia. 172p.

² McAuley, R., Lenanton, R., Chidlow, J., Allison, R. and Heist, E. 2005. Biology and stock assessment of the thickskin (sandbar) shark, *Carcharhinus plumbeus*, in Western Australia and further refinement of the dusky shark, *Carcharhinus obscurus*, stock assessment, Final FRDC Report – Project 2000/134, Fisheries Research Report No. 151, Department of Fisheries, Western Australia. 132p.

³ Welch, D.J., Ballagh, A.C., Newman, S.J., Lester, R.J.G., Moore, B.R., van Herwerden, L., Horne, J.B., Allsop, Q.,

Retained Species

Commercial landings (season 2011):

All species	110.5 tonnes
Barramundi	28.5 tonnes
Threadfin	74.2 tonnes

The principal species landed are two species of threadfin (king threadfin and blue threadfin) and barramundi. Small quantities of elasmobranchs (sharks and rays), black jewfish (*Protonibea diacanthus*) and tripletail (*Lobotes surinamensis*) are also landed. The composition of the elasmobranch catch varies considerably between fishing areas but it mainly consists of whaler shark species (*Carcharhinidae*), including pigeye sharks (*Carcharhinus amboinensis*), blacktip whalers (mainly *C. tilstoni*) and various species of rays. Sawfish (*Pristidae*) are totally protected under the *Fish Resources Management Regulations 1995* and may not be retained by this fishery, and are released alive wherever possible.

The total reported catch of all species in the KGBF in 2011 was 111 t (Kimberley Gillnet Figure 2). The total landings of barramundi from the KGBF were 28.5 t for 2011 (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 3), a decrease on the reported catch of 57.1 t in 2010. The 2011 landings of threadfin from the KGBF were 74.2 t (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 4), lower than that reported in 2010 (83.3 t) and within the midrange of catches reported from the fishery over the last decade (Kimberley Gillnet Table 1). The composition of the KGBF catch in 2011 is summarised in Kimberley Gillnet Table 2.

Recreational catch estimate (last estimate 2000):

2-10% of total catch

The most recent non charter boat data available are from a 12-month creel survey of recreational boat-based and shore-based fishing in the Pilbara and West Kimberley region conducted from December 1999 to November 2000 (Williamson et al., 2006⁴). In the entire survey area (Onslow to Broome), the total recreational fishing effort for the year was estimated to be 190,000 fisher days and the total recreational scalefish catch approximately 300 t. Recreational fishers in the survey area reported an estimated total catch of approximately 18 t of threadfin, whereas the estimated total catch of barramundi was less than 1 t. As this survey covered the Broome coast and Pilbara coast areas, the recreational catch can be estimated at around 10% of the combined

Saunders, T., Stapley J.M. and Gribble, N.A. 2010. Defining the stock structure of northern Australia's threadfin salmon species. Final Report to the Fisheries Research and Development Corporation, Project 2007/032. *Fishing and Fisheries Research Centre Technical Report No. 10*, Fishing & Fisheries Research Centre, James Cook University, Townsville, Australia. 180p.

⁴ Williamson, P. C., Sumner, N.R. and Malseed, B.E. 2006. A 12-month survey of recreational fishing in the Pilbara region of Western Australia during 1999-2000, Fisheries Research Report No. 153, Department of Fisheries, Western Australia, 61p

(commercial and recreational) threadfin catch and around 2% of the combined barramundi catch in these areas in 2000. The Department of Fisheries undertook a state wide recreational fishing from boat survey in 2011. The first results of the entire survey are due in late 2012.

The reported charter vessel catches for the north coast bioregion in 2011 were estimated to be approximately 4.5 t of barramundi and less than 1.0 t of threadfin.

Fishing effort/access level

Commercial

The fishery's 'effective effort' is calculated from the validated data as the total length of net set per gillnet hour (km gn.hr⁻¹). During 2011, the total effective effort across the fishery was 1023.3 km gn.hr⁻¹, which is a significant decrease on the 2010 effort figure of 2059.5 km gn.hr⁻¹ (Kimberley Gillnet Figure 2). This significant decrease in effort is linked to one vessel not operating in 2011, thus reducing the overall effort in the fishery and in particular the effort expended in Cambridge Gulf. There is considerable latent effort in the KGBF.

Recreational

Not assessed this season.

Stock Assessment

Assessment complete:

Barramundi Yes

Threadfin Yes

Assessment level and method:

Level 2 - Catch Rate

Breeding stock levels:

Barramundi Adequate

Threadfin Adequate

The level of catch of barramundi decreased substantially in 2011 due to a marked decrease in fishing effort in the Cambridge Gulf area. Fishing effort in the Broome Coast region (Roebuck Bay) has remained somewhat stable.

The catch rates for barramundi in the KGBF stabilised in 2011 (27.9 kg/km gn.hr⁻¹) at a similar level to that reported in 2010 (27.7 kg/km gn.hr⁻¹) but lower than the catch rates reported in 2008 (35.5 kg/km gn.hr⁻¹) and 2009 (38.8 kg/km gn.hr⁻¹; Kimberley Gillnet Figure 3). The catch rate for threadfin increased to 72.5 kg/km gn.hr⁻¹, compared to 40.4 kg/km gn.hr⁻¹ in 2010, a level similar to that reported in 2008 (65.5 kg/km gn.hr⁻¹) and 2009 (58.6 kg/km gn.hr⁻¹; Kimberley Gillnet Figure 4).

There is a need to update the stock assessments for both barramundi and threadfin and also a need to re-evaluate the effort measure used in the fishery. There is the potential for localised depletion risks to threadfin populations given their fine scale spatial stock structure.

Non-Retained Species

Bycatch species impact:

Low

The fishery operates at a relatively low intensity over a wide area of the Kimberley region, specifically targeting barramundi and threadfin. The fishing gear uses large mesh sizes, and hence does not generate a significant bycatch of species important to other sectors, but does take some sharks and rays. Where practicable, sharks and rays are released alive. However, there is some mortality of sharks and rays associated with gillnet capture. Because of the low spatial density of fishing effort relative to the widespread distribution of these species and the size-selectivity of the permitted mesh sizes, these impacts are unlikely to be significant to the stocks involved.

Protected species interaction:

Low

The fishing gear used for this fishery (gillnets) is known to result in the bycatch of protected crocodiles (*Crocodylus porosus*) and sawfish (Family Pristidae). These species are generally released alive or avoided as far as is practicable. Because of the low effort levels and the low spatial intensity of fishing effort, these impacts are unlikely to pose a significant threat to the sustainability of the stocks of these species. One crocodile was reported in 2011 and this was returned alive.

Catches of the speartooth shark (*Glyphis glyphis*) or the northern river shark (*Glyphis garricki*), which are listed under the *Environment Protection and Biodiversity Conservation Act 1999* as critically endangered and endangered, respectively, are rare in the KGBF. However, as these species look similar to other whaler shark species, they may be captured but misidentified. Given the fishery's overall low effort levels, particularly inside the freshwater drainages in which these species are most likely to occur, the fishing operations of the KGBF are unlikely to pose a significant threat to the sustainability of the stocks of these species. Any increase in effort levels inside freshwater drainages will need to be monitored.

Ecosystem Effects

Food chain effects:

Low

This fishery is unlikely to be having anything but a minimal effect on the nearshore and estuarine ecosystem of the Kimberley region.

Habitat effects:

Low

The fishing gear has minimal impact on the habitat. The area and habitat fished is subject to extreme tidal currents and associated effects.

Social Effects

Commercial

During 2011, six vessels fished in the KGBF with an average crew level of approximately 2.5 people, with an estimate of at least 15 people directly employed in the fishery. There was additional employment through local processors and

NORTH COAST BIOREGION

distribution networks. The fishery provides fresh fish for the local communities and the tourism industry throughout the Kimberley region.

Recreational

A significant number of recreational and charter anglers also fished across the region.

Economic Effects

Estimated annual value (to fishers) for 2010-11:

Level 1 - < \$1 Million

The value of the North Coast Nearshore and Estuarine Fishery is reported using the 6 categories defined in Fletcher et al. (2010¹) that are used to assess the relative economic (based on gross value product, GVP) and social amenity value associated with each ecological asset. These values are based on GVP figures derived from the 2010-2011 financial year.

The KGBF principally targets the high-value species barramundi and threadfin. The fishery's score value in 2010-11 was estimated to be 1 (i.e. Risk level – Negligible; Economic value – <\$1 million; However, the social amenity definition for the KGBF is Important, this is an important asset locally and/or the use or existence of the asset is important to the broader community).

Fishery Governance

Target commercial catch range:

Barramundi **25-40 tonnes**

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

The target catch range for barramundi (25–40 t) was derived from a double exponential smoothed forecasting model of the annual barramundi catches of the KGBF up to 1999. For the five years from 1999 to 2003, the level of barramundi catch was at the top end of the target catch range. The catch in 2004 exceeded the target range, although this was achieved at

a CPUE suggesting higher abundance levels than during the 1980s and 1990s. The barramundi catch in 2010 was above the target range for the third successive year. The catch for this species dropped within the catch range of this fishery in 2011 due to reduced effort levels. A review of the fishery is still recommended. This review should include the status of the barramundi stock, the current fishing and effort levels, the target catch range for barramundi along with the development of a target catch range for threadfin.

New management initiatives (2011/12)

The Department plans to review the KGBF management plan in order to modernise the fishery management arrangements.

External Factors

The barramundi stocks utilising the Kimberley river systems as nursery areas are expected to be reasonably resilient to fishing pressure. However, the impact of increasing exploitation from the charter and tourism sectors, as well as population growth associated with the gas and mining development sectors on barramundi stocks needs to be investigated.

Furthermore, the smaller, isolated stocks along the arid Pilbara coastline are likely to experience highly variable recruitment due to environmental fluctuations (e.g. the amount of rainfall). These stocks will be subject to increased exploitation pressure from recreational fishers (driven in the main by population growth resulting from gas and mining developments), and are likely to need specific management arrangements in the future.

In addition, the introduction of marine parks across the Kimberley region has the potential to concentrate fishing effort from multiple sectors into those areas that are easily accessible, further increasing risks of local depletion of barramundi and threadfin stocks.

KIMBERLEY GILLNET TABLE 1

Annual catches of the major target species by the KGBF from 2000-2011.

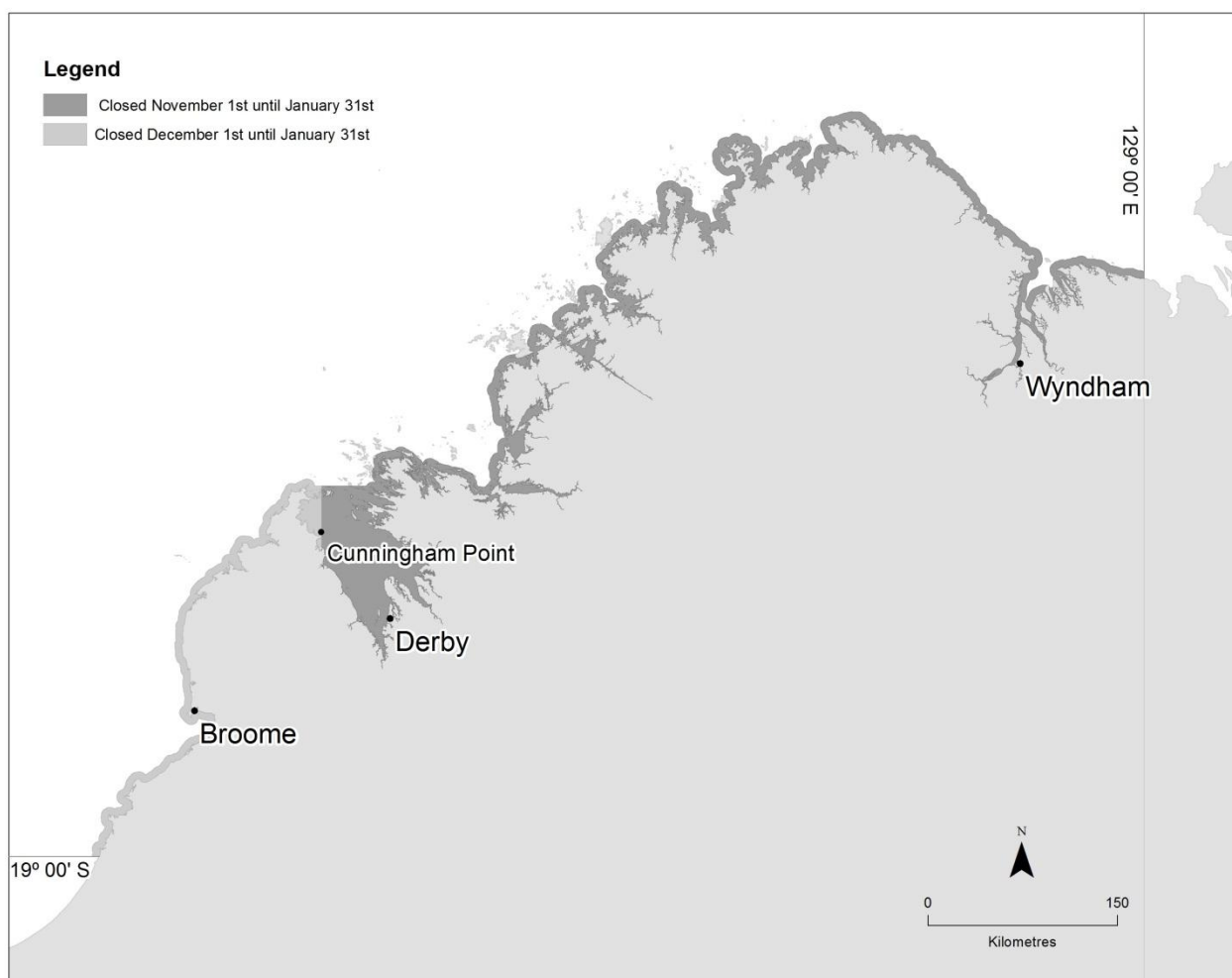
Species	Kimberley Gillnet Annual Catch (tonnes)											
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Barramundi	42.9	38.8	39.5	45.0	53.5	35.6	36.3	27.2	54.8	59.6	57.1	28.5
Threadfin	66.7	50.9	76.4	94.1	75.8	70.6	67.7	78.5	101.2	89.9	83.3	74.2
Total	120.7	100.5	124.4	148.0	136.1	117.8	109.9	111.4	165.6	167.3	150.9	110.5

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

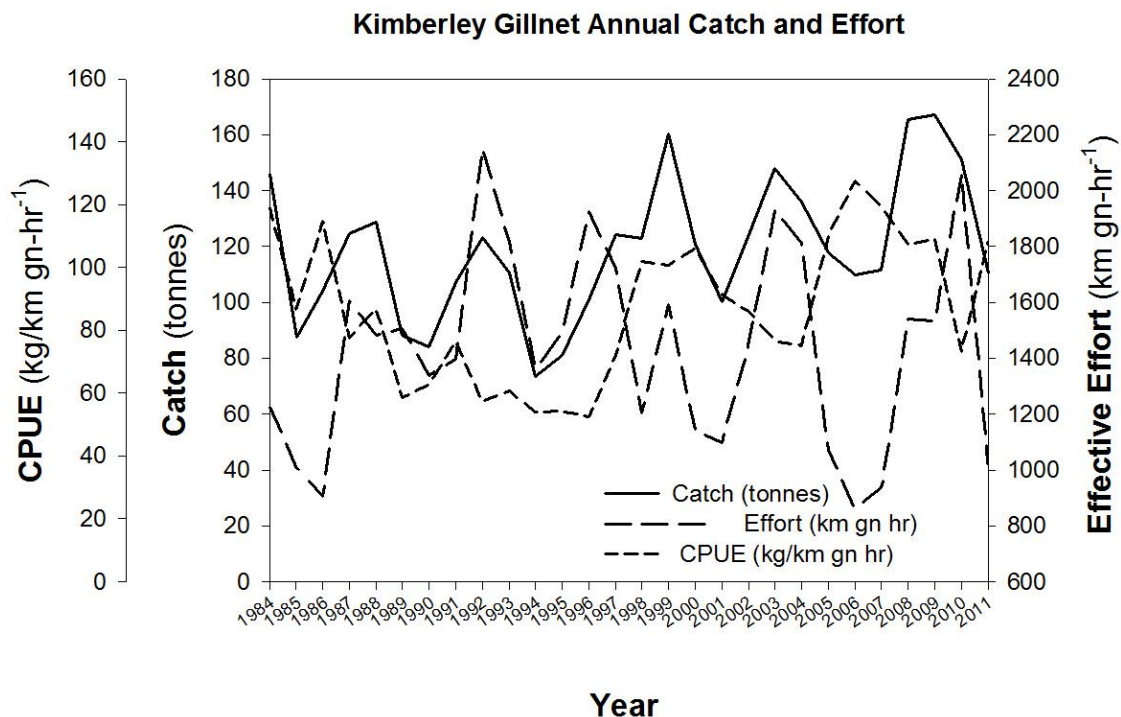
KIMBERLEY GILLNET TABLE 2

Summary of the reported catch (t) in the KGBF in 2011 and the percentage composition of each of the major species retained.

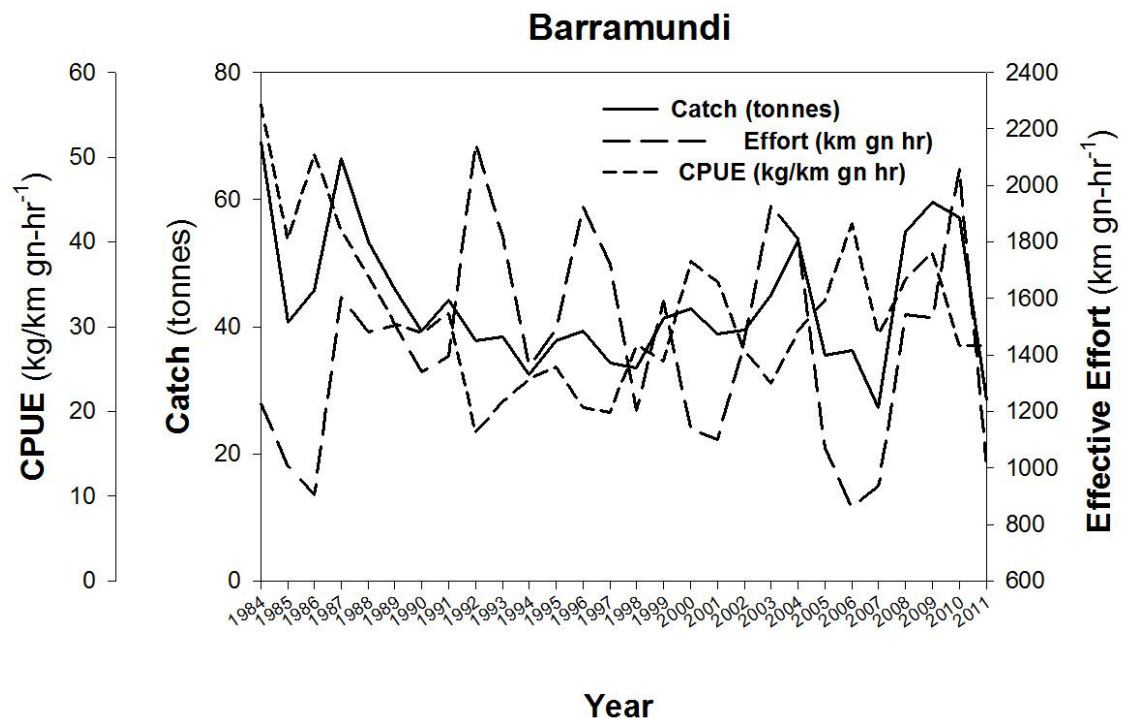
Species	Catch (tonnes)	Composition %
Threadfin	74.2	67.2
Barramundi	28.5	25.8
Tripletail	2.4	2.2
Black jewfish	2.5	2.2
Sharks and rays	1.5	1.4
Other fish	1.4	1.2
Total	110.5	100

**KIMBERLEY GILLNET FIGURE 1**

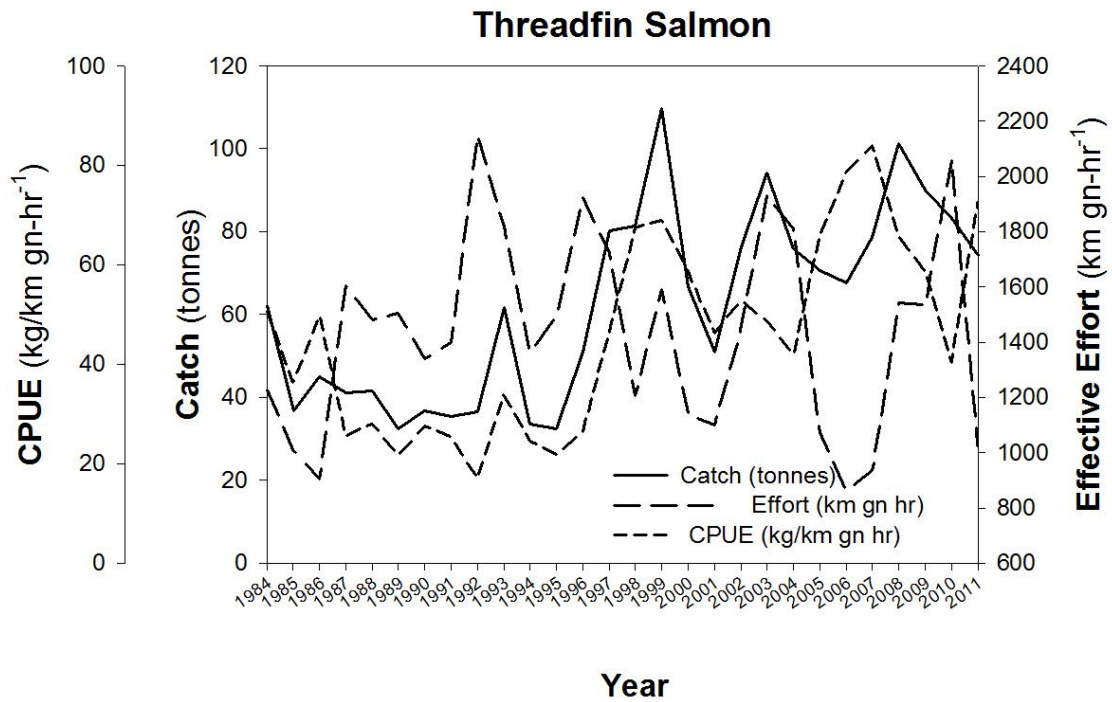
Location and extent of the KGBF within the Kimberley region of Western Australia. Note: this map is indicative only.

**KIMBERLEY GILLNET FIGURE 2**

The annual total catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, km gn.hr⁻¹) from the KGBF over the period 1984 to 2011.

**KIMBERLEY GILLNET FIGURE 3**

The annual catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, km gn.hr⁻¹) for barramundi from the KGBF over the period 1984 to 2011.

**KIMBERLEY GILLNET FIGURE 4**

The annual catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, km gn.hr⁻¹) for threadfin from the KGBF over the period 1984 to 2011.

North Coast Demersal Fisheries Status Report

S.J. Newman, C. Skepper, C. Wakefield, M. Sawyer, D. Boddington and R. Green

Main Features

Status		Current Landings	
Pilbara:		Total North Coast Demersal landings	2,693 t
Stock level	Adequate	Pilbara:	
		Total	1,656 t
Fishing Level		Red emperor	118 t
Trawl Fishery	Acceptable	Rankin cod	78 t
Trap Fishery	Acceptable	Bluespotted emperor	223 t
Line Fishery	Acceptable	Pilbara Fish Trawl Fishery	1,085 t
		Pilbara Fish Trap	459 t
Kimberley:		Pilbara Line	112 t
Stock level	Adequate	Charter (Recreational)	< 20 t (1.2% of total)
		Kimberley (NDSF):	
Fishing Level	Acceptable	Total	1,037 t
		Red emperor	128 t
		Goldband snapper	487 t
		Charter (Recreational)	< 5 t (1.5% of total)

Fishery Description

There are a number of commercial and recreational fisheries that operate in the northern bioregion which target, to varying degrees, the following tropical, demersal fish species (in order of gross tonnage); goldband snapper (*Pristipomoides multidentis*), bluespotted emperor (*Lethrinus punctulatus*), red emperor (*Lutjanus sebae*), crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*Lutjanus malabaricus*), Rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and frypan snapper (*Argyrops spinifer*). Each of these fisheries is outlined below.

Commercial

Pilbara

The Pilbara Demersal Scalefish Fisheries include the Pilbara Fish Trawl (Interim) Managed Fishery, the Pilbara Trap Managed Fishery and the Pilbara Line Fishery, which collectively use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures. The Trawl Fishery lands the largest component of the catch of demersal finfish in the Pilbara (and North Coast Bioregion) targeting all the main demersal species, with smaller subsets of species taken by the Trap fishery and fewer still by the Line Fishery.

Kimberley

The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the northwest coast of Western Australia in the waters east of 120° E longitude. The permitted means of operation within the fishery include handline, dropline and fish traps, but since 2002 it has essentially been a trap based fishery which uses gear time access and spatial zones as the

main management measures. The main species landed by this fishery are red emperor and goldband snapper.

Recreational

Recreational fishing activities on these species are mostly line based fishing from boats which are concentrated in inshore areas around key population centres, with a peak in activity during the dry season (winter months, April/May to September/October).

Governing legislation/fishing authority

Commercial

Pilbara

Pilbara Trap Managed Fishery Management Plan 1992

Pilbara Trap Managed Fishery Licence

Pilbara Fish Trawl Fishery (Interim) Management Plan 1997

Pilbara Fish Trawl Interim Managed Fishery Permit

Prohibition on Commercial Fishing for Demersal Scalefish (Pilbara Area) Order 1997

Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Order – Pilbara Fish Trawl)

Kimberley

Northern Demersal Scalefish Managed Fishery Management Plan 2000

Northern Demersal Scalefish Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption).

Recreational

Fish Resources Management Act 1994; *Fish Resources Management Regulations 1995* and other subsidiary legislation.

Consultation processes

Commercial

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

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues. Annual Broome Consultative Forum (Kimberley).

Boundaries

Commercial

Pilbara

The Pilbara Fish Trawl Fishery is situated in the Pilbara region in the north west of Australia. It occupies the waters north of latitude 21°35'S and between longitudes 114°9'36"E and 120°E. The Fishery is seaward of the 50 m isobath and landward of the 200 m isobath (North Coast Figure 1).

The Fishery consists of two zones; Zone 1 in the south west of the Fishery (which is closed to trawling) and Zone 2 in the North, which consists of six management areas. Areas 1 to 6 each cover 1,300; 1,800; 880; 1,500; 2,300 and 7,200 square nautical miles, respectively. The total area available for trawling in Zone 2 is 14,980 square nautical miles, however, only 6,900 square nautical miles are currently open (i.e. ~46% of Zone 2 is currently open to trawling). This represents less than 5% of the total shelf area available in the North Coast Bioregion. The exact latitudes and longitudes delineating the areas are listed in the *Pilbara Fish Trawl Fishery (Interim) Management Plan 1997*.

The Pilbara Trap Managed Fishery (North Coast Figure 1) lies north of latitude 21°44'S and between longitudes 114°9.6'E and 120°00'E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath. The exact latitudes and longitudes delineating the fishery are listed in the *Pilbara Trap Management Plan 1992*.

The Pilbara Line fishing boat licensees are permitted to operate anywhere within "Pilbara waters". This means all waters bounded by a line commencing at the intersection of 21°56'S latitude and the high water mark on the western side of the North West Cape on the mainland of Western Australia; thence west along the parallel to the intersection of 21°56'S latitude and the boundary of the Australian Fishing Zone and north to longitude 120°E. The exact latitudes and

longitudes delineating the Fishery are listed in the *Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006*.

Kimberley

The waters of the Northern Demersal Scalefish Fishery are defined as all Western Australian waters off the north coast of Western Australia east of longitude 120°E. These waters extend out to the edge of the Australian Fishing Zone (200 nautical miles) (North Coast Figure 2). The fishery is further divided into two fishing areas; an inshore sector (Area 1) and an offshore sector (Area 2; see North Coast Figure 2). Under a voluntary industry agreement (now formalised under an Exemption), the offshore sector (Area 2) has been further divided into 3 zones; A, B and C. Zone B comprises the area with most of the historical fishing activity. Zone A is an inshore developmental area and Zone C is an offshore deep slope developmental area representing waters deeper than 200 m. The inshore waters in the vicinity of Broome are closed to commercial fishing. This closure was put in place to reduce the potential for conflict between commercial fishers and recreational, charter and customary fishers (North Coast Figure 2).

Recreational

Recreational fishing in the North Coast Bioregion encompasses all waters in both the Pilbara and Kimberley regions, extending from the Ashburton River south of Onslow to the WA/NT border with the exception of some areas within Marine Parks.

Management arrangements

Commercial

Pilbara

The Pilbara Fish Trawl Interim Managed Fishery is managed through a combination of area closures, gear restrictions, and by the use of input controls in the form of individual transferable effort allocations monitored by a satellite-based vessel monitoring system (VMS). This Interim Management Plan was implemented for the Fish Trawl Fishery in the Pilbara in 1998, with effort levels determined to achieve the best yield from the Fishery while keeping exploitation rates of the indicator species at sustainable levels.

A large amount of the area within the boundaries of the Trawl Fishery is closed to trawling. Much of this has been closed since the implementation of the (Interim) Management Plan (1998) including Zone 1 of the Fishery and Area 3 of Zone 2 of the Trawl Fishery. In addition, Area 6 of Zone 2 has been closed since the commencement of the Interim Plan except for two periods of research trawling in 1998 and 1999. The area inshore of the 50 m depth isobath is also closed to trawling. Areas 1, 2, 4 and 5 are open to fishing all year, with separate effort allocations (in hours) in each Area, as outlined in the Interim Plan. The open areas of the Trawl Fishery are trawled with varying intensity due to differing effort allocation, substrate composition and economic considerations (e.g. distance from ports).

There are 11 permits for the Fishery, with the combined effort allocations being consolidated over time onto 3 full time vessels.

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The Trap Fishery is also managed primarily by the use of input controls in the form of individual transferable effort allocations monitored with a satellite-based VMS. There has also been a closure to trapping in Area 3 since 1998.

The authority to fish in the Trap Fishery is limited by reference to a specified number of trap days expressed in terms of units of entitlement. The capacity is currently limited to 5,456 trap days. However, the Management Plan allows the Director General to alter the value of these units. There are 6 licences in the Fishery, with the allocation consolidated onto 3 vessels.

The Line Fishery is managed under the Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order, 2006. Nine Fishing Boat Licences are exempted from this prohibition for any nominated 5-month block period within the year.

Comprehensive ESD assessments were submitted to the Commonwealth Government environmental agency, now called SEWPaC, in 2004 for both the Pilbara Trap and Trawl Fisheries to allow product to be exported. These ESD assessments determined that performance should be assessed annually for breeding stock levels, protected species interactions and habitat effects. As a result, the Pilbara Trap Fishery was declared an approved Wildlife Trade Operation in November 2004 for a period of three years. This was not renewed after December 2007 as the fishery was not exporting. The Pilbara Fish Trawl Interim Managed Fishery is an approved Wildlife Trade Operation until June 2013.

Kimberley

The Northern Demersal Scalefish Fishery is managed primarily through input controls in the form of an annual fishing effort capacity, with supplementary gear controls and area closures. The annual fishing effort capacity limits the amount of effort available in the fishery to achieve the notional target total allowable catch (NTAC). The annual effort capacity is set by the Director General based on the available research advice in consultation with licensees. This effort capacity is then allocated among license holders through units of entitlement on Managed Fishery Licences, for use in Area 2 of the Fishery. An Exemption provides for additional effort in Zone A (56 standard fishing days per 160 unit licence) and Zone C (50 standard fishing days per 160 unit licence), in order to encourage fishers to explore the lesser-fished waters of the NDSF.

The notional target TAC for Zone B is a recommended level of catch for the entire demersal species suite and is derived from the estimated sustainable catch of the key target species (determined through stock assessments) and their historical proportions in the catch. In 2011, Zone B effort allocation was 985.6 standard fishing days.

The areas that encompass Zone A and Zone C are likely to have a lower sustainable catch compared with Zone B, and thus exploratory TACs are set for Zone A and Zone C. These will need to be revised as effort and catches in these zones increase. In 2011, the Zone A effort allocation was 616 standard fishing days.

Access to the offshore sector (Area 2) of the NDSF is limited to 11 licences under an individually transferable effort (ITE) system. This allows the effort quota to be operated by a lesser number of vessels. For example, during 2011, 7 vessels (trap fishing only) collectively held and operated the

effort individually assigned to the 11 licences. Each trap must have an internal volume equal to or less than 2.25 m³. While there is no restriction on the number of traps that can be fished per vessel, each licensee is allocated an annual effort quota in 'standard fishing days' based on the use of 20 traps (or 5 lines) per day. If the number of traps (or lines) being fished increases beyond this level, the number of allowable fishing days declines. The number of days and traps fished, as recorded by the vessel monitoring system, is converted to standard fishing days. A comprehensive environmental risk assessment of this fishery has determined that performance should be reported against measures relating to breeding stocks of the two indicator species, red emperor and goldband snapper, and the cod/grouper complex (a suite of more than 10 species), as reflected by their catch levels.

Recreational

The recreational fishery for demersal fish in the North Coast Bioregion is managed in a similar manner to other Bioregions across the State through the use of input controls (e.g. size limits) and output controls (e.g. limits on the numbers of fish that can be taken by individuals and boats – these are assigned based on a number of risk categories).

From 2 March 2010 all persons fishing from a powered boat anywhere in the state have been required to hold a Recreational Fishing from Boat Licence or fish in the company of a licence holder. The Recreational Fishing from Boat Licence provides a state-wide database of recreational boat fishers that can be utilised for survey purposes.

Demersal fish, particularly the icon species such as coral trout and red emperor, are considered prime recreational target species. As such, resource-sharing issues will be a consideration in future management arrangements across this Bioregion.

Research summary

Pilbara

Monitoring and assessment of the Pilbara Trawl, Trap and Line Fisheries includes the collection of spatial data on effort and catch of 11 major target species from logbooks, VMS data, and weighed catches from unload data. Assessment of the status of the suite of retained demersal scalefish is based on the performance of indicator species (red emperor, Rankin cod, bluespotted emperor, brownstripe snapper, goldband snapper and ruby snapper) using various assessment methods constituting a weight-of-evidence approach. These methods include trend analysis of trawl catch rates using two measures of effort (time spent trawling reported in logbooks and time spent in each management area derived from VMS) for five indicator species and the total catch in each of the trawl-managed areas. In addition, ages are determined from otolith sections for selected indicator species in each trawl-managed area and the Trap Fishery, and for ruby snapper from the Line Fishery.

Estimates of fishing mortality are derived from age structures and compared to internationally recognised biological reference points (see Stock Assessment section). Approximately every 4-5 years the spawning biomass of two indicator species, red emperor and Rankin cod, are assessed using the age-composition and catch rate data synthesised into an integrated age-structured model.

In 2010, a fishery independent research survey was conducted which was aimed at describing the demersal fish assemblages associated with trawl, trap and closed management areas.

Kimberley

Assessment of the status of the demersal fish stocks in Zone B of the NDSF is determined annually using catch and catch rates of the major species or species groups, and every 4-5 years using an age-based stock assessment model to assess the status of two indicator species, red emperor and goldband snapper, based on age-composition data collected in previous years. Ongoing monitoring of this fishery is being undertaken using both catch and effort logbook and VMS data.

The catch from the NDSF also includes components from Zone A of the fishery. This zone has a somewhat similar catch composition to Zone B of the fishery. The level of catch from Zone A will be monitored closely in the future as this area of the fishery has been receiving more effort in recent years.

The catch from the NDSF also includes at times some species from the waters of Zone C in depths greater than 200 m. The resources of this Zone are unlikely to be substantial, and given the lower productivity of these longer-lived, deeper-slope reef fish, the sustainable catch from this zone is likely to be significantly lower than for Zone B.

Retained Species

Commercial landings (season 2011):

Pilbara Fish Trawl	1,085 tonnes
Pilbara Fish Trap	459 tonnes
Pilbara Line	112 tonnes
Kimberley (NDSF)	1,037 tonnes

The commercial catches of key species and species groups from across the North Coast Bioregion and their relative contribution to catches within the Pilbara and Kimberley sectors in 2011 are summarised in North Coast Table 9. The relative contribution of the Kimberley sector has been increasing as the catch from the Pilbara sector has been stable.

Pilbara

The total catch of demersal scalefish taken by the trawl fishery has declined from annual average catch levels of close to 2,500 t during the period 1995 – 2004 to an average of 1,200 t per annum since 2008 (North Coast Tables 1 and 2). These total annual catches have been below the target catch range (2,000 to 2,800 t) for five consecutive years, with less than 1,100 t landed in 2011 (North Coast Table 2). These reductions are considered to be a response to the effort reductions imposed on the trawl fishery since 2008.

The major target species landed by the trawl fishery in 2011 were bluespotted emperor 152 t (164 t in 2010), crimson snapper 130 t (93 t in 2010), brownstripe snapper 63 t (76 t in 2010), goldband snapper 56 t (63 t in 2010), red emperor 54 t (76 t in 2010), saddletail snapper 43 t (50 t in 2010), spangled emperor 18 t (15 t in 2010) and Rankin cod 12 t (14 t in 2010). The total retained by-product was 18 t (32 t in 2010) including bugs, cuttlefish, and squid (North Coast Table 2).

The total annual catch taken by the Pilbara trap fishery has remained relatively consistent since 2006 averaging 469 t per year and remaining within the target catch range of 400-500 t (North Coast Tables 1 and 2). The total catch of approximately 460 t in 2011 was slightly lower than the 2010 catch (North Coast Table 2). The major species taken by the trap fishery in 2011 were goldband snapper 74 t (37 t in 2010), bluespotted emperor 71 t (90 t in 2010), red emperor 62 t (89 t in 2010), Rankin cod 60 t (52 t in 2010), crimson snapper 49 t (48 t in 2010) and spangled emperor 20 t (20 t in 2010).

The total annual catch of scalefish taken by the line fishery is historically much lower than is taken by the trawl and trap fisheries (North Coast Tables 1 and 2). In 2011, the total annual catch for the line fishery was approximately 110 t, similar to the catch in 2010 and towards the upper limit of the target catch range of 50-115 t (North Coast Table 2). In recent years (since ~2006), the line fishery catches have been dominated by ruby snapper and goldband snapper, typically accounting for more than 40% of the total annual catch. In 2011, the ruby snapper catch was 30 t (56 t in 2010) and the goldband snapper catch was 20 t (17 t in 2010) (North Coast Table 1). This fishery and the Commonwealth's North West Slope Trawl Fishery are likely to be targeting the same stock (management unit) of ruby snapper, so catches from both commercial fisheries would need to be considered in any future assessment or harvest strategy.

Kimberley

After the initial development period from 1990 to 1992, the catch of the NDSF reached the first peak in catch (> 900t) in 1996 before declining to levels of about 500 t in 2003 (North Coast Figure 4). The total catch began to increase again in 2003, and the past four years have the highest recorded catches (> 1000 t) since the inception of the fishery. The 2011 catch of 1,037 t is the third highest catch recorded during this period, and as in 2010 is mainly due to increased levels of catch from Zone A of the fishery (North Coast Tables 6 and 7).

The NDSF principally targets red emperor and goldband snapper, with a number of species of snappers (Lutjanidae), cods (Epinephelidae) and emperors (Lethrinidae) comprising the majority of the remainder of the catch (North Coast Table 6). The species composition of the landed catch in 2011 is similar to that reported in 2010, with goldband snapper dominating the landed catch. The landed catch of goldband snapper decreased from 523 t in 2010 to 487 t in 2011. However, these last two years represent the highest reported landings of this species, continuing an overall trend of increasing catches since 2005. The total catch of red emperor in 2011 was 128 t (141 t in 2010) and continues a decreasing catch trend for this species since 2005. The cods/groupers catch in 2011 (155 t) was similar to that reported in 2010 (153 t), and represents the highest level of catch reported for this species complex. Rankin cod dominates the composition of the cod/grouper catch complex. The catch of Rankin cod decreased from 49 t in 2010 to 41 t in 2011 (North Coast Table 7).

The catch rate of red emperor in Zone B in 2011 decreased slightly, continuing a declining trend in catch rates since 2007 (North Coast Figure 5). The catch rates for goldband snapper in Zone B also decreased slightly, but remained within the higher range reported since 2009. These high levels of catch rate (2009 – 2011) have followed the sharp

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increase in catch rates from 2006 to 2009 (North Coast Figure 6). The catch rates of the cod/grouper complex in Zone B also decreased slightly, but again remains comparatively high following the increasing catch rate trend from 2002 to 2010 (North Coast Figure 7).

The 2011 catch of red emperor, goldband snapper and cods/groupers were within acceptable levels as defined in the Export exemption for this fishery (see 'Fishery Governance' section), with no species or species complex exceeding the trigger point (20% increase in average catch of the previous 4 years).

Recreational catch estimate (season 2011):

Pilbara 1.2%

Kimberley <1.0%

Pilbara

While there is a major recreational fishery in the Pilbara and the charter sector is an increasing user of the resource, the inshore closures to the commercial sector provide a high degree of spatial separation between the user groups. The recreational and charter sectors do not catch significant quantities of most species targeted by the commercial Pilbara demersal scalefish fisheries. The reported charter vessel catch of demersal scalefish in the offshore waters of the Pilbara (depth > 30 m) in 2011 is estimated to be ~1.2% (~20 t) of the commercial catch. However, due to the increasing population in the Pilbara from mining developments, catches are likely to increase in the future. The Department of Fisheries undertook a state wide recreational fishing from boat survey in 2011. The first results of the entire survey are due in late 2012.

Kimberley

Historically, there has been little recreational or charter boat fishing effort directed towards the demersal fishes in Area 2 of the NDSF, the species that are targeted by commercial fishers. However, this is now changing with charter vessels moving into the inshore demersal waters of the NDSF. The reported charter vessel catch of demersal scalefish in the inshore demersal waters of the NDSF (depth > 30 m) in 2011 is estimated to be less than 1% (< 5 t) of the commercial catch. Most of the recreational fishing effort targeting demersal finfish in the Kimberley region is thought to be concentrated in the Broome sector of Area 1, which is closed to commercial fishing. The magnitude of recreational fishing catch is small relative to the total commercial catch. However, the increasing number of people associated with oil and gas developments in the Kimberley region has the capacity to significantly increase the level of recreational catch taken from nearshore and inshore demersal waters of the NDSF. The Department of Fisheries undertook a state wide recreational fishing from boat survey in 2011. The first results of the entire survey are due in late 2012.

Fishing effort/access level

Pilbara

Fishing effort used by the trap and line sectors of the commercial fishery are based on monthly catch and effort returns (North Coast Table 3). Trawl Fishery effort is recorded as the net bottom time (hours) taken from skippers' logbook data, along with the time spent in each management area derived from VMS data.

The trawl fleet had the equivalent of three full-time vessels. The percentage of allocated hours used by the trawl fleet during the 2010/11 season were 102% in Area 1, 109% in Area 2 (noting that vessels can exceed their entitlement within an area by 48hr as long as overall entitlement is not exceeded), 92% in Area 4 and 57% in Area 5. Trawling has not been permitted in either Area 3 or Area 6 since 1998 and trapping has not been permitted in Area 3 since 1998 (North Coast Figure 1).

In 2011, trap fishers were allocated 5,457 trap days (capacity is set in trap days with a value per unit of 1 unit = 1 trap day), with 89% of the units used as calculated from the VMS.

In 2011, line fishers reported operating for 376 days, compared with 266 days in 2010.

Kimberley

The seven fish trap vessels that fished in the NDSF in 2011 reported using between 10 and 36 fish traps per day. Line fishing has not been reported since 2002 and no line fishing was undertaken in Zone B of the NDSF in 2011. Effort across all zones of the fishery decreased in 2011 to 1,042 days (1,178 days in 2010; North Coast Table 8).

The total effort allocated in Zone B in 2011 was 986 standard fishing days (i.e. using 20 traps) (North Coast Table 8). The number of standard fishing days (SFDs) recorded in Zone B using VMS data was 879 SFD's (89%). That is, 11% of effort allocated to Zone B in 2011 was not used. A total of 616 standard fishing days was allocated to Zone A in 2011. The number of SFDs recorded using VMS data was 163 (237 SFD's in 2010), indicating that ~74% remained unutilised in Zone A at the end of the season. The effort expended in Zone C in 2011 was negligible.

Thus, latent effort exists in all Zones of this fishery.

Stock Assessment

Assessment complete:

Pilbara Yes

Kimberley Yes

Assessment level and method:

Pilbara

Level 2 - Catch and catch rates (Annual)

Level 3 - Fishing mortality (Periodic - 2008)

Level 5 - Integrated model (Periodic - 2007)

Kimberley

Level 2 - Catch and Catch rates (Annual)

Level 5 - Integrated Model (Periodic -2007)

Breeding stock levels:

Pilbara

Trawl Fishery Adequate

Trap Fishery Adequate

Line Fishery Adequate

Kimberley Adequate

Pilbara

There are three tiers of assessment used in the Pilbara, that when combined constitute a weight-of-evidence approach to determine overall stock status based on the performance of indicator species that represent the entire demersal suite of species. The different tiers of assessment (see How to Use This Volume for more details) are applied to the various indicator species of this suite. Catch and catch rate analyses are used to assess five indicator species and the total combined retained catch on an annual basis. Fishing mortality estimates (F) derived from age structure data are used to assess red emperor, Rankin cod, goldband snapper and bluespotted emperor relative to internationally recognised biological reference points (BRP) based on ratios with natural mortality¹ on a periodic basis with the last analysis completed using 2008 data. An age-structured model incorporating catch rates, catch history and age structure data is used to assess spawning biomass levels for red emperor and Rankin cod also on a periodic basis (~5 years) with the last assessment completed in 2007.

Catch Rates

Catch rates are derived from logbook catch data and adjusted according to the unload data, so that catches match reported unloads with the area component obtained from logbooks. There are two measures of effort used to derive catch rates including the duration of the trawl shots as reported in logbooks and the time spent in each management area on each trip derived from VMS data. VMS data have only been available since 2000. Catch rates were calculated using the adjusted catch divided by effort (separately for both methods) by area for each trip. A moderate efficiency increase (0-4% per year) is applied to nominal catch rates based on trawl-time as this level of efficiency increase is typical for many trawl fisheries internationally.

Mean trawl catch rates of the indicator species and the total catches decreased each year from 2004 to 2008 (North Coast Figures 3). Since 2009, the catch rates of the shorter lived indicator species (bluespotted emperor and brownstripe snapper) and total catch have increased each year, whereas those of longer lived indicator species (red emperor, Rankin cod and goldband snapper) have remained relatively stable (North Coast Figures 3).

Fishing Mortality

The high rate of fishing mortality of red emperor (> BRP Limit level) in the western areas (Areas 1 and 2) of the trawl fishery (North Coast Table 4), and the declining catch rates of several species including the indicator species of red emperor and Rankin cod led to a reduction in effort of 16% in Areas 1 and 2 and 4% in Area 4 in 2009. This followed an industry agreed effort reduction in Area 1 in 2007 and 2008.

Age Structured Model

The age-based stock assessment models for the two indicator species, red emperor and Rankin cod, were last run in 2007.

The outcomes of these model runs indicated that; 1) red emperor spawning biomass was greater than 40% of virgin biomass overall, with declining trends forecast for Areas 1 and 4 and stable forecast trends for Areas 2 and 5 for future years; and 2) Rankin cod spawning biomass was greater than 40% of virgin biomass overall, with a declining trend forecast for future years across most management areas. However, this assessment indicated that the spawning biomass for these indicator species of the Pilbara Demersal Fishery as a whole were above their target levels, indicating satisfactory breeding stock levels and a moderate risk of recruitment overfishing. These assessments were last run prior to effort reductions in the trawl fishery and the fishing mortality estimates from age structures of indicator species collected in 2007, 2008 and 2011. These age-based stock assessment models are scheduled to be updated following the completion of fishing mortality estimates derived from age structures of these indicator species collected in 2011.

Current Assessment

Following concerns for the sustainability of the Pilbara demersal scalefish resource based on; 1) declining catch rates of all indicator species and the total catch from 2003-2008, and; 2) fishing mortality estimates that exceeded limit references levels for red emperor in Areas 1 and 2 in 2007, voluntary effort reductions were undertaken by the trawl industry in 2008 in Area 1 and implemented legislatively in 2009, in Areas 1, 2 (16% combined) and 4 (4%). This has resulted in the lowest recorded level of effort for the trawl fishery since the individual transferable effort system was introduced in 1998. It has been two years since these effort reductions were introduced and early signs of stock rebuilding are evident from increasing catch rates of the shorter lived indicator species (bluespotted emperor and brownstripe snapper). These species are expected to display positive responses earlier than the longer lived indicator species (red emperor and Rankin cod) considering they are selected by the trap and trawl fisheries at a younger age (i.e. 2-3 vs. 5-6 years) and they have inherently higher population productivity. The longer lived indicator species (red emperor and Rankin cod) have displayed marginal increases in catch rates in some management areas and stable catch rates in others since the implementation of effort reductions (2009). If they are also recovering, it is expected increases in catch rates will be start to be reported from 2013/14 onwards due to the lag between recruitment and vulnerability to the trawl fishery (5-6 years of age). Otoliths of the indicator species, red emperor, Rankin cod, bluespotted emperor, brownstripe snapper and ruby snapper were collected in 2010/11 from each management area of the trawl, trap and line fisheries. The age structures derived from these otolith collections will be used to evaluate changes in fishing mortality since previous estimates in 2007/08 and therefore the sustainability of current exploitation levels.

¹ The BRPs for long-lived (> 20 years) species include (1) the Target level, where $F \leq 2/3$ the ratio of natural mortality (M), for which fishing mortality is sustainable; (2) Threshold level, where $F = M$, which indicates fishing has exceeded sustainable levels; and (3) Limit level, where $F = 1.5M$, which indicates that fishing has greatly exceeded sustainable levels.

Pilbara: The major performance measures for the fish stocks in the Pilbara demersal fisheries relate to breeding stock levels of the long-lived indicator species, i.e. red emperor and Rankin cod. The target level of spawning biomass is 40% of the initial level when the catch was first recorded. The limit level is 30% of the initial spawning biomass. The spawning biomass levels of the target species were assessed as adequate (spawning biomass was greater than 40% of virgin biomass) in 2007 by synthesising the available data in an age-structured model.

Kimberley

Assessment of the indicator species in the NDSF is also undertaken using a multi-tiered approach. Catch and catch rates are assessed annually and an age structured stock assessment model is applied using relevant data on a periodic (5 year) basis with the last assessment completed in 2007.

Catch Rates

The determination of catch per unit of effort (CPUE) prior to 2009 was based on mean catch rates calculated from monthly returns. During 2009 a transition from monthly returns to trip returns was undertaken to establish an improved level of spatial and temporal catch reporting. As a consequence there were two sources of catch returns for vessels operating in the NDSF during 2009; daily returns and monthly returns. In 2010 and 2011, all NDSF vessels reported catch and effort using daily logbook returns. Catch per unit of effort for daily logbook data is determined by calculating the mean CPUE from the analysis of catch and effort for every fishing trip undertaken in a year. Catch rates for Zone B only are presented in North Coast Figures 5-7, as this area represents the historical core fishing area of the NDSF prior to zoning in 2006. During 2011, Zone B catch rates for the indicator species were 119 kg/std day for red emperor, 544 kg/std day for goldband snapper and 150 kg/std day for cods/groupers. Catch rates for these three principal species/species groups were slightly lower than those reported in 2010 (132 kg/std day for red emperor, 577 kg/std day for goldband snapper and 164 kg/std day for cods/groupers). The catch rate for red emperor has been declining gradually since 2007, while the catch rates for goldband snapper and cods/groupers have only decreased slightly from recent years, where the catch rates were the highest recorded.

While both the 2011 catch of goldband snapper and cods/groupers from all zones exceeded the average of the previous four years, they did not exceed the ESD trigger point of a 20% increase in catch above the average of the past four years. The catch of red emperor was below the average of the previous 4 years.

Increases in catch levels are, by themselves, not very sensitive indicators of stock status but combined with the previous estimates of fishing mortality of goldband snapper being close to the upper acceptable limit, further material increases in their catch would represent an unacceptable risk given the information currently available. While several scenarios may explain the increased catches of goldband snapper in recent years, their validity should be resolved following the next collection and analysis of the representative age samples. In addition, recent work has been undertaken to standardise catch rates in the fishery for input into the next age structured stock assessment model evaluation.

Age Structured Model

The spawning biomass of the key target species in the NDSF was last estimated by an age-structured stock assessment model in 2007, which indicated the spawning biomass was above the international reference point of 40% of virgin biomass but with a slight declining trend for both red emperor and goldband snapper. These model outputs were reviewed by Prescott and Bentley in 2009, who concluded that the model was appropriate for use but would benefit from modifications, including the better determination of levels of model uncertainty. The model is currently being updated with continuous ongoing improvements being undertaken until the next assessment evaluation.

Current Assessment

The most recent model based assessment estimates indicated that there was a high probability that the spawning stocks of the indicator species were both above their respective threshold levels at that time. The overall catch levels and the species based catches were all within the acceptable ranges for the fishery, noting significant increases in goldband catches since 2007. The catch rates for the indicator species were either stable or declining gradually and the F based assessments indicated that the fishing level on the indicator species were either lower than the target level or between target and threshold levels. Consequently the stocks for the suite of species targeted by this fishery are effectively fished and currently considered to be at acceptable levels. If catches in Zone B are maintained at current levels, there is a low likelihood that the spawning stocks of any species within this suite declining to unacceptable levels. The current risk to sustainability for this suite is therefore moderate. Zone A of the fishery continues to receive increasing levels of effort and catch. There is currently a low to moderate risk to the sustainability of the fishery resources in this zone. Zone C of the fishery received a negligible level of effort in 2011. Therefore, there is currently a very low risk to the sustainability of the fishery resources in this zone.

NDSF: The performance measures for this fishery relate to the maintenance of adequate breeding stocks for the key indicator species as indicated by the catch levels. In 2011, the catches of goldband decreased from 2010, and did not exceed the performance indicator of a 20% increase in catch above the average catch of the preceding four years. The 2011 level of catch of cods/groupers was above that taken in 2010, and although also above the average of the previous four years, did not exceed the trigger point.

The 2011 red emperor catch was below the average of the preceding four years. The spawning biomass was greater than 40% of virgin biomass in 2007 with a slight declining trend for both red emperor and goldband snapper. All three species/groups are thus considered to currently have adequate breeding stock levels.

Non-Retained Species

Bycatch species impact:

Pilbara

Moderate

Kimberley

Low

Pilbara

An independent observer program designed to monitor bycatch and interactions with protected species was completed in September 2009. The outcomes of the observer program are reported in the FRDC report for Project No. 2008/048. This project suggested trialling a top-opening in the trawl nets to potentially further reduce the incidental capture of dolphins and turtles. Investment in a top-opening net along with additional modifications has been in development and undergone flume tank tests and sea trials by industry since 2010. This modified net design and other mitigation measures ('pingers') are being trialled within a dedicated observer program in 2012 in consultation with SEWPaC. The fish trap and line fisheries have minimal bycatch (see Kimberley below).

Kimberley

As a result of the catching capacity of the type of gear used and the marketability of most species caught, there is a limited quantity of non-retained bycatch in this fishery. The most common bycatch species is the starry triggerfish (*Abalistes stellaris*), but the numbers taken are not considered to pose a significant risk to the sustainability of this species.

Protected species interaction:

Pilbara	Moderate
Kimberley	Negligible

Pilbara

The fish trawl fishery has an incidental capture of bottle nosed dolphins, turtles, sea snakes, pipefish and seahorses (North Coast Table 5). Turtles and sea snakes are generally returned to the water alive but dolphins, pipefish and seahorses are generally moribund when landed. The catch of these species is recorded in compulsory skipper logbooks and reported annually to SEWPaC. The bycatch of dolphins and turtles has remained well below the levels observed prior to the introduction of exclusion grids in trawl nets in 2006. Given the area of distribution and expected population size of these protected species, the impact of the fish trawl fishery on the stocks of these protected species is likely to be minimal. There is a small catch of green sawfish, a species that is protected in WA waters. Measures to further mitigate protected species interactions by the fish trawl fishery (outlined above) have been under development since 2010 in consultation (and within timeframes established) with SEWPaC and these will be trialled in 2012 using dedicated above and below water observer programs.

The reporting of interaction with protected species has improved for the Kimberley and Pilbara trap fisheries. These fisheries regularly capture sea snakes. In 2011 the Pilbara and Kimberley trap fisheries reported 151 and 231 sea snakes respectively, all of which were returned alive.

Pilbara: The performance measures for the impact of the trawl fishery on protected species: skippers are required to record incidents of capture and to minimise mortality. Despite dolphins foraging inside trawl nets during ~98% of trawls (FRDC report, Project No. 2008/048) their capture is very rare (~0.005 trawl⁻¹ in 2011, reported by skippers in compulsory logbooks).

Based on estimates from independent observers, exclusion devices that were made compulsory in fish trawl nets in 2006 reduced the incidental catch of dolphins by 64% and turtles by 97%. Subsequently, dolphin mortalities reported in skipper logbooks have reduced to less than 20 per year since 2006 (North Coast Table 5).

Kimberley

Using trap gear in continental shelf regions is very unlikely to interact with protected species. Recent video observations indicate that the potato cod (*Epinephelus tukula*), a totally protected species, is present in high numbers at discrete locations within the fishery. Potato cod rarely enter traps due to their large size and girth limiting their capacity to pass through the entrance funnel into the traps.

Ecosystem Effects

Food chain effects:

Pilbara	Low
Kimberley	Negligible

Pilbara

The current Fish Trawl Fishery operates with standard stern trawling gear (single net with extension sweeps) within an area previously trawled by foreign vessels. Historical research by CSIRO has suggested that the extensive Taiwanese pair Trawl Fishery caused a significant decrease in the biomass of finfish on the North West Shelf, and a change in species composition towards smaller (shorter lived) species. The current WA Fish Trawl Fishery, which developed when the fish stocks had begun to recover, uses a much larger mesh size and much lighter ground gear, and operates at lower exploitation rates and only in restricted parts of the shelf. At the present levels of catch and effort by the fish trawl, fish trap, and line catch, the broader effect of the Fishery on the trophic levels and community structure of the North West Shelf is considered to be at an acceptable level. Significantly, Hall and Wise (2011) demonstrated that there has been no reduction in either mean trophic level or mean maximum length in the finfish catches recorded within the Pilbara (i.e. no fishing down of the food web) over the past 30 years.

Kimberley

The need to maintain relatively high levels of biomass for the species caught in this fishery to meet stock recruitment requirements results in a negligible risk to the overall ecosystem from the fishery. Hall and Wise (2011) demonstrated that there has been no reduction in either mean trophic level or mean maximum length in the finfish catches recorded within the Kimberley (i.e. no fishing down of the food web) over the past 30 years.

Habitat effects:

Pilbara	Moderate
Kimberley	Low

Pilbara

Direct impacts to the habitat are limited to those of the Pilbara Fish Trawl Fishery, which is restricted to less than 7% of the North West Shelf (North Coast Figure 1). Area 3

NORTH COAST BIOREGION

and the waters inside 50 m are permanently closed to fish trawling, Zone 1 is closed to fish trawling, and Area 6 has had no fish trawl effort allocation since 1998.

Within the areas actually trawled, past research has indicated that approximately 10% of the sessile benthic fauna (e.g. sponges) are detached per year. It is not known whether the detachment rate exceeds the rate of re-growth. Considering effort for the trawl fishery is at historically low levels, the effective area trawled within the managed areas has been greatly reduced.

Kimberley

As a result of the gear design, the fishery has little impact on the habitat overall, although there may be some rare interactions with coral habitats which are not common in areas where the fishery operates.

Pilbara: The performance measure for the fish trawl impact on the North West Shelf habitat was set as a maximum area of operation by the trawlers. With the current closures within the licensed area of the fishery (50 m to 200 m depth), 46% of the area is accessible to the trawl vessels. Plots of trawl activity from VMS data indicate the actual area trawled is significantly less than this.

Social Effects

Pilbara

It is estimated that 14 fishers on 3 vessels were directly employed during 2011 in the Pilbara Fish Trawl Fishery, and 8 fishers on 3 vessels in the Trap Fishery, and at least 21 fishers on 7 vessels in the line fishery. Overall, at least 41 people were directly employed in the Pilbara Demersal Scalefish Fisheries.

This fishery supplies significant amounts of fish to Perth, with catches from the Pilbara fisheries dominating the Perth metropolitan markets and supporting the local fish-processing sector. The exports from this fishery have been minimal in the last few years due to the increased value of the Australian dollar.

Kimberley

Seven vessels fished in the 2011 fishing season, with approximately three crew per vessel, indicating that at least 21 people were directly employed in the NDSF. Approximately half the fish from this fishery are supplied to Perth metropolitan markets, while the other half are supplied to east coast metropolitan markets.

Economic Effects

Estimated annual value (to fishers) for 2010-11:

Pilbara Level 3 - \$5 - 10 million

Kimberley Level 3 - \$5 - 10 million

The value of each of the North Coast Demersal fisheries is reported using the 6 categories defined in Fletcher et al. (2010) that are used to assess the relative economic (based on gross value product, GVP) and social amenity value associated with each ecological asset. These values are based on GVP figures derived from the 2010-2011 financial year.

Pilbara

The fish trawl demersal finfish catch is dominated by lower-valued species such as bluespotted emperor and threadfin bream, and its score value in 2010-11 was estimated to be 2 (i.e. Risk level – Low; Economic value – \$1-5 million; Social amenity definition – Some, the asset may be caught recreationally and/or there is some specific interest in the asset by the broader community). The fish trap and line catches are dominated the valuable species such as red emperor and goldband snapper, and the demersal scalefish catch from these sectors was estimated to have a score value in 2010-11 of 2 (fish trap; i.e. Risk level – Low; Economic value – \$1-5 million; Social amenity definition – Some, the asset may be caught recreationally and/or there is some specific interest in the asset by the broader community) and 1 (line; i.e. Risk level – Negligible; Economic value – < \$1 million; Social amenity definition – Minimal, there is no recreational fishing for the asset and no specific broader community interests), respectively.

Kimberley

The NDSF principally targets the higher-value species such as the goldband snapper and red emperor. The fishery's score value in 2010-11 was estimated to be 3 (i.e. Risk level – Moderate; Economic value – \$5-10 million; Social amenity definition – Important, this is an important asset locally and/or the use or existence of the asset is important to the broader community).

Fishery Governance

Target commercial catch range:

Pilbara Fish Trawl 2,000–2,800 tonnes

Pilbara Fish Trap 400–500 tonnes

Pilbara Line 50–115 tonnes

Kimberley (NDSF) 600–1000 tonnes (All Zones)

Current Fishing (or Effort) Level

Pilbara

Trawl Fishery Acceptable

Trap Fishery Acceptable

Line Fishery Acceptable

Kimberley Acceptable

Pilbara

In the Fish Trawl Fishery, the total catch was still well below the target catch range continuing a trend of the last four seasons. Considering that; 1) catch rates of indicator species are increasing or stable since effort reductions; 2) effort within the trawl fishery is currently at historically low levels; and 3) results from a higher level fishing mortality-based stock assessment and ecosystem based ecological assessment will be available in 2013 and 2014; current levels (2011) of effort and catch in the Pilbara fish trawl fishery are considered to impose a moderate risk for stock sustainability for the Pilbara Demersal Scalefish resource.

In the fish trap fishery, the total catch was within the target catch range in 2011. The line catch was at the upper limit of the acceptable catch range in 2011.

Kimberley

For the 2011 calendar year, the total allowable effort was set at 986 standard fishing days in Zone B, and 616 standard fishing days in Zone A, of the fishery respectively. The Zone A allocation aims to facilitate the exploration and development of this area of the fishery, while there is also further scope for fishers to develop Zone C (the deep slope area). At these levels of total effort and at recent catch rates, the total catch of the fishery is expected to be in the range of 600–1,000 t. The 2011 catches were marginally above the reported range. However, given the recent increases in fishing effort in Zone A, there is a need to review the target catch range for this fishery.

In addition to the overall catch target, ESD performance measures state that the annual catch of each of the key target species/groups (red emperor, goldband snapper and the cod/grouper complex) taken by the fishery should not increase by more than 20% above the average for the previous four years. Of the key target species/groups, the 2011 catch of goldband snapper and the cods/groupers complex were above the average of the previous four years, but did not exceed the ESD performance measure, while the red emperor catch remained significantly below the trigger level. Several different scenarios could explain the increased catches of goldband snapper in recent years and the validity of each of these scenarios should be resolved with the collection of the next representative age sample.

New management initiatives (2011/12)

Pilbara

The Pilbara Fish Trawl Interim Managed Fishery Management Plan cessation date was recently extended to 30 June 2013. The extension was provided to allow for the implementation of the Fisheries Research and Development Corporation (FRDC) Project 2008/048 *Reducing dolphin bycatch in the Pilbara finfish trawl fishery* recommendations, being; 1) the need for further net modifications, i.e. the installation of top opening escape hatches, to potentially further reduce dolphin capture rates; and 2) observer coverage combined with deployment of net-mounted video cameras in underwater housings for the trials, to be assessed. Following this, assessment regarding the long-term future of the Pilbara Fish Trawl Interim Managed Fishery, including consideration of moving the Fishery to “managed” Fishery status will be carried out.

Kimberley

There is a need to incorporate the industry agreed zoning and effort allocation arrangements of Area 2 of the NDSF into the management plan. The Department continues to consider projects related to the outcomes of the Prescott Review in consultation with licensees.

External Factors

The Commonwealth’s North-west Marine Bioregional Plan incorporates the aim of introducing marine reserves, which are likely to contain areas closed to fishing. This has the potential to restrict access to fishing in parts of the North Coast Bioregion to all sectors, i.e. commercial, recreational and charter.

Under the Offshore Constitutional Settlement, commercial trawl vessels licensed by the Commonwealth may operate in waters outside of a line that is meant to represent the 200 m isobath as part of the North West Slope Trawl Fishery (NWSTF). However, as this line encompasses waters in Zone B of the NDSF, any future catches by Commonwealth trawl vessels in these waters that are shallower than 200 m will impact on the demersal fish resources of the NDSF.

Climate change and climate variability has the potential to impact fish stocks in a range of ways including influencing their geographic distribution (e.g. latitudinal shifts in distribution). However, it is unclear how climate change may affect the sustainability risk to North Coast demersal fisheries.

Pilbara

The available fishing area has decreased slightly over recent years as a result of exclusion zones for gas pipelines and associated facilities. Seismic surveys also restrict the operation of fishers. However, there is little information as to the impacts and therefore the risks from seismic operations on demersal scalefish.

Kimberley

The impacts of environmental variation on the fishery are not considered to be large as target species are long-lived and inter-annual variability is likely to be ‘smoothed’. Some commercial fishers within the fishery have raised concerns about the increasing numbers of charter vessels operating in the offshore waters of the NDSF, which could generate resource-sharing issues in the future. In addition, offshore developments in the energy/gas industry may involve exclusion zones thus potentially limiting fisher access to some areas of the fishery. Increasing development of the Kimberley region is also likely to see a marked increase in the recreational effort and this may impact on stock sustainability. The Department of Fisheries undertook a state wide recreational fishing from boat survey in 2011. The first results of the entire survey are due in late 2012.

NORTH COAST TABLE 1

Commercial catches (tonnes) and the percentages of each major species taken by trawl, trap and line in the Pilbara in 2011 (estimates rounded to the nearest tonne).

Species		Trawl catch		Trap catch		Line catch		Total catch tonnes
		tonnes	%	tonnes	%	tonnes	%	
Bluespotted emperor	<i>Lethrinus punctulatus</i>	152	68%	71	32%	-	-	223
Crimson snapper	<i>Lutjanus erythropterus</i>	130	70%	49	26%	6	3%	185
Rosy threadfin bream	<i>Nemipterus furcosus</i>	79	99%	1	1%	-	-	80
Brownstripe emperor	<i>Lutjanus vitta</i>	63	77%	19	23%	-	-	82
Goldband snapper	<i>Pristipomoides multidens</i>	56	37%	74	49%	20	13%	150
Red emperor	<i>Lutjanus sebae</i>	54	46%	62	53%	2	2%	118
Saddletail snapper	<i>Lutjanus malabaricus</i>	43	66%	16	25%	6	9%	65
Spangled emperor	<i>Lethrinus nebulosus</i>	18	39%	20	43%	8	17%	46
Frypan snapper	<i>Argyrops spinifer</i>	30	94%	2	6%	-	-	32
Rankin cod	<i>Epinephelus multinotatus</i>	12	15%	60	77%	6	8%	78
Ruby snapper	<i>Etelis carbunculus</i>	-	-	-	-	30	100%	30
Other demersal scalefish		448	79%	85	15%	34	6%	567
All demersal scalefish		1,085	66%	459	28%	112	7%	1,656

NORTH COAST TABLE 2

Summary of reported commercial catches (tonnes) of demersal scalefish by line, trap and trawl in the Pilbara fishery, as well as by-product from the fish trawl fishery for the past decade.

Year	Demersal Scalefish			Total	By-product*
	Line	Trap	Trawl		Trawl
2002	90	306	2,310	2,706	180
2003	81	363	2,860	3,304	154
2004	240	395	2,837	3,449	113
2005	260	408	2,371	3,005	80
2006	105	473	2,222	2,800	46
2007	102	460	1,704	2,266	36
2008	86	508	1,210	1,804	37
2009	123	455	1,044	1,622	37
2010	117	489	1,259	1,865	32
2011	112	459	1,085	1,656	18

* By-product in 2011 consists mainly of bugs, cuttlefish, and squid.

NORTH COAST TABLE 3

Summary of the fishing effort in the Pilbara Demersal Scalefish Fisheries for the past decade. The trap, line and trawl effort (days) are derived from monthly catch and effort returns. The trawl effort (hours) is nominal effort from operators' logbook data.

Year	Line (days)	Trap (days)	Trawl (days)	Trawl (hours)
2001	401	446	1,162	15,330
2002	660	418	1,035	14,830
2003	715	412	1,014	14,663
2004	816	418	953	15,372
2005	993	425	886	14,721
2006	418	467	914	15,792
2007	344	429	841	14,197
2008	278	428	831	11,966
2009	282	483	713	10,605
2010	366	472	659	9,723
2011	376	420	545	7,338

NORTH COAST TABLE 4

Estimates of fishing mortality (F) relative to Exploitation Reference Points (ERPs) calculated for each of the indicator species collected in different management areas of the commercial trawl and trap fisheries in the Pilbara region from 2006 to 2008. ns = not sampled.

Indicator species	Year	Trawl area (Zone 2)				Trap
		1	2	4	5	
Red emperor	2007	$F > F_{\text{limit}}$	$F > F_{\text{limit}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	$F_{\text{limit}} > F > F_{\text{threshold}}$
Rankin cod	2006	$F = F_{\text{target}}$	$F < F_{\text{target}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	$F = F_{\text{threshold}}$	$F < F_{\text{target}}$
Goldband snapper	2008	$F_{\text{threshold}} > F > F_{\text{target}}$	$F < F_{\text{target}}$	$F < F_{\text{target}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	ns
Bluespotted emperor	2008	$F_{\text{threshold}} > F > F_{\text{target}}$	ns	ns	ns	ns

NORTH COAST TABLE 5

Reported by-catch of protected species by skippers in the Pilbara trawl fishery in 2011.

	Number released Alive	Number deceased*	Total Reported
Bottlenosed dolphins	2	16	18
Pipefish	21	32	53
Green sawfish	6	0	6
Narrow sawfish	36	1	37
Seahorses	0	1	1
Sea-snakes	58	7	65
Turtles	8	0	8

*Where the condition was not reported, the animal was considered deceased.

NORTH COAST TABLE 6

Recent total annual catches of major target and by-product species or species groups across all zones in the NDSF.

Species	NDSF annual catch (tonnes)						
	2005	2006	2007	2008	2009	2010	2011
Goldband snapper (<i>Pristipomoides spp.</i>)	429	336	405	457	485	523	487
Red emperor (<i>Lutjanus sebae</i>)	192	166	179	173	156	141	128
Saddletail snapper (<i>Lutjanus malabaricus</i>)	92	79	99	104	108	125	87
Spangled emperor (<i>Lethrinus nebulosus</i>)	21	28	15	18	23	30	20
Cod/grouper (Epinephelidae)	110	129	126	148	142	153	155
Other species	78	63	107	110	132	144	161
Total demersal scalefish catch	922	801	933	1010	1046	1116	1037

NORTH COAST TABLE 7

Catches of major target and by-product species or species groups by zone in the NDSF in 2010 and 2011.

Species	NDSF annual catch (tonnes)			
	2010		2011	
	Zone A & C	Zone B	Zone A & C	Zone B
Goldband snapper (<i>Pristipomoides</i> spp.)	29.5	493.1	13.1	473.7
Red emperor (<i>Lutjanus sebae</i>)	41.1	100.4	38.8	88.8
Saddletail snapper (<i>Lutjanus malabaricus</i>)	21.0	104.6	12.5	74.8
Spangled emperor (<i>Lethrinus nebulosus</i>)	3.5	26.4	1.9	17.8
Rankin cod (<i>Epinephelus multinotatus</i>)	16.0	33.0	17.8	23.4
Other Cods/groupers (Epinephelidae)	23.2	80.7	25.2	88.9
Other species	65.0	78.7	78.7	81.9
Total demersal scalefish catch	199	917	188	849

NORTH COAST TABLE 8

Total catches (t) of demersal finfish and effort (days) by line and trap vessels in the NDSF for the past decade.

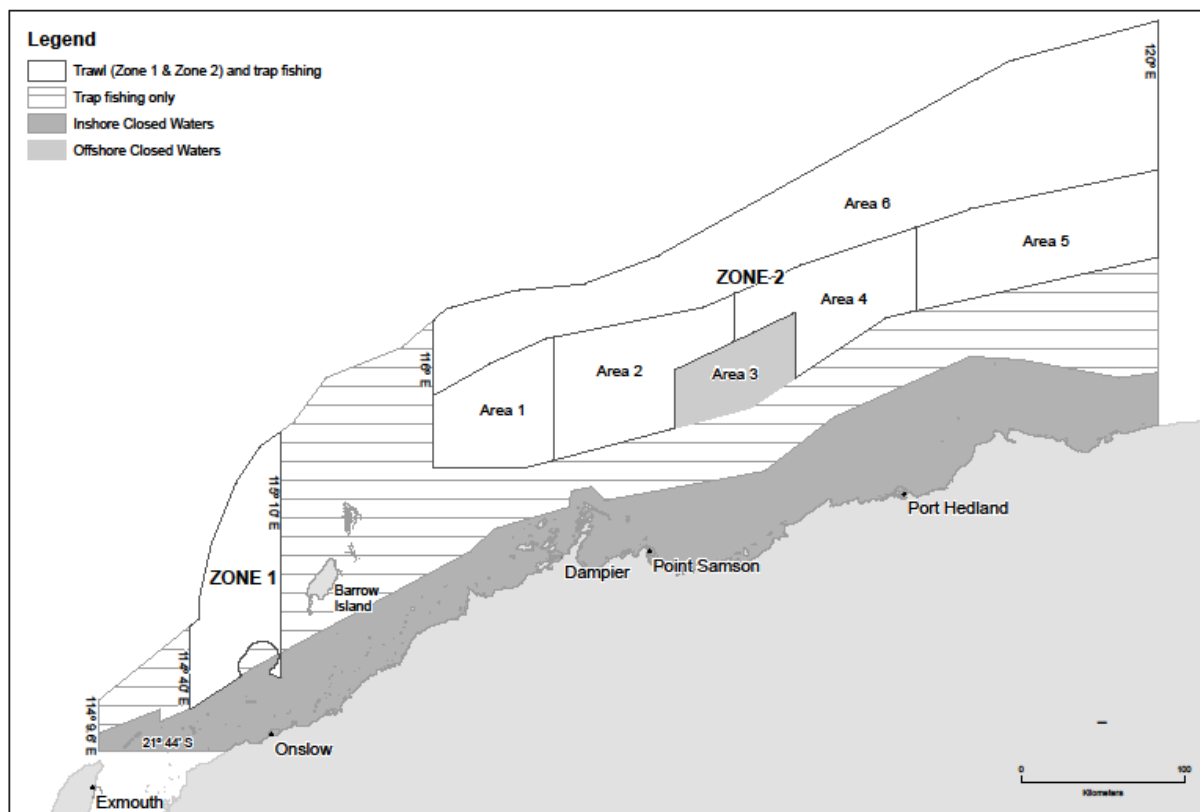
Year	Total allowable effort (days)	Line catch (t)	Line effort (days)	Trap catch (t)	Trap effort (days)	Total catch (t)
2001	1,672	47	136	462	928	509
2002	1,760	0	0	434	900	434
2003	1,760	0	0	552	1,060	552
2004	1,760	0	0	690	1,300	690
2005	1,760	0	0	922	1,318	922
2006	1,144	0	0	801	1,193	801
2007	1,144*	0	0	933	1,235#	933
2008	1,144*	7	0	1,003	1,150#	1,010
2009	1,144*	0	0	1,046	1,090#	1,046
2010	1038*	0	0	1,116	1,178#	1,116
2011	986*	0	0	1,037	1,042#	1,037

(* = TAE is for B Zone only; # = total effort is from all zones; 2011 Estimated Catch: Zone A = 188 t, Zone B = 849 t; 2011 Estimated Effort: Zone A = 163 SFDs, Zone B = 879 SFDs)

NORTH COAST TABLE 9

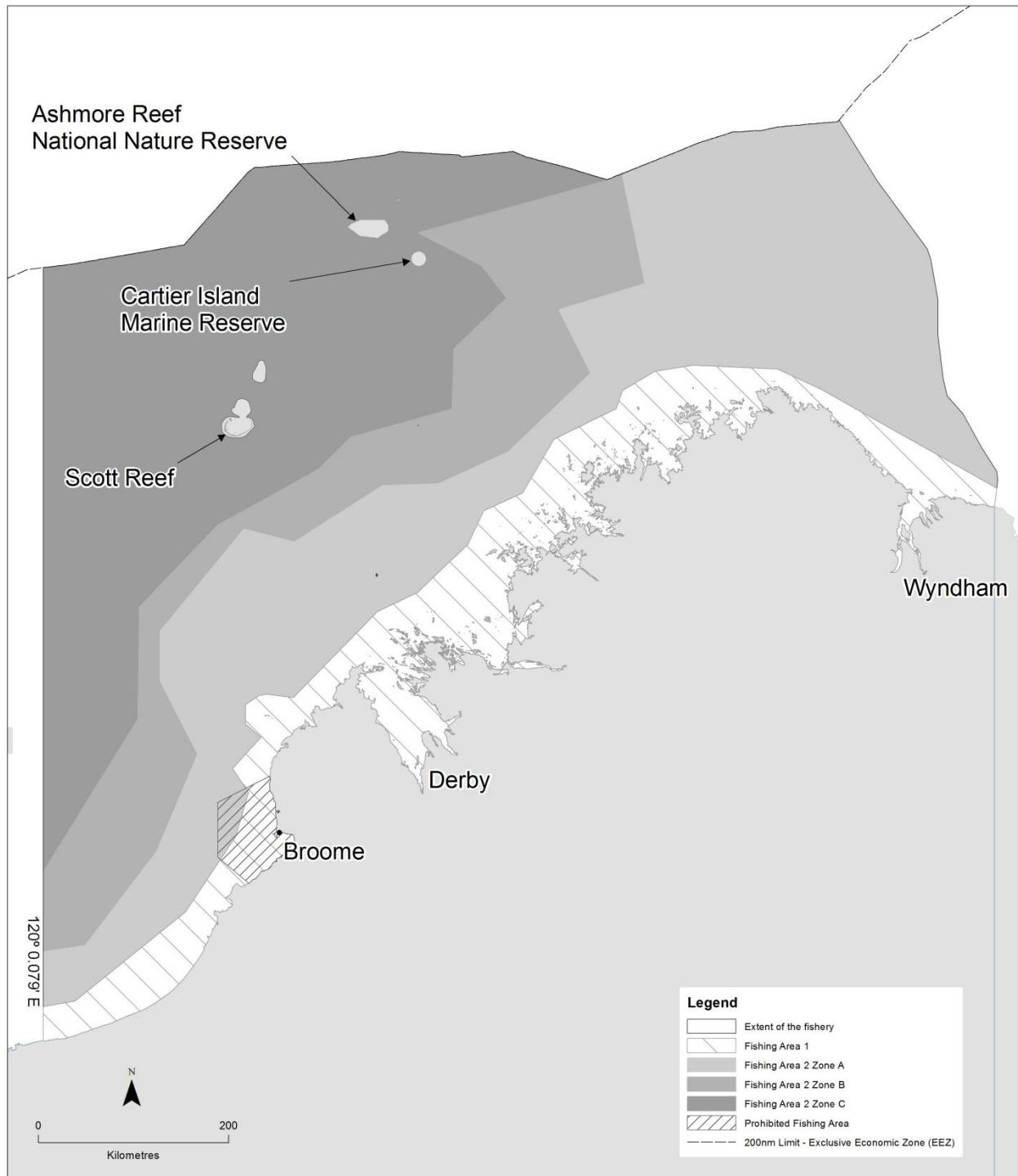
Summary of the commercial catches and the relative contribution (% composition) of each of the major species taken within the Pilbara and Kimberley sectors of the North Coast bioregion in 2011.

Species	Pilbara catch		Kimberley (NDSF) catch		Total catch
	tonnes	%	tonnes	%	tonnes
Red emperor	118	48	127.6	52	245.6
Saddletail snapper	65	43	87.3	57	152.3
Crimson snapper	185	80	45.2	20	230.2
Brownstripe snapper	82	96	3.0	4	85
Goldband snapper	150	24	486.7	76	636.7
Spangled emperor	46	70	19.6	30	65.6
Bluespotted emperor	223	85	38.3	15	261.3
Rankin cod	78	65	41.2	35	119.2
Frypan snapper	32	97	<1	3	33
Rosy threadfin bream	80	99	<1	1	81
Other demersal scalefish	567	75	187	25	754
Total all demersal scalefish	1656	61	1037	39	2693



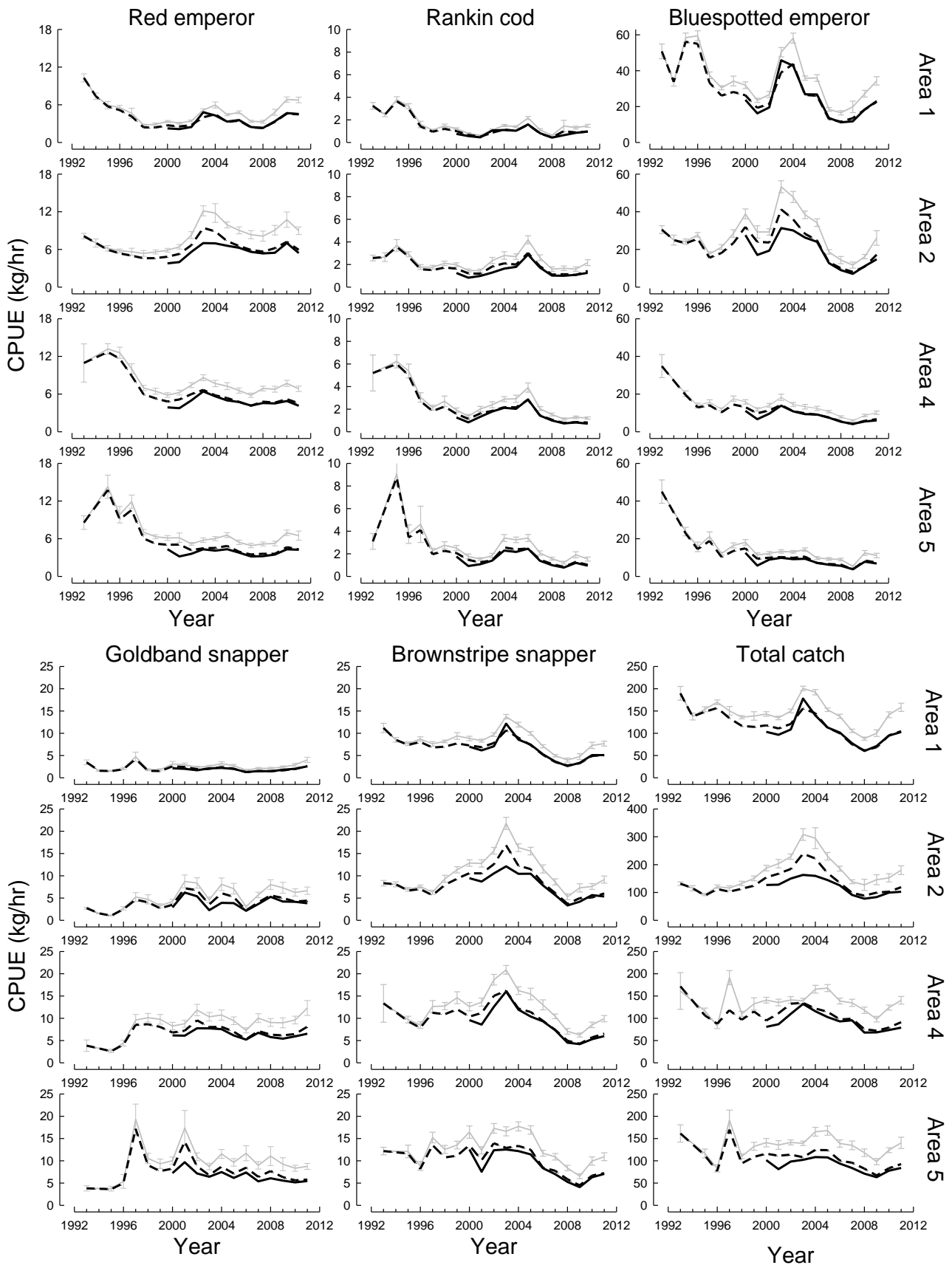
NORTH COAST FIGURE 1

Demersal scalefish fisheries of the Pilbara region of Western Australia. 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.



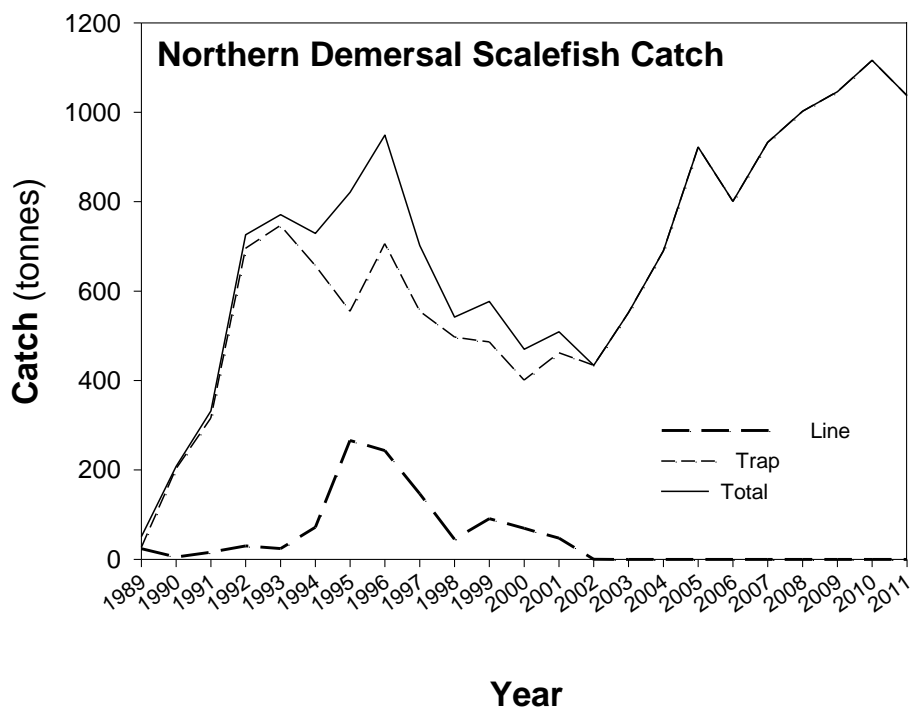
NORTH COAST FIGURE 2

Location of the Northern Demersal Scalefish Managed Fishery in the Kimberley region of Western Australia. Access areas and boundaries within the fishery are shown.

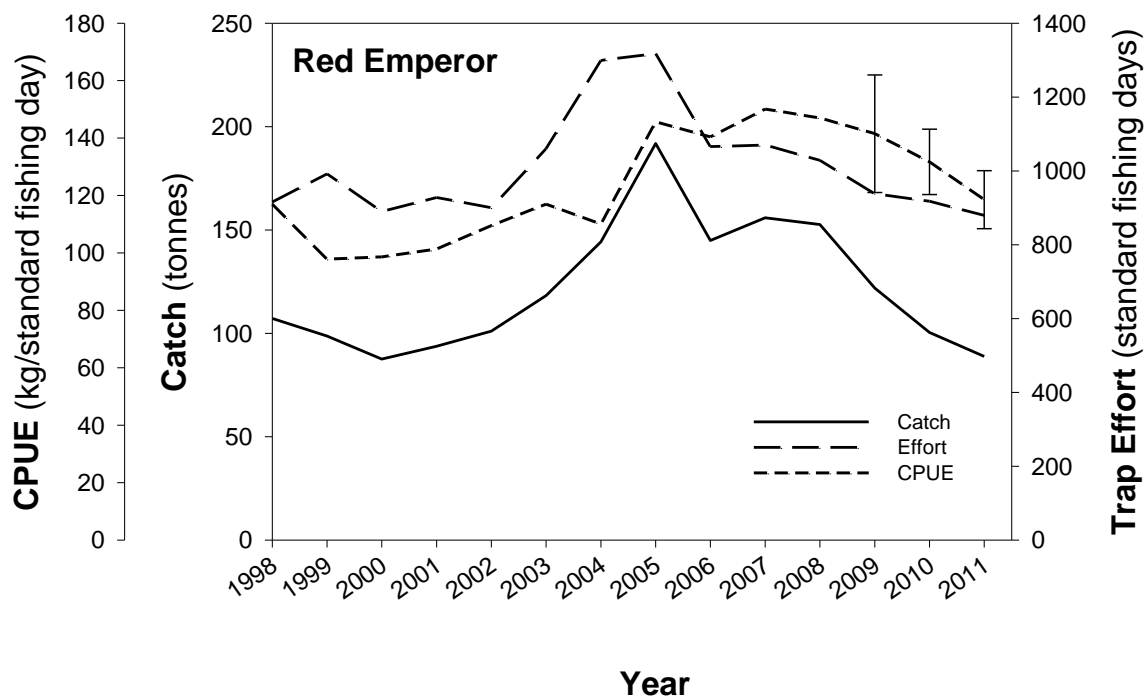


NORTH COAST FIGURE 3

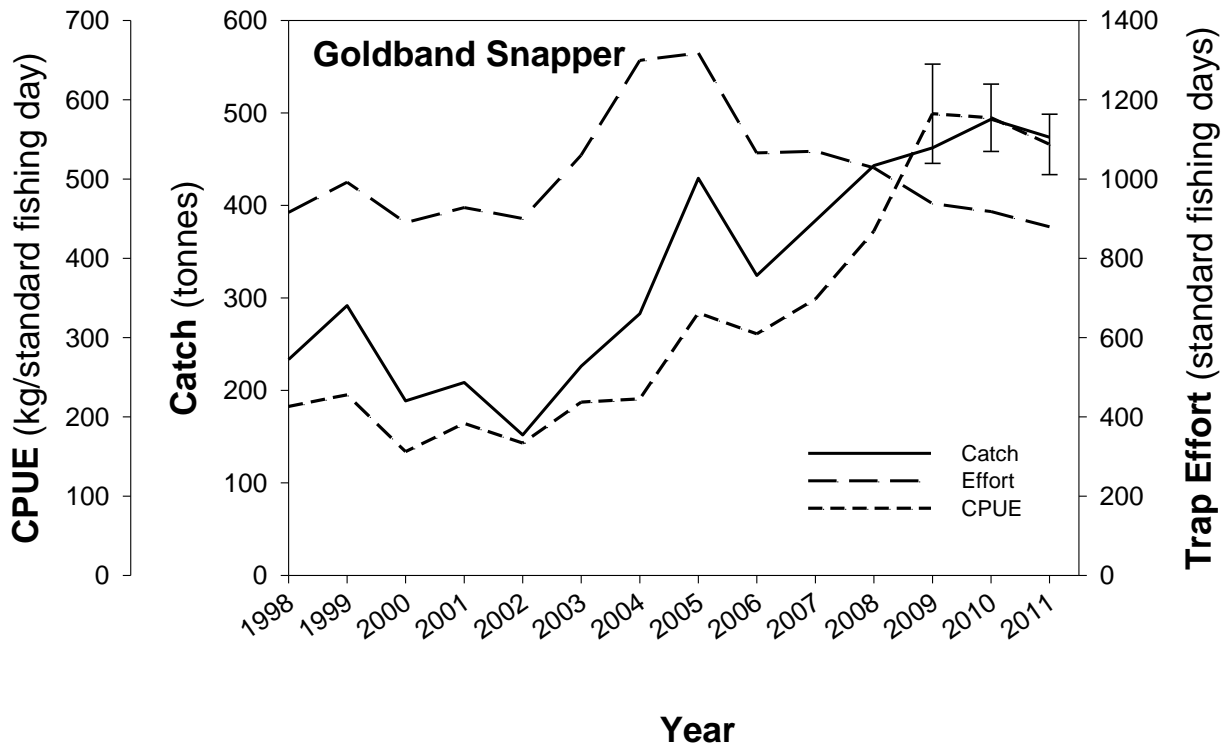
Annual mean Catch Per Unit Effort (CPUE, kg/hour) for five indicator species and the total catch in Areas 1, 2, 4 and 5 of the Pilbara Trawl Fishery from 1993–2011. The solid grey line is nominal catch rate (± 1 se) with trawl time as the effort measure, the dashed grey line is catch rate incorporating efficiency increase (trawl time as the effort measure) and the solid black line is catch rate using the time spent in each area as the effort measure (derived from VMS, data available since 2000).

**NORTH COAST FIGURE 4**

Catch levels of demersal finfish in the NDSF by line and trap, 1989–2011 (All Zones).

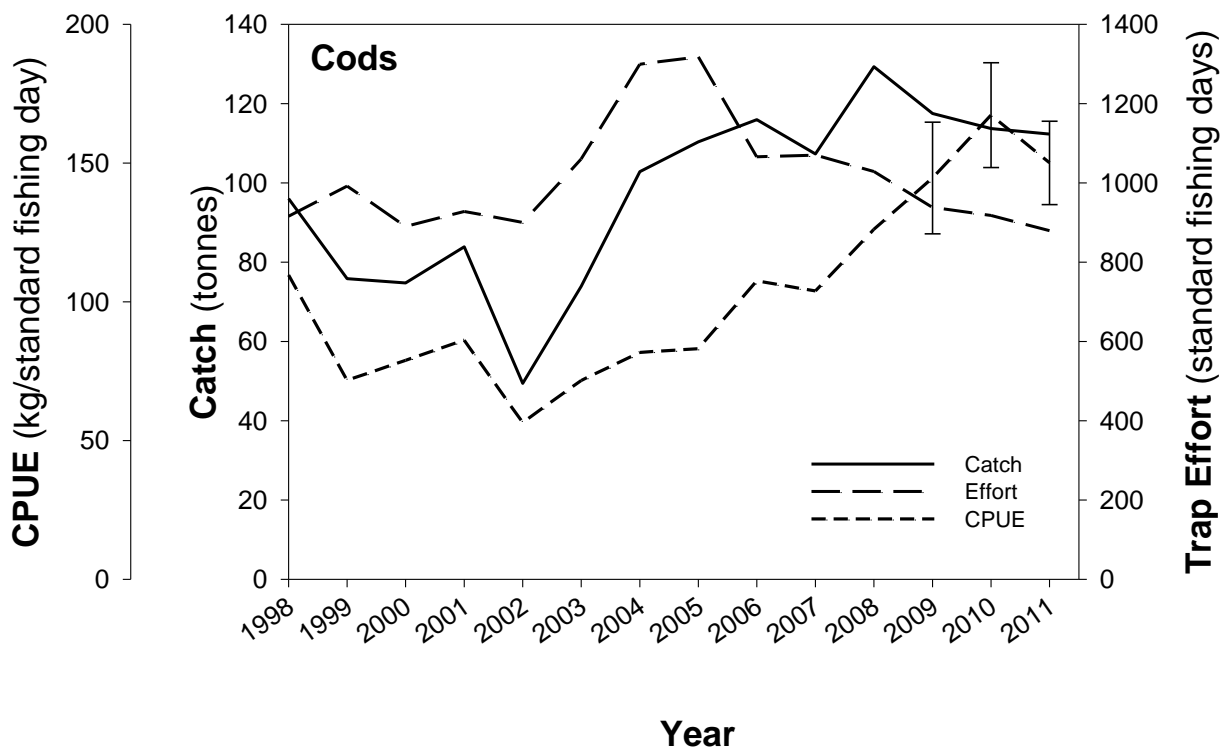
**NORTH COAST FIGURE 5**

Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998–2011 (2006–2011 for Zone B only, catches represent total landings in B Zone, whereas effort and CPUE are determined from commercial vessel activity only). Standard error bars illustrate variability in CPUE from the two sources of catch returns since 2009, and variability in trip CPUE data from daily log books (2010–11).



NORTH COAST FIGURE 6

Catch, effort and catch per unit of effort of goldband snapper in the NDSF by trap, 1998–2011 (2006–2011 for Zone B only, catches represent total landings in B Zone, whereas effort and CPUE are determined from commercial vessel activity only). Standard error bars illustrate variability in CPUE from the two sources of catch returns since 2009, and variability in trip CPUE data from daily log books (2010–11).



NORTH COAST FIGURE 7

Catch, effort and catch per unit of effort of cod/grouper in the NDSF by trap, 1998–2011 (2006–2011 for Zone B only, catches represent total landings in B Zone, whereas effort and CPUE are determined from commercial vessel activity only). Standard error bars illustrate variability in CPUE from the two sources of catch returns since 2009, and variability in trip CPUE data from daily log books (2010–11).

Mackerel Managed Fishery Report: Statistics Only

B. Molony, E. Lai and J. Wakefield

Fishery Description

Commercial

The Mackerel Fishery uses near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands to target Spanish mackerel (*Scomberomorus commerson*). Jig fishing is also used to capture grey mackerel (*S. semifasciatus*), with other species from the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium* also contributing to commercial catches.

Recreational

Recreational fishers target similar species using a range of gears including trolls, shore-based drift fishing with balloons and spear guns.

Boundaries

Commercial

The Fishery extends from the West Coast Bioregion to the WA/NT border, with most effort and catches recorded north of Geraldton, especially from the Kimberley and Pilbara coasts of the Northern Bioregion. Catches are reported separately for three Areas: Area 1 - Kimberley (121° E to WA/NT border); Area 2 - Pilbara (114° E to 121° E); Area 3 - Gascoyne (27° S to 114° E) and West Coast (Cape Leeuwin to 27° S) (Spanish Mackerel Figure 1).

Recreational

The fishery operates between the West Coast Bioregion and the WA/NT border, with most activity occurring between Perth and Dampier.

Management arrangements

Commercial

An Interim Management Plan was implemented for the Mackerel Fishery in August 2004, with fishing commencing under the plan in 2005. An Individual Transferable Quota (ITQ) system was introduced including setting Total Allowable Commercial Catches (TACCs) for each Area of the Fishery, allocation of the entitlement to take quota in the form of units, and establishment of minimum unit holding requirements to operate in the Fishery.

The maximum quantity of mackerel that may be taken from each Area of the Fishery during any permit period is limited to the quantity of mackerel determined by the Director General. The TACC for each Area of the Fishery for 2011 was:

	Spanish and other mackerel	Grey mackerel
Area 1:	205 t	60 t
Area 2:	126 t	60 t
Area 3:	79 t	60 t

The Plan includes limitations on the number of permits to fish in the Fishery and the type of gear that can be used. Boats operating in the Fishery are monitored by VMS and the master of an authorised boat is required to submit logbook

returns and catch and disposal records. Seasonal closures were removed in May 2008, as they were no longer a necessary tool to maintain sustainable and efficient management of the Fishery after quotas were put in place in 2006.

Permit holders may only fish for mackerel by trolling or handline. There are currently 65 permits in the Fishery with 23, 21 and 21 permits in Areas 1, 2 and 3 (respectively), with the combined quota allocations being consolidated onto 4, 3 and 9 boats operating within Areas 1, 2 and 3 (respectively).

A comprehensive ESD assessment of this Fishery determined that levels of Spanish mackerel breeding stock should be used as an annual performance measure for the Fishery. In November 2009, the Fishery was exempt from the export controls of the *Environment Protection and Biodiversity Conservation Act 1999* for a period of five years.

Landings and Effort (Season 2011)

Spanish mackerel	284.4 tonnes
Grey mackerel	13.4 tonnes
Other mackerel	0.7 tonnes

Commercial

The majority of the catch is taken in the Kimberley Area, reflecting the tropical distribution of mackerel species (Spanish Mackerel Figure 2). Estimates of catches are monitored through mandatory logbook systems with the total catch of Spanish mackerel in the 2011 season estimated at 284.4 t, similar to the total Spanish mackerel catch taken in previous years (2009: 284.2 t; 2010: 283.6 t) but lower than the peak catches in the early 2000s. Reductions in total catches since the early 2000s reflect reductions in fishing effort across all Areas with the highest effort reductions occurring in the Gascoyne Coast Bioregion.

A total of 14.1 tonnes of other mackerel were landed in the 2011 season, including 13.4 t of grey mackerel. The catch of grey mackerel in 2011 was the highest since 2006 but remains well below the TAC and the historical high catches of 'other mackerel' recorded in the late 1980s and 1990s.

All estimates reported do not include fish caught and released or lost to sharks.

Recreational

Catch estimates and resource sharing by this sector are currently only available through creel surveys which have occurred periodically (Spanish Mackerel Table 1). Reported annual catches of Spanish mackerel by recreational charter boats are relatively minor. Anecdotal reports from recreational fishers indicated a higher than usual abundance of Spanish mackerel in the lower West Coast Bioregion during 2011. This is likely to be associated with a marine heat wave event that occurred during this period. New estimates of recreational catches will be available in late 2012.

Fishery Governance

Target commercial catch range (TACC):

246 – 410 tonnes

The total catch in 2011 of 284.4 t was within the acceptable catch range. The reported catch from the Kimberley Area of 182.7 t was within the Area's acceptable catch range (110 – 205 t), and within the range reported since 2005. Catches in the Pilbara Area have been relatively stable since 2006 and the 2011 catch of 54.8 t was below the acceptable range (80 – 126t). Catches from the Gascoyne/West Coast Area in 2011 were 46.8 t, below the acceptable range of 56 – 79 t but similar to the range of catches from this Area since 2004. A review of the acceptable catch ranges and the TACC has been discussed at annual management meetings for this fishery.

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

Fishing effort throughout the Fishery has broadly stabilised since 2006 following reductions due to management changes. This is reflected by stable or increasing catch rates in all three Fishery Areas (Spanish Mackerel Figure 2). The 2011 catch rate in Area 1 (Kimberley) reverses the trend of recent years. This may be due to changes in biomass distribution and

availability of Spanish mackerel in this management Area due to oceanographic conditions (e.g. the influence of the marine heat wave of 2010/11).

The performance measure set for the Fishery is the status of the Spanish mackerel spawning stock. As the minimum legal size of 900 mm total length is similar to the size at maturity for this species, the spawning stock is essentially the same as the exploited stock. In this context, catch rates across the major areas of the Fishery are a general indicator of breeding stock levels.

Additionally, the total catches of Spanish mackerel remain within the target range. The total catch for this Fishery has remained within the acceptable catch range since 1991.

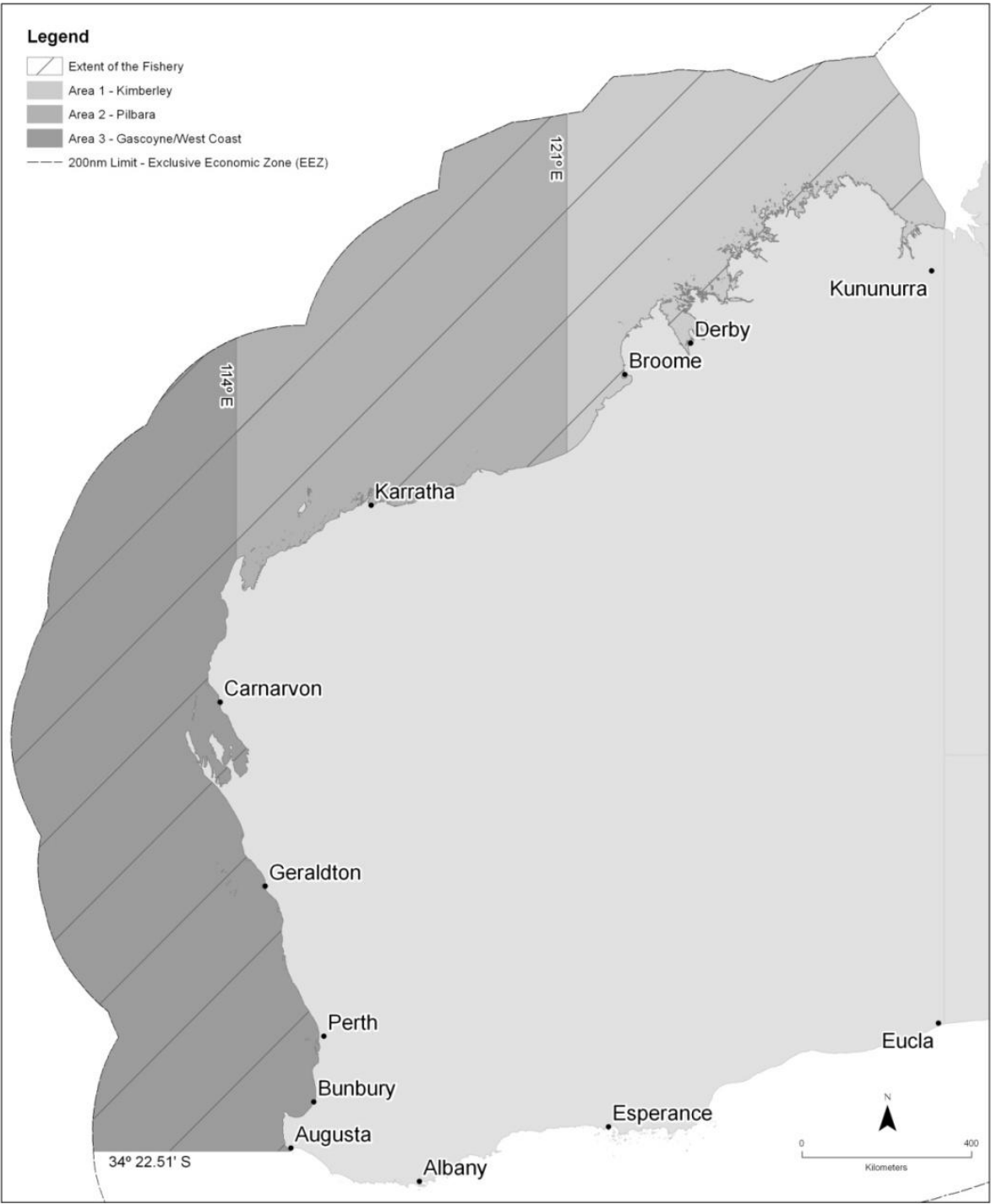
New management initiatives (2011/12)

The Mackerel Fishery (Interim) Management Plan 2005 expired on 31 December 2011 and was replaced by the Mackerel Managed Fishery Management Plan on 1 January 2012. Permit holders in the interim fishery were eligible for the grant of a Managed Fishery Licence under the new Plan. There are currently 49 fishing units in the Fishery with 15, 16 and 18 in Areas 1, 2 and 3 (respectively).

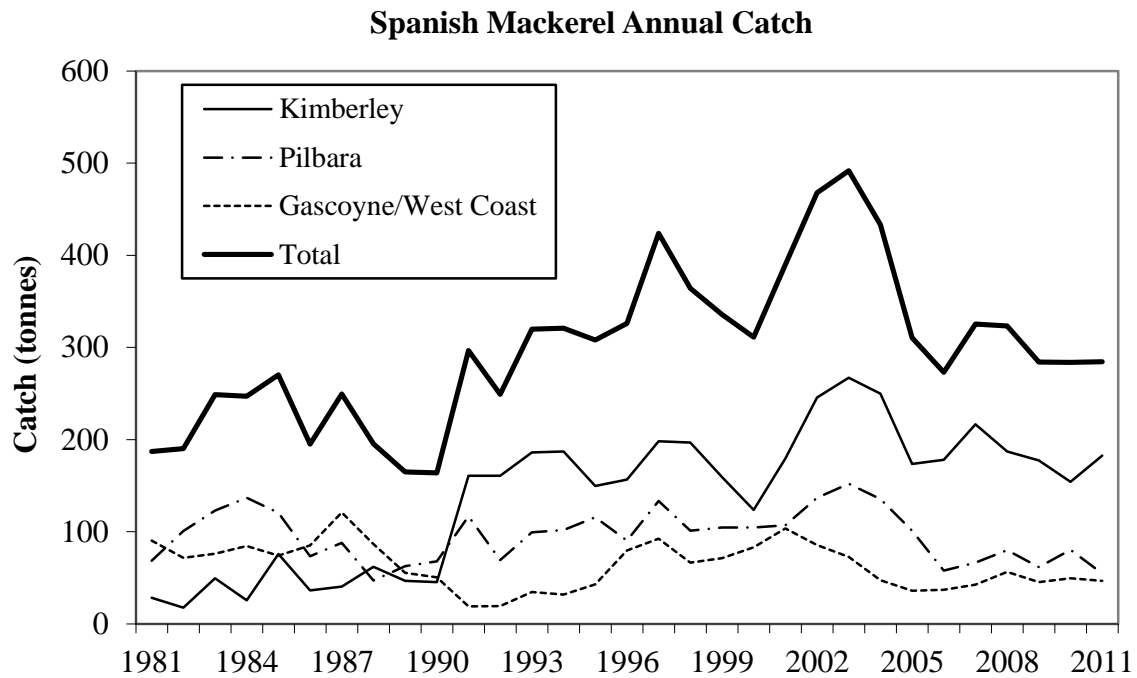
SPANISH MACKEREL TABLE 1

Recreational catch estimates of Spanish mackerel in Western Australia

Bioregion	Year	Retained catch	Share	Source
Pilbara (including Broome)	1999/2000	Spanish: 28 t Other: 11 t	21 % 15 %	Williamson et al. (2006)
Gascoyne	1998/1999	Spanish: 48 t Other: 8 t	42 % 10 %	Sumner et al. (2002)
West Coast	2005/2006	Spanish: 7 t Other: <1 t	45 % < 3 %	Sumner et al. (2008)

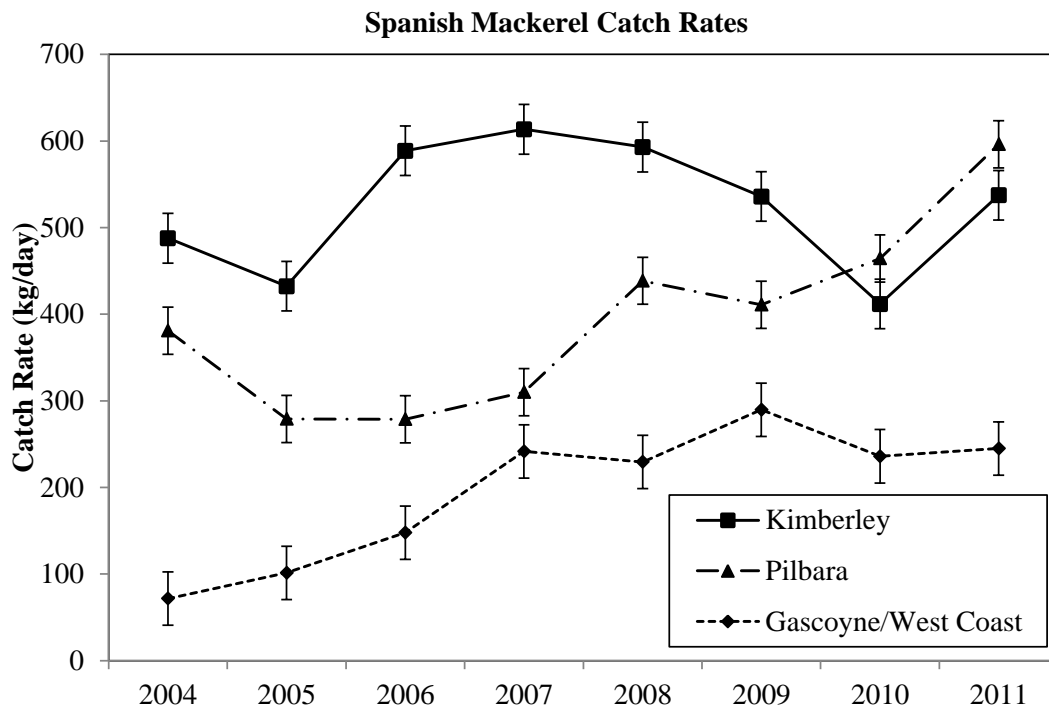


MACKEREL MANAGED FISHERY FIGURE 1
Map of the extent of the Mackerel Managed Fishery.



SPANISH MACKEREL FIGURE 2

Annual catches of Spanish mackerel in Western Australia, 1979–2011. Note: new management arrangements began in 2005 and quotas were introduced in 2006.



SPANISH MACKEREL FIGURE 3

Annualised catch rates of Spanish mackerel in Western Australia derived from daily logbooks, 2004–2011.

Northern Shark Fisheries Status Report

R. McAuley and F. Rowland

Main Features			
Status		Current Landings	
Stock level		Total sharks (2010/11)	0 t
Sandbar shark	Inadequate	Total scalefish (2010/11)	0 t
Blacktip sharks	Adequate	Shark catches by other commercial Fisheries (2010/11)	1t
Fishing Level	Acceptable	Recreational	Not assessed
	(potentially unacceptable)	Charter	Not assessed

Fishery Description

The 'northern shark fisheries' comprise the state-managed WA North Coast Shark Fishery (WANCSF) in the Pilbara and western Kimberley and the Joint Authority Northern Shark Fishery (JANSF) in the eastern Kimberley. Historically, the primary fishing method employed in these fisheries was demersal longlining with a relatively small amount of pelagic gillnetting in the JANSF. The northern shark fisheries have targeted various species since fishing commenced in 1994, including sandbar (*Carcharhinus plumbeus*), blacktip (*Carcharhinus* spp.), tiger (*Galeocerdo cuvier*), hammerhead (Sphyrnidae) and lemon sharks (*Negaprion acutidens*). Due to the small number of vessels authorised to fish in the northern shark fisheries and the commonality of gear-types and target species, data from the two fisheries are combined and they are considered as a single fishery for reporting purposes. As there was no reported fishing activity in the northern shark fisheries during 2009/10 or 2010/11, much of the following report is based on assessment of fishing returns submitted between 2006/07 and 2008/09. However, as only a few vessels reported fishing during those three years, annual catch and effort statistics cannot be reported separately and have been combined to ensure individuals' fishing activities cannot be identified.

Governing legislation/fishing authority

Fisheries Notice no. 476

Fisheries Notice no. 602

Fisheries Notice no. 601

Condition 127 and 129 on a Fishing Boat Licence

Other written authorities

Ministerial Exemption (WANCSF)

Consultation processes

WA Fishing Industry Council / Northern Shark Industry Association meetings.

Boundaries

The WANCSF extends from longitude 114°06' E (North West Cape) to 123°45' E (Koolan Island), and the JANSF from longitude 123°45' E to the WA/NT border (Northern Shark Figure 1).

Management arrangements

The commercial take of shark in northern Western Australian waters east of 123°45' E longitude is jointly managed by the Commonwealth Government and the State of Western Australia under an arrangement agreed through the Offshore Constitutional Settlement in February 1995. Under this arrangement, the State was given management responsibility for the JANSF on behalf of the WA Fisheries Joint Authority, whose members include the State and Commonwealth Ministers for Fisheries. Permitted fishing methods are demersal longlines and gillnets.

The solely Western Australian-managed sector of the northern shark fishery was closed by a Section 43 order under the *Fish Resources Management Act 1994* in 2005. Those subsequently permitted to fish in the WANCSF were restricted to approximately 40% of the fishery's previous area under a Ministerial Exemption. This exemption entitles the use of longlines with metal snoods and pelagic gillnets. Longlines are restricted to a maximum of 1,000 hooks and gillnets are limited to 2 kilometres maximum length, 160 – 185 mm stretched mesh size, and a maximum drop of 100 meshes. Additionally, gillnets must be attached to vessels at all times and may not come into contact with the seabed.

The WANCSF is now effectively zoned into three areas with separate levels of access. The area between North West Cape and a line of longitude at 120° E and all waters south of latitude 18° S has been closed indefinitely, primarily to protect the breeding stock of sandbar sharks. Operators are only allowed to fish in the area between 16° 23' S and 18° S latitude between 1 October and 31 January. Operators are allowed to fish in the remaining area (north of 16° 23' S latitude and between 120° and 123° 45' E longitude) throughout the year. A total of 200 gillnet fishing days and 100 longline fishing days are permitted in the WANCSF,

with no more than 100 of those days allowed in the southern area (i.e. between 16° 23' and 18° S latitude). All vessels operating in the WANCSF are required to report fishing activities via the Vessel Monitoring System (VMS) and daily logbooks.

Formal management arrangements have not been implemented in the JANSF and management arrangements for this fishery (and the associated WANCSF) have been a matter of ongoing dialogue between the State and Commonwealth. In April 2008 the JANSF's export approval under the EPBC Act was revoked due to the lack of formal management arrangements and concerns about the fishery's ecological sustainability. In February 2009 the Wildlife Trade Operation approval that allowed the export of products from the WANCSF expired and therefore, no product from either fishery can currently be legally exported.

Given that the majority of income from these fisheries was historically generated by the export of shark fins, the ongoing economic viability of the northern shark fisheries is uncertain. The Department of Fisheries is currently reviewing future options for managing the WANCSF and is working with the Commonwealth Government to finalise management arrangements for the JANSF.

Research summary

Research to assess the status of northern shark stocks was initiated as an extension of research into the targeted shark fisheries operating in the South and West Coast Bioregions. A three-year FRDC-funded project that concluded in 2005 provided an age-structured demographic assessment of the status of the northern shark fisheries' then principal target species, the sandbar shark (*Carcharhinus plumbeus*) and an improved understanding of the fisheries and of northern shark stocks more generally. Additional information on these fisheries and others that take sharks as bycatch in the North Coast Bioregion was collected during a series of Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) and FRDC-funded research projects to assess sustainability risks to Australia's tropical sharks and rays. Results from those projects have provided risk assessments for 75 elasmobranch species caught by 29 fisheries operating across the northern half of Australia and concluded that numerous species taken in the WA northern shark fisheries were at high risk of unsustainable exploitation.

Demonstrating the ecological sustainability of the northern shark fisheries is dependent on establishing robust estimates of sustainable harvest levels for target, byproduct and bycatch species. In particular, issues associated with blacktip sharks, sandbar shark and mackerel sustainability, as well as Threatened, Endangered and Protected (TEP) species interactions with pelagic gillnets require evaluation. Further research to estimate key biological parameters and fishing mortality rates for these and other species is required before any robust assessment of the fisheries' ecological sustainability can be undertaken.

To improve understanding of the northern shark fisheries' operations, a new daily/trip catch and effort reporting system was introduced in 2006/07.

Retained Species

Commercial landings (season 2010/11)

Northern Shark Fisheries: 0 tonnes

Other Commercial Fisheries: 1 tonne

The Northern shark fishery has not operated since 2008/09 and the level of shark catch by other commercial fisheries in this bioregion is negligible.

Recreational catch estimate: Not assessed

Commercial Fishing effort/access level

There was no reported fishing effort in the northern shark fisheries in 2010/11.

Two or three vessels reported sporadic activity in the fisheries between 2006/07 and 2008/09, which amounted to approximately 47% of the fisheries' permitted longline effort and 3% of their permitted gillnet effort.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Sandbar shark: Level 3 - Catch
(relative to previous direct survey)

Blacktip sharks: Level 1 - Catch

Breeding stock levels:

Sandbar shark: Inadequate

Blacktip sharks:
Adequate (based on NT assessment)

For details of sandbar shark assessment, see Demersal Gillnet and Longline Fisheries Status Report.

The status of the multi-species northern Australian blacktip shark stock complex was previously assessed using an age-structured model and time-series of CPUE data from the various Australian and Taiwanese-operated fisheries that have targeted them since the 1970s. However, that assessment did not provide specific advice on the status of Western Australian stock components and the reliability of the catch, effort and biological data upon which the model relies is questionable. Assessing the status of these stocks is further complicated by the cryptic impacts of illegal foreign fishing, unreported catches in domestic fisheries and uncertainty in the species composition of the target fisheries' catches. While the NT assessment of blacktip sharks was this stock was at acceptable levels with a 2,000 tonne per year maximum sustainable yield, these results may be unreliable for the Western Australian blacktip stock.

Assessing the status of other North Coast bioregion shark stocks is also complicated by poor species identification in catch returns prior to 2000 and a general lack of basic biological information. Thus, monitoring the status of other northern shark stocks will remain limited to analyses of reported catches and catch rates from the target commercial fisheries and from a ten-year time series of fishery-independent survey data. Although between 2006/07 and

NORTH COAST BIOREGION

2008/09 the nominal commercial fisheries CPUE of tiger and hammerhead sharks were at their highest levels since the late 1990s, these rates were derived from relatively small catches and limited effort. Thus, previous declines of 78% and 84% in their respective CPUE between the late 1990s and mid 2000s, remain of concern.

Non-Retained Species

Bycatch species impact: Not fully assessed

There has previously been observed discarding of unsaleable sharks, rays and scalefish in these fisheries although the magnitude of this cannot be reliably estimated. Although risks to other scalefish species were previously rated as low to negligible during the ESD risk assessment process, these assessments will require revaluation if levels of pelagic gillnet fishing effort escalate above historical levels.

Protected species interactions (Longline only)

The northern shark fisheries were rated as having a generally low risk of interacting with Threatened, Endangered and Protected (TEP) species through the ESD risk assessment process. However, as this assessment was based on the majority of fishing effort being applied by longlines, these interactions will need to be reassessed if levels of pelagic gillnet fishing effort escalate above historical levels. Previous ESD risk assessments for individual TEP species groups in the northern shark fisheries are discussed with reference to contemporary data below.

Sharks and rays: Because the northern shark fisheries generally operate some distance offshore, they pose a negligible risk to spartooth sharks (*Glyphis garricki* and *G. glyphis*) and sawfish (Pristidae), which have primarily inshore, estuarine and riverine distributions. The closure of the south western portion of the WANCSF is expected to reduce the risk of interactions with white sharks (*Carcharodon carcharias*) and grey nurse sharks (*Carcharias taurus*), which have primarily temperate and sub-tropical distributions. Whale sharks (*Rhincodon typus*) are understood to spend the majority of their time feeding pelagically and are therefore unlikely to be caught by demersal longlines. However, the risk of entanglement in pelagic gillnets is uncertain.

Turtles: No turtle captures have either been observed or reported in the northern shark fisheries. Although turtles are possibly more susceptible to capture by pelagic gillnets than demersal longlines, the amount of active gillnet effort over the last several years has been small relative to the fisheries' operational area and historical levels of gillnet effort in the fisheries.

Billfish: The small observed bycatch of billfish by demersal longlines in the northern shark fisheries was assessed as being insufficient to impact breeding stocks. This level of bycatch is unlikely to increase given current restrictions on fishing effort.

Cetaceans: As almost all northern shark fishery effort prior to 2005/06 was applied by demersal longlines, the risk of interaction with cetaceans was previously assessed as negligible. Although potential increases in the use of gillnets may result in higher levels of interaction with cetaceans, there are no empirical data from domestic pelagic gillnet

fisheries to estimate cetacean capture rates. However, the bycatch of dolphins is cited as the primary reason for restricting the Taiwanese-operated pelagic gillnet fishery that operated in the same area during the 1970s and 1980s and the risk of cetacean interactions will need to be re-assessed should gillnet effort increase.

Ecosystem Effects

Food chain effects: Negligible

Given the relatively small shark catches intended under current effort restrictions, the associated risk of any detrimental food chain effects is likely to be negligible. However, given the long recovery times expected for overexploited stocks of long-lived sharks, such as sandbar sharks (and possibly other species, eg. tiger and hammerhead sharks), unassessed residual food chain effects may persist for decades. It may also be necessary to reassess this risk if higher levels of fishing effort resume in the future.

Habitat effects: Negligible

The principal types of fishing gear that may be used to target sharks in the region are set so that they either do not, intermittently or unintentionally come into contact with the seabed. The physical impact of these gear-types on the seabed is therefore considered to be minimal. Despite fishing being constrained to a reduced area in 2005, the concurrent reduction in overall effort capacity is likely to have reduced the risk of habitat effects further.

Social Effects

Direct: Northern shark fishing vessels reported crews of between 3 and 5 in 2008/09. However, as only two or three fishing vessels have operated for a few months each year, these fisheries represent a part time source of employment.

Indirect: Sharks are viewed as a menace by some members of the community due to their perceived danger to bathers and their predation of recreationally prized fish. However, others consider them to be important components of marine ecosystems that need to be conserved.

Economic Effects

Estimated annual value (to fishers) for

2009/10 and 2010/11 nil

Fishery Governance

Target effort range:

600 gillnet days (1,200 kilometre gillnet days)
maximum

300 longline days (300,000 hook days) maximum

Target catch range:

Sandbar sharks: < 20 tonnes

Current fishing (or effort) level:

Effort: Acceptable (2010/11)

Sandbar shark catch: Acceptable (2010/11)

There was no reported fishing effort in the northern shark fisheries in 2010/11 (or 2009/10).

Total fishing effort was significantly lower and more sporadic between 2006/07 and 2008/09 than prior to 2005/06 (Northern Shark Figure 2). The few vessels that have been active since 2005/06 reported using 516 (57%) of the 900 permitted longline fishing days and 59 (3%) of the permitted 1800 gillnet fishing days between 2006/07 and 2008/09. As operators generally reported using less than the maximum permitted amount of fishing gear (i.e. 1,000 longline hooks or 2,000 m of gillnet), 47% of the 900,000 permitted hook days and 3% of the 3,600 permitted km gillnet days were used during these three years.

Although total shark catches had declined significantly from their 2004/05 peak of 1,294 tonnes, the mean annual sandbar shark catch of 63 tonnes between 2006/07 and 2008/09 far exceeded the sustainable upper limit of 20 tonnes (Northern Shark Figure 2 and 3). As breeding biomass of the sandbar stock is likely to be at the minimal acceptable limit reference point (40% of unfished biomass) and possibly continuing to decline (see Demersal Gillnet and Longline Fisheries Status Report), the catches of this species by the northern shark fisheries were at unacceptable levels. With the fishery currently not operating, this would be assisting with breeding stock recovery.

New management initiatives (2011/12)

Future management arrangements for the JANSF and the WANCSF are the subject of continuing discussion between the State and Commonwealth Governments.

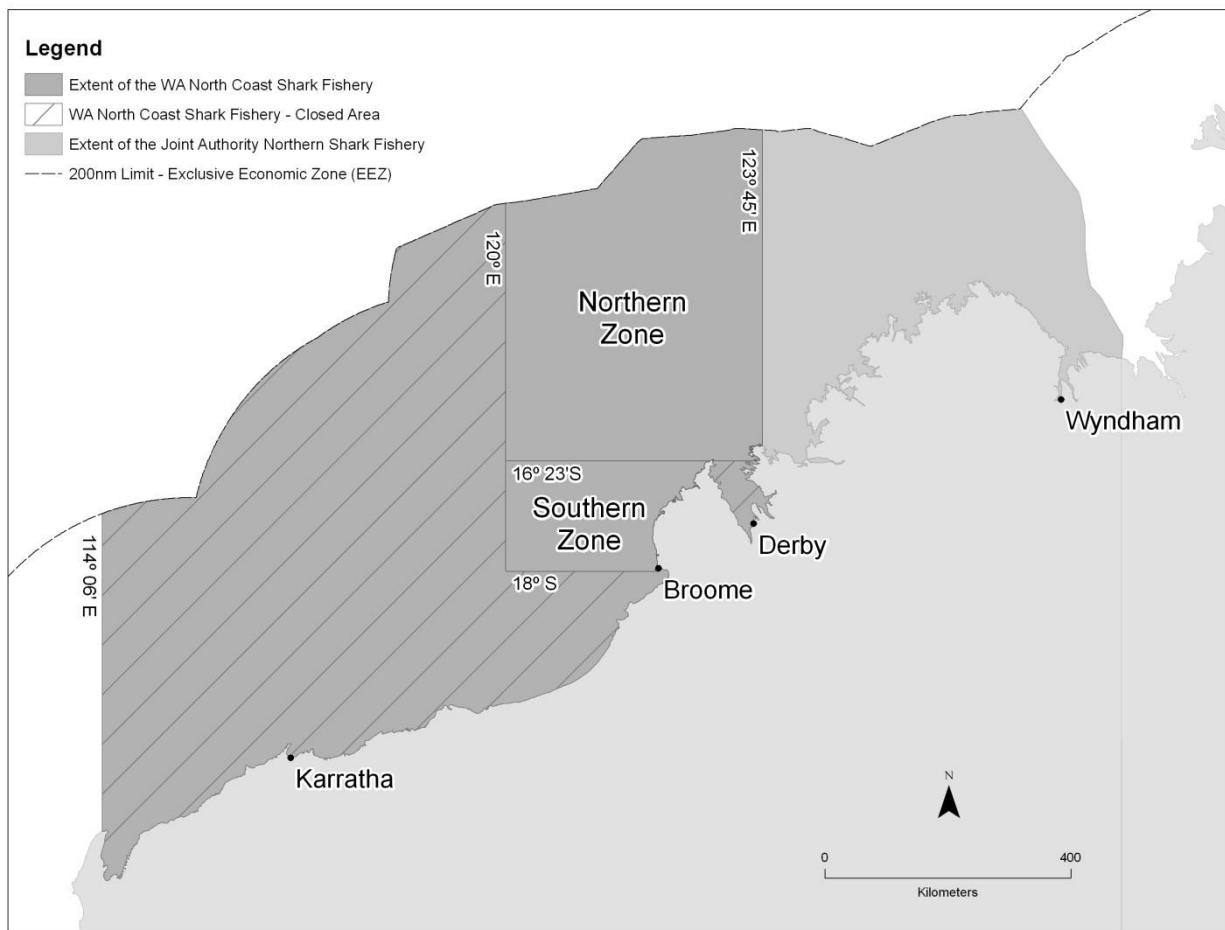
External Factors

The primary external factor affecting the northern shark fisheries is the withdrawal (JANSF) and expiry (WANCSF) of export approvals under the Commonwealth Government's EPBC Act. Development of demonstrably ecologically sustainable management arrangements required for the fisheries' re-approval is hampered by a lack of contemporary pelagic gillnet data in the North Coast Bioregion and other factors beyond the WA fisheries' control including: Illegal, Unregulated and Unreported (IUU) shark catches, cross-jurisdictional catches of target and byproduct stocks and long-term impacts on the breeding stock of sandbar sharks, the latter being critical to the sustainability of West Coast Demersal Gillnet and Demersal Longline Fishery catches (see Demersal Gillnet and Longline Fisheries Status Report)

NORTHERN SHARK TABLE 1

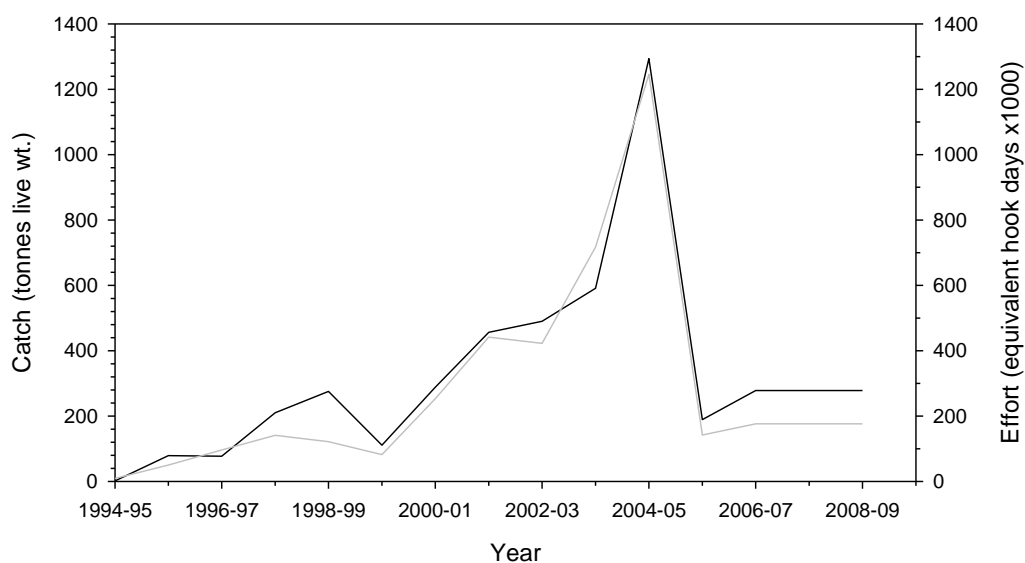
Northern shark fisheries' (WANCSF and JANSF) elasmobranch catch from 2006/07 to 2008/09. Data are amalgamated across these three years due to the confidentiality of records from the small number of vessels that were active in the fisheries in those years.

Name	Species or taxon	2006/07 - 2008/09 catch (tonnes)	
		Total	Mean annual
Blacktip shark	<i>Carcharhinus</i> spp.	202.0	67.3
Sandbar shark	<i>Carcharhinus plumbeus</i>	188.5	62.8
Pigeye shark	<i>Carcharhinus amboinensis</i>	138.4	46.1
Tiger shark	<i>Galeocerdo cuvier</i>	103.1	34.4
Hammerhead sharks	Sphyrnidae	82.9	27.6
Lemon shark	<i>Negaprion acutidens</i>	45.4	15.1
Spot-tail shark	<i>Carcharhinus sorrah</i>	36.2	12.1
Dusky shark	<i>Carcharhinus obscurus</i>	10.4	3.5
Shovelnose rays	Rhinobatidae, Rhynchobatidae	8.5	2.8
Other elasmobranchs		18.9	6.3
Total elasmobranchs		834.4	278.1
Grey mackerel	Scomberomorus	6.2	2.1
Cod	Serranidae	1.3	0.4
Spanish mackerel	<i>Scomberomorus commerson</i>	0.6	0.2
Mackerel, other	Scombridae	0.3	0.1
Other scalefish	Teleostii	0.7	0.2
Total scalefish		9.1	3.0



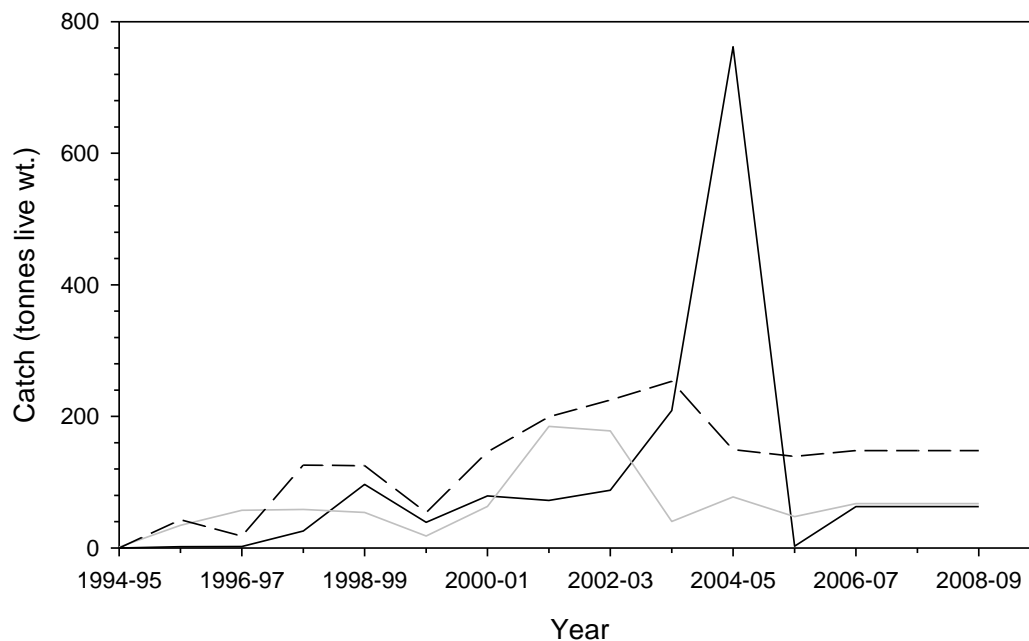
NORTHERN SHARK FIGURE 1

Management boundaries of the WA northern shark fisheries



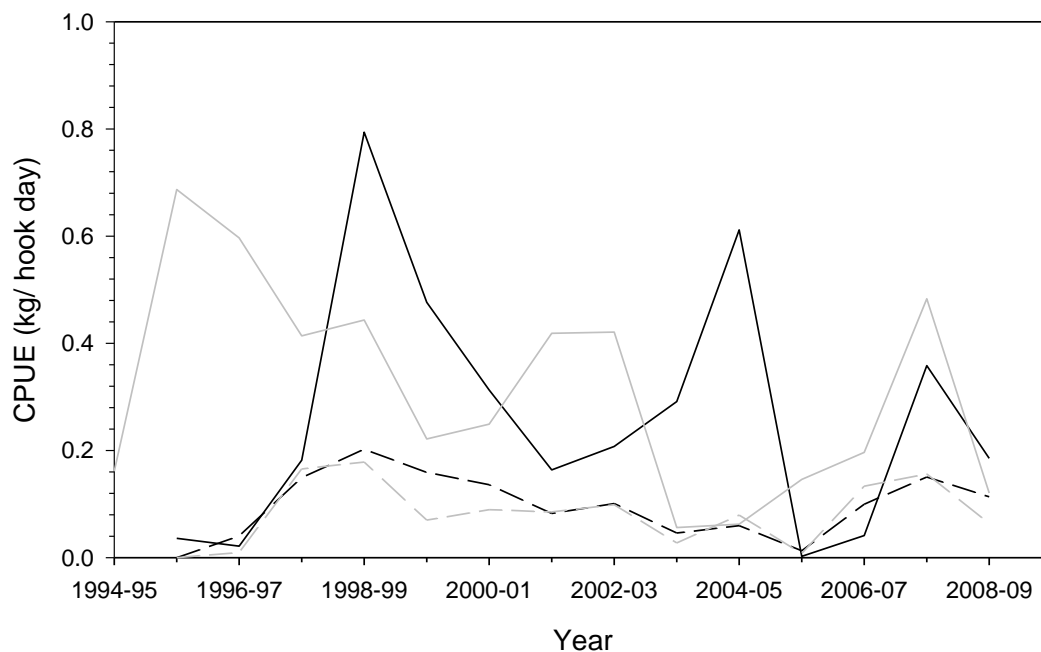
NORTHERN SHARK FIGURE 2

Total annual elasmobranch landings and standardised fishing effort (WANCSF and JANSF). Black line is catch (tonnes estimated live weight) and grey line is standardised total fishing effort (thousand hooks). Data from 2006/07 – 2008/09 have been averaged due to the confidentiality of records from the small number of vessels that were active in the fisheries in those years. There has been no effort or catches since 2009/10 in this fishery.



NORTHERN SHARK FIGURE 3

Annual catches (tonnes estimated live weight) of indicator and other shark species by the northern shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2009/10. Solid black line is for sandbar shark, grey line is blacktip sharks and dashed black line is other sharks. Data from 2006/07 – 2008/09 have been averaged due to the confidentiality of records from the small number of vessels that were active in the fisheries in those years. There has been no effort or catches since 2009/10 in this fishery.



NORTHERN SHARK FIGURE 4

Nominal Catch Per Unit Effort (CPUE) of indicator and secondary target shark species in the northern shark fisheries. Solid black line is sandbar shark, solid grey line is blacktip sharks, dashed black line is tiger shark and dashed grey line is hammerhead sharks. There has been no effort or catches since 2009/10 in this fishery.

Pearl Oyster Managed Fishery Status Report

A. Hart and D. Murphy and N. Moore

Main Features

Status		Current Landings	
Stock level	Adequate	Commercial Pearl Oyster Catch	
Fishing level	Acceptable	Shell numbers (All Zones)	796,158 shells

Fishery Description

The Western Australian pearl oyster fishery is the only remaining significant wild-stock fishery for pearl oysters in the world. It is a quota-based, dive fishery, operating in shallow coastal waters along the North-West Shelf.

The harvest method is drift diving, in which six to eight divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legal-sized oysters by hand as they are seen. The species targeted is the Indo-Pacific, silver-lipped pearl oyster (*Pinctada maxima*).

Governing legislation/fishing authority

Pearling Act 1990

Pearling (General) Regulations 1991

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

Consultation process

The Department undertakes consultation directly with licensees on operational issues. Formal license holder engagement is convened by the West Australian Fishing Industry Council (WAFIC) under a Service Level Agreement with the Department.

Boundaries

The fishery is separated into 4 zones (Pearl Figure 1), as follows:

Pearl Oyster Zone 1: NW Cape (including Exmouth Gulf) to longitude 119°30' E. There are 5 licensees in this zone.

Pearl Oyster Zone 2: East of Cape Thouin (118°20' E) and south of latitude 18°14' S. The 9 licensees in this zone also have full access to Zone 3.

Pearl Oyster Zone 3: West of longitude 125°20' E and north of latitude 18°14' S. The 2 licensees in this zone also have partial access to Zone 2.

Pearl Oyster Zone 4: East of longitude 125°20' E to the Western Australia/Northern Territory border. Although all licensees have access to this zone, exploratory fishing has shown that stocks in this area are not economically viable. However, pearl farming does occur.

There is also a 'buffer zone' between zones 1 and 2, which may be accessed by licensees from both Zones, although in practice, it is generally only utilised by Zone 1 licensees.

Management arrangements

The Western Australian pearling industry comprises three main components: the collection of pearl oysters from the wild; production of hatchery-reared pearl oysters; and grow-out of pearls on pearl farm leases. Quota limits are set for the take of pearl oysters from the wild to ensure the long-term sustainability of the resource.

In 1996 the WA Government granted hatchery options to licensees as part of an incentive program to encourage them to adopt new technology that enabled the production of pearls from oysters reared in hatcheries, thus reducing the reliance on the wild stocks of pearl oysters. Hatchery bred oysters are now a significant component of pearl production in Western Australia.

The pearl oyster fishery is managed primarily through output controls in the form of a total allowable catch (TAC) divided up into individually transferable quotas (ITQs). There are 572 wild-stock ITQ units allocated across three management zones (Zone 1 – 115; Zone 2 – 425; Zone 3 – 32) and 350 hatchery ITQ units allocated amongst 14 pearling licensees.

The value of a hatchery quota unit is 1,000 shell. The value of wild-stock quota units varies, depending on the status of wild stocks, but historically has been about 1,000 shell per unit when pearl stocks are at normal levels. However, wild stock quota units for Zone 2/3 for the 2011 season were set at 3,500 shell (TAC: 1,600,000), as result of high stock levels (Pearl Table 1).

Wild stocks are reviewed each year by the Department of Fisheries to enable the TAC to be set for each zone of the fishery. There is a new minimum legal size of 100 mm shell length; this is under trial for seasons 2011-2013. Historically the legal size limit has been 120 mm shell length, and maximum legal sizes and area-specific TACs have been set where appropriate, for example in Exmouth Gulf in Zone 1.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of pearl oysters. Boxed text in this status report provides the annual assessment of performance for this issue.

NORTH COAST BIOREGION

Research summary

Current stock assessment research is focused on:

- Stock assessment using catch and effort statistics (taking into account discard rates), piggyback spat settlement (0+ and 1+) and length-frequency sampling to estimate the total allowable catch.
- Monitoring an index of settlement for predicting future years catch levels 4 – 6 years ahead using the relative number of piggy back spat.
- Research on decision rules for determining the TAC.
- Understanding environmental drivers of pearl oyster abundance.

The Department of Fisheries' Research Division's Fish Health Unit also provides a comprehensive disease-testing program to the industry.

There are several other significant research projects being carried out by the pearling industry focusing on environmental management, improved health and safety for pearl divers and pearl oyster health. The main aims of the pearl oyster health study are to:

- Investigate aspects of oyster oodema disease (OOD) in *Pinctada maxima*, to assist in mitigating the impacts and understand pathways to disease and disease response in pearl oysters.

Retained Species

Commercial landings (season 2011):

796,158 oysters

In 2011, the number of wild-caught pearl oysters was 796,158 (Pearl Tables 1 and 2). The TAC for the pearl oyster fishery was 1,600,000, thus only 50% of the TAC was caught, as this was the quantity required under market conditions. In comparison, only 397,947 oysters were caught in 2010. The increased take was due to continued improvement in economic conditions and return of buyers in the market after the Global Financial Crisis.

In 2011, only Zones 2 & 3 were fished (Pearl Table 1). The total of 796,158 shell includes 30,949 Mother of Pearl (MOP), which are the large oysters (>175 mm shell length). This represents a 144% increase on the quantity of MOP taken in 2010 (Pearl Table 1) and this is only the second time MOP have been caught since 1986. There has been no fishing in Zone 1 since 2008 (Pearl Table 2).

Fishing effort/access level

Total effort was 14,361 dive hours (Pearl Tables 1 and 2), an increase of 220% from the 2010 effort of 4,447 hours. Of this, 643 hours was applied to MOP diving.

Stock Assessment

Assessment complete:	Yes
Assessment level and method	Level 3
Catch rate predictions, standardised CPUE	
Breeding stock levels:	Adequate

A stock assessment of the *Pinctada maxima* fishery was undertaken for the 2011 fishing season based on catch and effort statistics, settlement analysis (64,406 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (12,100 shells measured), shell discard rates by size and location, population surveys, and an evaluation of the predictive capacity of 0+ and 1+ spat settlement data.

These were used to generate trends in stock indicators, from which the determination of the TAC for 2012 was undertaken and provided to the Stock Assessment Working Group (SAWG). The SAWG is a Department-Industry group that provides integrated advice to the Director General on the sustainable harvest of the pearl oyster resource. The results for each zone, and issues relevant to stock sustainability, were as follows:

Zone 2/3: The catch rate achieved by the fishery is an indicator of the abundance of the 3/4 to 6/7-year-old oysters specifically targeted for pearl production. Year-to-year variations reflect changes in recruit abundance, while the long-term trend in catch per unit effort (CPUE) involves an element of effort efficiency change. In 2011, CPUE was 55 shells per dive hour, a decline of 38% from 2010 (89 shells per dive hour), but this was the highest value since this time series began in 1979 (Pearl Table 1). Although the fishery maintained a relatively high CPUE in 2011 (the third highest), the decline indicates that stock levels are returning to normal levels after record spat recruitment in 2005.

Catch rate prediction: Recruitment to the fishery is predicted by the piggyback spat abundance index at 4 to 6 years prior to the current fishing year and is used in conjunction with effort controls to set the quota for forthcoming years. A very high 0+ recruitment detected in the Zone 2 fishery in 2005 was confirmed in the 1+ year class in 2006, and again in the 2+ age class from population surveys in 2007. This cohort entered the commercially fished population between 2009 and 2011 resulting in the highest CPUE for over 30 years.

The 2011 stock abundance in Zone 2 was predicted to be lower than 2010, but with an additional large residual stock left over from uncaught TAC in 2009 and 2010. To account for this, the 2011 TAC in Zone 2/3 was increased slightly to 1,600,000 (3,500 shell per unit). This is 250 % above the baseline level of 1,000 shell per unit (Pearl Table 1). Using the catch prediction system, the catch quota for 2012 has been reduced to 639,800 shell which is closer to historic levels of quota.

Zone 1: The Zone 1 fishery has not been fished for three years.

Breeding stock: Under average growth and mortality, recruitment into the pearl oyster breeding stock exceeds natural mortality, and hence breeding stocks are likely to be increasing in most years. This results from the 'gauntlet' fishing strategy employed by the industry, in which the young, fast-growing shell (principally males) of 120 – 165 mm shell length are targeted for their fast pearl-producing qualities. The fishery is trialling a minimum size of 100 mm for 3 years, however the basis of quota setting will still be the abundance in the 120-165 mm size class.

Animals that survive this 'gauntlet' are effectively protected from the age of 6 to 7 years onward, and may live for another 15 to 20 years. With very low natural mortalities, this results

in a large residual broodstock being built-up over time. In Zone 1, breeding stock should also be increasing due to the low effort since 2002, including no fishing in 2004, 2009 - 2011 (Pearl Table 2).

The performance measures for this fishery, which relate to breeding stock biomass, include the area of fishing compared to the distribution of the stock and the catch rates of young oysters within each of the fishing zones.

All performance measures were met for 2011. The area of fishing remains substantially less than 60% of the distribution of oysters within this region. The catch rates in Zones 2 and 3 were both still above their respective performance levels, with a combined catch rate of 55 oysters/hour.

Non-Retained Species

Bycatch species impact: **Negligible**

Divers have the ability to target pearl oysters of choice (species, sizes and quality of *P. maxima*). Pearl oysters brought to the vessel after hand collection are young and have relatively little epiphytic growth (fouling organisms). A small number of over-sized or under-sized oysters are returned to the substrate.

Protected species interaction: **Negligible**

There is no interaction between the pearl oyster fishing operation and protected species.

Ecosystem Effects

Food chain effects: **Negligible**

The fishery removes only a small proportion of the biomass of pearl oysters on the fishing grounds and is considered to have negligible impact on the food chain in the fishing area.

Habitat effects: **Negligible**

Pearl divers have minimal contact with the habitat during fishing operations. The main habitat contact is by pearl oysters held in mesh panels on holding sites following capture. However, these sites cover a very small proportion of the habitat and the activity concerned is unlikely to cause any lasting effect.

Similarly, the pearl farming operation, which uses longline systems in areas of high tidal flow to culture pearls, has limited impact on the environment. Physical effects are limited to static anchoring systems in typically sand/mud habitats. Environmental management research (see 'Research summary') has found categorically that pearl farming has negligible impacts on habitat and environment.

Social Effects

Direct

Pearl oyster fishing vessels operate from the Lacepede Islands north of Broome to Exmouth Gulf in the south. The number of vessels in the fishing fleet has been slowly reducing from 16 in 1997 (overall), mostly due to increased fleet efficiency and increased reliance on hatchery-produced shells. In 2009, with the negative impact of the Global Financial Crisis (GFC) on the industry, only two vessels fished. The number of vessels fishing increased to 5 in 2011, as the effects of the GFC began to abate.

Most vessels presently operate 10 – 14 crew for the fishing of pearl oysters between March and June each year. These vessels also support shell operations and a number of other pearl farm functions throughout the year.

Indirect

Prior to the GFC, the pearling industry provided employment for approximately 500 people in the northern coastal regions, including in the operation of the pearl farms. However the impact of the GFC resulted in a substantial reduction in personnel employed in the pearling industry.

Economic Effects

Estimated annual value (Total Industry value) for 2011 **Level 5 - > \$20 million (\$93 million)**

A precise estimate of the total industry value is difficult to achieve, owing to the variable time lags that occur between harvesting and sale to offshore buyers, and the costs incurred in marketing before sales take place. Based on information provided by the industry, the value of cultured pearls and by-products in 2011 was considered to be approximately \$93 million, which is slightly lower than 2010, in which it was around \$99 million.

Fishery Governance

Target effort range: **14,071 - 20,551 hours**

The target effort range relates to the time required to achieve the TAC in the pearl oyster fishery of 1,655,000 oysters in 2011 (1,600,00 oysters in Zone 2/3, and 55,000 oysters in Zone 1).

Acceptable effort ranges for individual management zones are 11,456 – 15,819 dive hours for Zone 2/3 and 2,615 – 4,732 dive hours for Zone 1. These ranges are based on the 5-year period (1994 – 1998) following the introduction of global positioning systems (GPS) into the fishery, and reflect the typical variation in abundance of the stock under natural environmental conditions.

Zone 2/3 of the pearl oyster fishery achieved its catch with 14,361 dive hours of effort (Pearl Table 1), which was within the target range.

Zone 1 of the pearl oyster fishery was not fished in 2011 (Pearl Table 2).

NORTH COAST BIOREGION

Current effort level: **Acceptable**

Overall fishery effort level is acceptable, but current catch levels reflect market issues and not stock abundance.

New management initiatives (2012)

DoF has approved a two-year trial (2012/2013) for industry to take smaller shell legally, 100-120mm, and to harvest MOP. The request to take smaller shell was put forward by industry to evaluate the economics for their business model. DoF confirmed there were no sustainability issues, under a fixed TAC.

In 2010, the Minister approved a new departmental funding model for the pearling industry through the establishment of wild stock fishery access fees based on the gross value of the wild stock pearl oysters taken, rather than a recovery of management costs model. The pearl oyster fishery first operated under the new funding model during the 2011 licensing period. The introduction of new consultation arrangements in 2009 saw the dissolution of the Pearling Industry Advisory Committee and consultation with the pearling industry is undertaken with WAFIC as the peak commercial fishing body in WA and the PPA as the relevant sector body.

A new State Act of Parliament to ensure the sustainability and management of all WA's aquatic biological resources is

planned for introduction into Parliament in 2012. The new Act will replace both the Fish Resources Management 1994 and the Pearling Act 1990. The Department is facilitating a review of the current legislative framework ahead of the introduction of the new Act to adopt a more streamlined governance structure for the pearl oyster fishery and activities associated with pearl culture.

External Factors

The pearl oyster stocks underpinning the fishery in Zone 2/3 continue to provide a sufficient level of production to support this major Western Australian industry, however preliminary research points to environmental factors being an external driver of the current high abundance. The industry will continue to experience difficulty from the Global Financial Crisis, which had a major impact on the market for luxury goods, including pearls. The low catch and effort between 2009 and 2011 are a direct result of companies opting not to fish because of this. Future signs for 2012 suggest a market recovery but natural declines in oyster abundance due to lower settlement. Finally, the on-going issue of the OOD (oyster oedema disease) continues to hamper hatchery-production capacity in some sectors of the Industry, however to date there is no evidence the disease has affected wild stocks.

PEARL TABLE 1

Pearl shell catch and effort – Broome area (Zone 2/3) for the past decade.

Year	Wild stock quota	No. of culture shells	No. of MOP ¹ shells	Total shells	Dive hours	Culture shells/hr	Average depth	Total shells/hr
2001	502,500	502,484	0	502,484	12,054	41.7	12.1	41.7
2002	479,750	479,562	0	479,562	15,661	30.6	13.4	30.6
2003	457,000	456,988	0	456,988	14,242	32.1	13.6	32.1
2004	457,000	404,984	0	404,984	11,994	33.8	12.3	33.8
2005	502,500	488,303	0	488,303	14,807	32.9	12.1	32.9
2006	502,500	467,436	0	467,436	11,992	39.0	13.7	39.0
2007	548,400	550,972	0	550,972	12,514	44.0	12.9	44.0
2008	822,600	810,115	0	810,115	15,387	52.6	14.7	52.6
2009	1,005,400	260,002	0	260,002	3,285	79.2	11.4	79.2
2010	1,500,000	385,270	12,677	397,947	4,447	89.0	14.9	89.4
2011	1,600,000	765,209	30,949	796,158	14,361	55.8	12.2	55.4
2012	639,800							

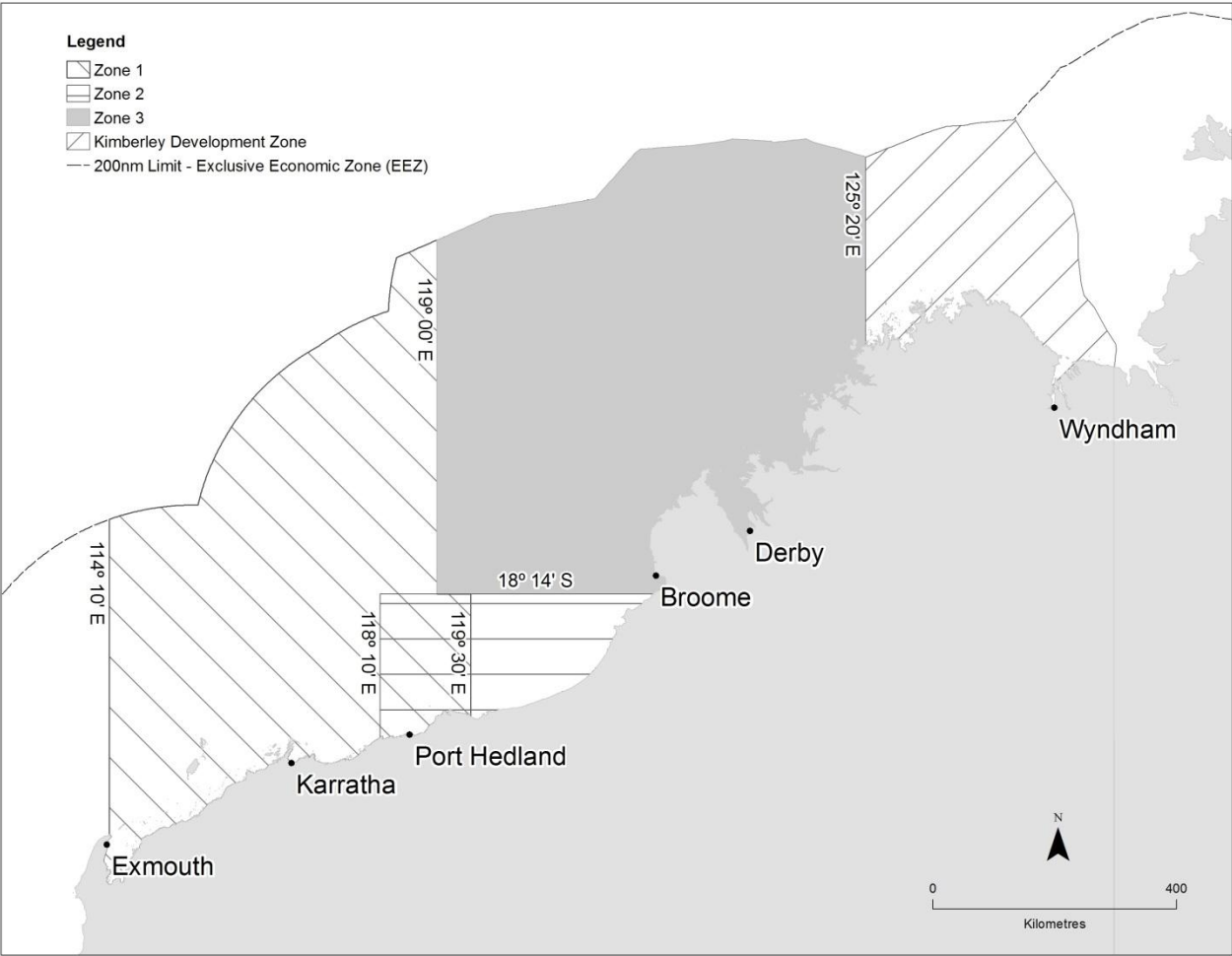
Notes: Total catches exceeding quota are a result of fisher shell tally error and the collection of broodstock shell being included as part of culture shell tallies. ¹ 'MOP' is an abbreviation for mother-of-pearl; ² wild stock quota in 2008 initially set at 639,800 (see SOF 2007 report), however a mid-season review increased it to 822,600 because of enhanced stock abundance

PEARL TABLE 2

Pearl shell catch and effort in Zone 1 for the past decade.

Year	Wild stock quota	No. of culture shells	Dive hours	Culture shells/hr
2001	115,000	68,931	9,480	7.3
2002	55,000	29,126	2,729	10.7
2003	45,000 ⁴	22,131	1,647	13.4
2004	45,000 ⁴	0 ⁵	0 ⁵	
2005	55,000 ⁶	25,572	1,084	23.6
2006a	55,000 ⁷	36,546	1,343	27.2
2006b	35,000 ⁷	34,900	349	100
2007	55,000	49,686	2,138	23.0
2008	55,000	10,092	398	25.3
2009	55,000	0	0	
2010	55,000	0	0	
2011	55,000	0	0	
2012	55,000			

1. A developmental period was introduced into the fishery from 1993 to 1997 to encourage hatchery production technology. The main undertakings were the introduction of 3 new Zone 1 pearl industry licences, and an increase in TAC of pearl shell in Zone 1 (from 55,000 to 115,000 shell).
2. Management arrangements in 1994 and 1995 allowed fishing of quota a year ahead.
3. Hatchery stock used since 1999 has reduced the need for wild-stock shell between 1999 and 2005.
4. In 2003 and 2004, the 115,000 Zone 1 quota was still maintained, however only 45,000 could be caught from wild stock due to hatchery shell substitution.
5. In 2004, no wild-stock quota was taken as only hatchery oysters were used.
6. Post 2005, the wild-stock quota for management and compliance purposes was returned to its long-term sustainable level of 55,000.
7. A higher TAC in 2006 was the result of an additional 35,000 experimental quota (2006b) allocated for a lightly-exploited stock within a pearl farm lease, and 34,900 of this quota was caught in 349 dive hours at a CPUE of 100 shells per hour. The remainder was caught at 27.2 shells per hour.



PEARL FIGURE 1
Distribution of pearl oyster stocks and fishing zones in Western Australia.

Beche-de-mer Fishery Status Report

A. Hart, D. Murphy and R. Green

Main Features

Status		Current Landings	
Stock level	Adequate	<i>Holothuria scabra</i> – Sandfish	56 t
Fishing level	Acceptable		

Fishery Description

Beche-de-mer, also known as 'sea cucumbers' or trepang, are in the Phylum Echinodermata, Class Holothuroidea. They are soft-bodied, elongated animals that usually live with their ventral surface in contact with the benthic substrate or buried in the substrate.

The Western Australian beche-de-mer fishery is primarily based in the northern half of the State, from Exmouth Gulf to the Northern Territory border, however fishers do have access to all Western Australian waters. It is a hand-harvest fishery, with animals caught principally by diving, and a smaller amount by wading. While six species have been taken, prior to 2007 it was primarily a single species fishery, with 99% of the catch being sandfish (*Holothuria scabra*). Since then, an additional species (deepwater redfish - *Actinopyga echinites*) has also been targeted and the fishery is now generally a two species fishery.

Governing legislation/fishing authority

Fisheries Notice no. 366

Exemption under Section 7(3)(c) of the *Fish Resources Management Act 1994*

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation)

Consultation process

Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), under a Service Level Agreement with the Department. Annual Broome Consultative Forum.

Boundaries

The beche-de-mer fishery is permitted to operate throughout Western Australian waters with the exception of a number of specific closures around the Dampier Archipelago, Cape Keraudren, Cape Preston and Cape Lambert, the Rowley Shoals and the Abrolhos Islands.

Management arrangements

The developing fishery for beche-de-mer is managed through input controls including limited entry, maximum number of

divers, species-dependent minimum legal size limits, and gear restrictions. Access to the fishery is limited to the 6 Fishing Boat Licence holders listed in the Instrument of Exemption enabling the take of beche-de-mer.

Beche-de-mer may only be harvested by hand or diving by licensed commercial fishers operating under the authority of a Fishing Boat Licence that is listed on the Instrument of Exemption.

The maximum number of divers (per endorsed fishing boat licence) allowed to dive for beche-de-mer at any one time is four, with a maximum number of six crew allowed on the vessel.

There are six species of beche-de-mer harvested in Western Australia. At present, the minimum target lengths for these commercial beche-de-mer species are based on the Northern Territory's minimum sizes, which have been set based on size at sexual maturity.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of beche-de-mer. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Current research is focused on reporting of annual catch and effort statistics. A daily catch and effort designed for the fishery was implemented in 2007. The logbook obtains species-specific, fine-scale catch and effort data and appropriate environmental information, such as depth fished.

Retained Species

Commercial landings (season 2011):

56 tonnes (live weight)

Landings

In 2011 the total beche-de-mer catch was 56 t live weight (Beche-de-mer Table 1), a decrease of 54% over last year's catch of 121 t, due to nil catch from the newly developing redfish fishery with all effort focused on the traditional sandfish fishery.

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The 56 t catch was therefore just of *Holothuria scabra* (Beche-de-Mer Figure 1), which is 60 % higher than the 2010 catch of 35 t for this species. This is the first time in the last five years that *Actinopyga echinites* has not been caught and industry has advised they are adopting a rotational fishing strategy with *A. echinites*, with 2011 being a rest period.

Fishing effort/access level

Only 2 licensed vessels fished for beche-de-mer in 2011, the same as 2007 to 2010. This represents 33% of the potential number of vessels that have an endorsement to fish.

Total effort was 1539 hours fished – about 104% higher than in 2010 and approximately 25% above the average of the last 6 years for sandfish fishing only (Beche-de-mer Table 1), comprising of 123 hours wading and 1416 hours diving.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Level 2 -Catch rate

Breeding stock levels: Adequate

The overall catch rate for sandfish (diving only in 2011) was 37 kg/hour, this is 20% below last year's catch rate of 46 kg/hour but close to the average of the last 10 years of 36 kg/hour (Beche-de-mer Figure 1).

Estimates of Maximum Sustainable Yield (MSY) of sandfish were obtained for the entire WA fishery and Kimberley sub-regions using a biomass dynamics model. Current average catch of sandfish is below the MSY (Beche-de-mer Table 2), indicating that the level of fishing is sustainable. However, large variability in the estimates of q (0.21 – 0.55) for the same species suggests that a cautious interpretation of the model outputs is required. The model is updated with new data every year.

The species performance measure for the Sandfish fishery are catches remaining in the range 20 – 100 t and catch rate remaining above 25 kg/hour. In 2011, both the catch (56 t) and catch rate (37 kg/hr) measures were met.

The species performance measure for the Redfish fishery are catches remaining in the range 40 – 150 t and catch rate remaining above 60 kg/hour. In 2011, there was no fishing so the performance measures could not be evaluated.

Non-Retained Species

Bycatch species impact: Negligible

No bycatch species are known to be taken in this fishery. Given the selective method of fishing used (diving or wading, collection by hand only), the minimal level of interaction with other species is likely to be maintained.

Protected species interaction: Negligible

There are currently no known interactions with protected in this fishery and given the methods of collection this is likely to remain the case.

Ecosystem Effects

Food chain effects: Negligible

This fishery harvests only a small amount of sandfish and redfish per annum. The effect from this harvesting on the rest of the ecosystem, given that the catch is spread over a wide region, would be insignificant.

In addition, predation on the beche-de-mer is relatively infrequent due to the toxins present in their body tissues. It is highly unlikely these animals are a major diet for higher-order predators, due to these toxins acting as an effective defence system.

Habitat effects: Negligible

Divers collect beche-de-mer as they drift over the bottom; there is minimal impact on the habitat as divers are highly selective in their fishing effort and no fishing gear or lines contact the seabed. The vessels work during the day and anchor at night, usually further inshore where they are protected from the open ocean that is subject to higher seas and wind. Most fishers are mindful of the habitat they choose to anchor over, so they avoid more diverse bottom habitat.

There are some areas where fishers can access beche-de-mer by wading through shallow water mangrove lagoons and estuaries. This is a minor component of the fishery. This method may be applied in areas of the Kimberley that are accessible and prone to extreme tidal movements. Wading usually occurs on soft sandy substrates, with minimal impact on these habitats.

Social Effects

In 2011, two vessels with a total of ten crew worked in the fishery. Additional individuals are employed for the processing of the product. These activities are mostly located in the Northern Territory where the fishing fleet is based.

Economic Effects

Estimated annual value (to fishers) for 2011:

Level 1 - < \$1 million

The estimated annual value for 2011 was \$187,000 based on an average product price of \$10.00/kg for sandfish (gutted and boiled) or \$3.33/kg live weight. This is a farm gate value and supports a substantial processing and value-adding sector.

Fishery Governance

Sandfish catch range: 20 – 100 tonnes

Redfish catch range: 40 – 150 tonnes

Current fishing level of 56 tonnes for Sandfish is within the target range. As no fishing for redfish was undertaken, in 2011 there was no assessment. If the fishery does move to a rotational harvest strategy for redfish, an updated catch range may need to be developed.

New management initiatives (2012/13)

A review of the developing Beche-de-mer fishery is planned for 2013/14.

The species-specific information on catch and effort from the daily logbook, implemented in 2007, has facilitated the

development of species-specific performance indicators and these will be refined as more information arises.

External Factors

The remoteness of the currently fished stock and the large tidal ranges where it occurs are natural barriers to uncontrolled expansion of fishing of beche-de-mer. Marine park planning has to date restricted this fishery from general use zones of MPAs. However consideration of removal of this restriction is currently underway as all other fisheries have access to general use zones. If successful, this action will likely seem some expansion into previously unfished areas.

BECHE-DE-MER TABLE 1

Catch and effort of Beche-de-mer in Western Australia for the last decade.

Year	¹ Live Wt (t) (all species)	Hours fished (all methods)	Live Wt (t) (Sandfish)	Hours fished (Sandfish)	Live Wt (t) (Redfish)	Hours fished (Redfish)	Live Wt (t) (Teatfish)
2001	90	2,434	88	2,414	2	20	0.2
2002	87	3,235	87	3,235	0		0
2003	122	4,877	121	4,867	1	10	0
2004	81	2,117	81	2,117	0		0.2
2005	78	1,876	75	1,876	0		0
2006	58	2,662	55	2,632	3	30	0.3
2007	113	1,804	26	976	87	828	0
2008 [^]	196 ²	1,544	27	448	169	1096	0
2009	129	1,423	31	701	98	722	0
2010	121	1,053	35	754	86	299	0
2011*	56	1539	56	1539	0	0	0

¹ Sandfish represented 99% of catch until 2006

² Redfish represented 86% of catch in 2008

[^] Diving only method used in recent years

* Sandfish represented 100% of catch by diving (93%) and wading (7%)

BECHE-DE-MER TABLE 2

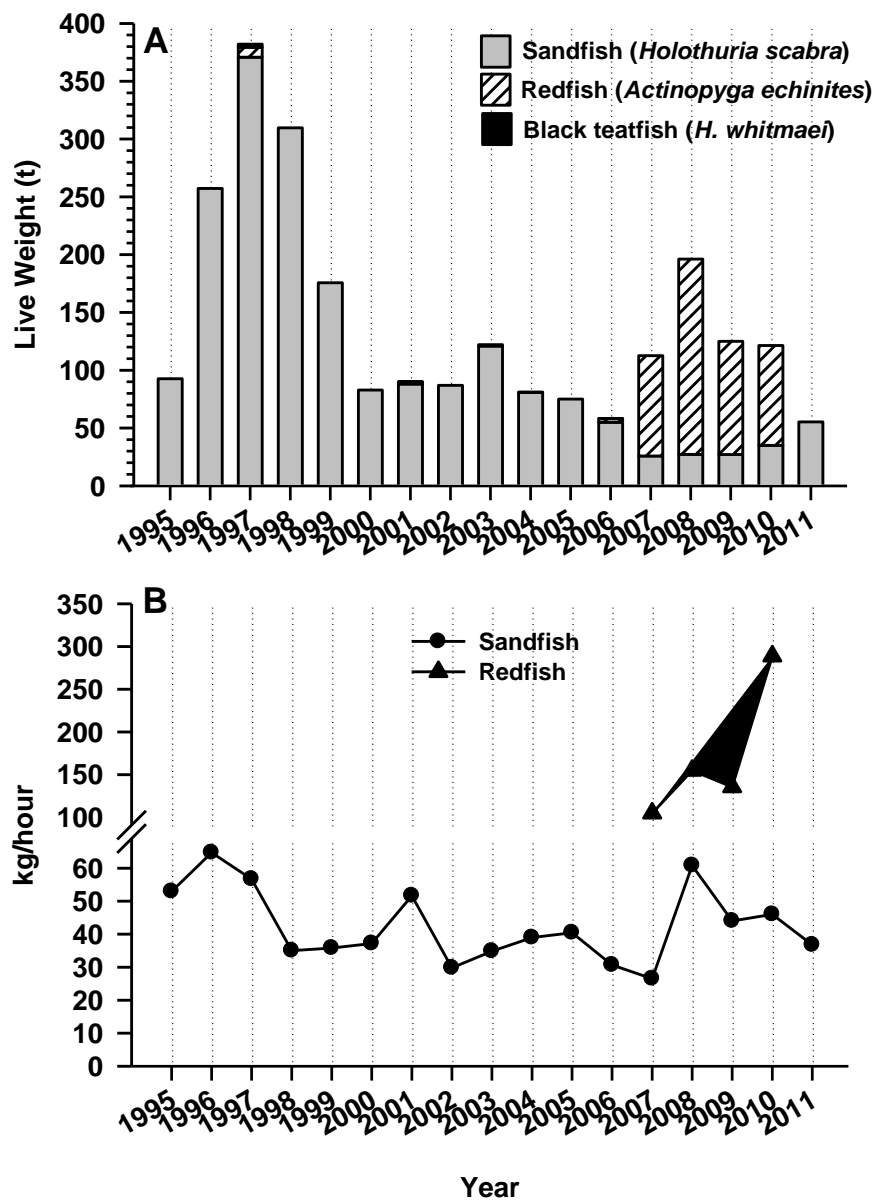
Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Beche-de-Mer fishery.

Area	MSY (t)	Current average catch (2005-2011) (t)	Parameter estimates*		
			r	K (t)	q
Entire Fishery	140	44	0.83	969	0.21
Kimberley region (Grid 1425 and 1426)	70	40	0.94	423	0.55

* r – intrinsic rate of increase

k – carrying capacity (Virgin biomass)

q – catchability or fishing power

**BECHE-DE-MER FIGURE 1**

A) Production (tonnes/live weight) by species, and B) catch rate (kg per crew day) from the Western Australian Beche-de-mer fishery.

North Coast Crab Fishery Status Report

D. Johnston, D. Harris, C. Marsh, C. Syers, R. Green and P. Carter

Main Features

Status		Current Landings	
Stock level		Blue swimmer crab	
Blue swimmer crab	Adequate	Commercial	20 t
Mud crab	Unknown	Recreational	approx 35% of total
Fishing Level		Mud crab	
Blue swimmer crab	Acceptable	Commercial	600 kg
Mud crab	Acceptable	Recreational	Not available for current year

Fishery Description

Blue Swimmer Crab

The blue swimmer crab (*Portunus armatus*) is found along the entire Western Australian (WA) coast, in a wide range of inshore and continental shelf areas, from the inter-tidal zone to at least 50 m in depth. However, the majority of the commercially and recreationally-fished stocks are concentrated in the coastal embayments and estuaries between Geographe Bay in the south west and Nickol Bay in the north.

Blue swimmer crabs are targeted using a variety of fishing gear but most commercial crab fishers in WA now use purpose-designed crab traps. Operators in the Pilbara Developing Crab Fishery are only permitted to use 'hourglass' traps. The Onslow and Nickol Bay prawn trawl fisheries also retain crabs as a by-product.

The Pilbara Developing Crab Fishery was established in 2001 via the Developing New Fisheries process, following the granting of an exemption from existing trap prohibition legislation, pursuant to section 7 of the *Fish Resources Management Act 1994* (FRMA). The exemptions were issued to allow for the sustainable exploration of the commercial viability of fishing crab stocks along the Pilbara coastline.

Mud Crab

Four species of mud crab (*Scylla* spp.) have been identified in the Indo-West Pacific region, of which the green mud crab (*Scylla serrata*) and brown mud crab (*Scylla olivacea*) occur in Western Australia (Keenan *et al.*, 1998)¹. The maximum size reported for green mud crabs is between 250 – 280 mm carapace width (CW) (Lloris, 2001)², whereas the maximum size of brown mud crabs is between 135 – 139 mm CW

(Tongdee, 2001)³. An identification brochure outlining minimum legal size limits and defining characteristics between green and brown mud crabs was produced by the Department of Fisheries in 2011 and is widely available to members of the public.

The green mud crab is predominantly found in estuarine habitats in north-western Australia from the Northern Territory border to Shark Bay, but have also been found as far south as the Wilson Inlet at Denmark in years of strong southern coastal current flow (Gopurenko *et al.*, 2003)⁴. The brown mud crab has a more restricted distribution limited to northern embayments, with most catches from King Sound 200 km northwest of Broome. Brown mud crabs are more tolerant of low salinity than green mud crabs, but less tolerant of lower temperatures. They are also considered to exhibit a strong preference for the intertidal zone, while green mud crabs make regular use of both intertidal and subtidal habitats up to 20 m depth offshore (Hill, 1994⁵, Robertson, 1996⁶).

Mud crabs are fished commercially in the Kimberley region between Broome and Cambridge Gulf near the WA and Northern Territory border, with fishing effort concentrated

1 Keenan, C.P., Davie, P.J.F., and Mann, D.L. (1998). A revision of the genus *Scylla* de Hann, 1833 (Crustacea: Decapoda: Brachyura: Portunidae). *Raffles Bulletin of Zoology*. 46(1): 217-245.

2 Lloris, D. (2001). FAO/SIDS species identification sheet: *Scylla serrata*

3 Tongdee, N. (2001). Size distribution, sex ratio and size at maturity of mud crab (*Scylla* spp.) in Rangong Province, Thailand. *Asian Fisheries Science* 14: 113-120.

4 Gopurenko, D., Hughes, J.M., and Bellchambers, L.M. (2003) Colonisation of the south-west Australian coastline by mud crabs: evidence for a recent range expansion or human-induced translocation? *Marine and Freshwater Research*. 54: 833-840.

5 Hill, B.J. (1994) Offshore spawning by the portunid crab *Scylla serrata* (Crustacea: Decapoda). *Marine Biology*. 120:3. 379-384.

6 Robertson, W.D. (2011) Abundance, population structure and size at maturity of *Scylla serrata* (Forsk.) (Decapoda: Portunidae) in Eastern Cape estuaries, South Africa. *South African Journal of Zoology*. 31:4. 177-185.

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around Cambridge Gulf, Admiralty Gulf, York Sound and King Sound (see North Coast Crab Figure 1).

Mud crab trap design varies between individual fishers but is usually rectangular or round in shape. The rectangular design generally follows the dimensions of 1000 mm length, 540 mm width and 300 mm height with a mesh size of 50x20x2 mm with 2 openings for crabs to enter the trap. The round trap design is generally 500 mm high; 1000 mm diameter and 50 mm mesh size (knot to knot) with 4 openings for crabs to enter the trap.

There are currently 3 commercial operators and 2 Aboriginal corporations holding exemptions to fish for mud crabs in WA. The fishers generally operate from March to November, with May to September being the most productive months to avoid summer and associated seasonal cyclone weather events. Commercial operators generally fish on a part-time basis with most operating other endorsements including Kimberley Gillnet and Barramundi Managed Fishery Licences and fishing boat charters. Operators tend to fish remote waters for long periods of time in large mother ships, using small dinghies known as doreys to enter mangrove estuaries with crab traps generally checked each daylight high tide.

Governing legislation/fishing authority

Commercial

Blue Swimmer Crab

Fish Traps Prohibition Notice 1994

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

Nickol Bay Prawn Fishery Management Plan 1991

Nickol Bay Prawn Managed Fishery Licence

Onslow Prawn Fishery Management Plan 1991

Onslow Prawn Managed Fishery Licence

Mud Crab

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

Notice 539 – Crab Fishing Restrictions (Roebuck Bay) Notice 1991

Notice 194 – Mud Crabs (Scylla sp)

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation

Consultation process

Commercial

Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), under a Service Level Agreement with the Department. Annual Broome Consultative Forum (Mud crabs)

Recreational

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

Boundaries

Blue Swimmer Crab

Crabbing activity along the Pilbara coast is centred largely on the inshore waters from Onslow through to Port Hedland, with most commercial and recreational activity occurring in and around Nickol Bay.

The boundaries of the Onslow Prawn and Nickol Bay Prawn Managed Fisheries which also capture crabs as by-product are described in the relevant status report elsewhere within this document.

Mud Crab

Three operators are permitted to fish from King Sound to the Northern Territory border, with closed areas around communities and fishing camps. One Aboriginal Corporation is permitted to fish in King Sound, with the other Aboriginal Corporation permitted to fish in a small area on the western side of the Dampier Peninsular, north of Broome.

Notices issued under the *Fish Resources Management Act 1994* prohibit all commercial fishing for mud crabs in Roebuck Bay and an area of King Sound near Derby.

Management Arrangements

Blue Swimmer Crab

Commercial access to blue swimmer crab stocks in WA is governed by a series of separate management arrangements provided for under the legislative framework of the *Fish Resources Management Act 1994*. Individual fisheries are managed under an input control system, primarily through the regulation of vessel and trap numbers. Supplementary controls cover retainable species and associated minimum size limits, gear specifications, and area, seasonal and daily time restrictions. The principal management tool employed to ensure adequate breeding stock in the commercial crab fisheries involves maintaining minimum size limits well above the size at sexual maturity. The commercial minimum size of 135 mm carapace width in the Pilbara crab fishery should ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

The management arrangements for the Pilbara Developing Crab Fishery are set by conditions on the exemption and are aimed at ensuring the stock and environment are protected. The management measures include gear restrictions, a minimum size limit, spatial closures and reporting requirements. A maximum of 400 pots are permitted in the fishery.

Management controls for the Onslow and Nickol Bay Prawn Managed Fisheries are based on limited entry, seasonal and area closures, and gear controls including bycatch reduction devices (grids). The fleet is composed of trawlers up to 23 metres in length; operating twin- or quad-rigged otter trawls to a maximum headrope length of 16 fathoms (29.27 m). The Department of Fisheries' vessel monitoring system (VMS) monitors the activities of all trawlers in these fleets.

Recreational fishing for blue swimmer crabs in WA is managed through a series of input and output controls. As with commercial fishing, the principal management tool employed to sustain an adequate breeding stock involves maintaining minimum size limits well above the size at sexual maturity. A minimum legal size limit of 127 mm carapace width applies in the waters of the north Coast

bioregion, along with a bag limit of 20 crabs per person with a boat limit of 40 crabs. Restrictions also govern gear types that can be used to take blue swimmer crabs.

Mud Crab

Access to the commercial Mud Crab Fishery has been granted via Instruments of Exemption, issued under Section 7 of the *Fish Resources Management Act 1994*, since 2006. The mud crab fishery is managed under an input control system, primarily through the regulation of vessel and trap numbers (maximum of 1,070 traps), gear restrictions and spatial closures.

Breeding stocks are protected by maintaining minimum size limits (150 mm CW for green mud crab and 120 mm CW for brown mud crabs) well above the size at sexual maturity. These size limits apply to both the recreational and commercial take of the species.

In addition to the minimum size limits, recreational fishers for mud crabs are restricted to a daily bag limit of 5 mud crabs, with a boat limit of 10 mud crabs (except for lower King Sound where the boat limit is 20).

Research Summary

Blue Swimmer Crab

Data for the assessment of blue swimmer crab stocks in the North Coast bioregion is obtained from trap fishers' compulsory monthly catch and effort returns and daily research log books, and trawl fishers' daily logbooks.

Baseline information on the biology and ecology of blue swimmer crabs has been generated by a number of Fisheries Research and Development Corporation (FRDC)-funded projects conducted by the Department of Fisheries and Murdoch University over the past decade.

Mud Crab

Data for the assessment of mud crab stocks in the North Coast bioregion is obtained from trap fishers' compulsory catch and effort returns and daily logbooks. Relevant research information is sourced from 2 recent FRDC funded projects involving NT Fisheries investigating escape gap sizes of traps (Grubert and Lee, submitted)¹ and environmental correlations with mud crab catches in the Northern Territory (Maynecke *et al.*, 2010)².

Retained Species

Commercial landings (season 2010/11):

Blue swimmer crabs

20 tonnes (19.9 t trap and 0.1 t trawl)

Mud crabs

<1 tonne

Blue Swimmer Crabs

The combined commercial catch of blue swimmer crabs from trap based crab fishers and prawn trawlers operating along the Pilbara coast during 2010/11 was 20 t, a 29% decrease on the 2009/10 catch of 28 t (North Coast Crab Figure 2). The majority of the recorded catch is taken by the trap fishery, with trawlers retaining only 0.1 t of crabs during 2011. This catch accounted for 2% of the state commercial blue swimmer crab catch of 1087 t for 2010/11 (West Coast Blue Swimmer Crab Figure 1).

Mud Crab

The total catch of mud crabs for the North Coast Crab Fishery during 2011 was <1 t and a decrease on the 2010 catch of around 2 t (North Coast Crab Figure 3). This catch accounted for 100 % of the state commercial mud crab catch for 2011. The 2011 catch was also a significant decrease from the 5 year mean of 3800 kg due to a large drop in catch and effort as only one commercial operator fished and only one Aboriginal Corporation fished in the 2011 period. The combination of cyclonic and flooding weather events and difficulty in retaining crew reflects this trend for 2011.

Recreational catch:

Blue Swimmer Crab Pilbara coast

approximately 50% of total

A survey of recreational crabbing was conducted along the Pilbara coast between December 1999 and November 2000. The survey estimated the recreational catch of blue swimmer crabs for the region over the 12-month period to be 22 t, with most of the catch (19 t) taken from Nickol Bay (Williamson *et al.*, 2006)³. This represented the majority of the catch from Nickol Bay in that year, as commercial operations targeting blue swimmer crabs in the area did not begin until the following year. No further surveys quantifying recreational catch have been undertaken since the 2000 survey. If this level of recreational effort has been maintained and the abundance has been consistent, it would provide for about 50% of the total catch based on current commercial catches.

Mud Crab

There is currently no data available for Kimberley recreational catch for 2011. A recreational survey conducted in the Pilbara between December 1999 and November 2000 reported the following recreational catch levels: 18 209 kg green mud crab and 4 655 kg brown mud crab (Williamson *et al.*, 2006¹).

The Department of Fisheries undertook a state wide recreational fishing from boat survey in 2011. The first results of the entire survey are due in late 2012.

¹ Grubert, M.A. and Lee, H.-S. 2012. Improving gear selectivity in Australian mud crab fisheries, Northern Territory Department of Resources, Fishery Report. Submitted.

² Meynecke, J.-O., Lee, S.-Y., Grubert, M., Brown, I., Montgomery, S., Gribble, J., Johnston, D. and Gillson, D. (2010) Evaluating the Environmental Drivers of Mud Crab (*Scylla serrata*) Catches in Australia. Final Report 2002/012. FRDC and Griffith University.

³ Williamson, Peta C., Sumner, Neil R. & Malseed, Benjamin E. (2006). A 12-month survey of recreational fishing in the Pilbara region of Western Australia during 1999-2000. Fisheries research report (Western Australia. Dept. of Fisheries) no. 153. (61 p.).

NORTH COAST BIOREGION

Fishing effort/access level

Blue Swimmer Crab

Crab trap fishers along the Pilbara coast reported 23,310 trawl lifts during 2010/11, a 29% decrease on the 32,700 trawl lifts reported for 2009/10.

Mud Crab

Mud Crab fishers along the Kimberley coast reported 784 trawl lifts during 2011, a 39% decrease on the 2004 trawl lifts reported for 2010 (North Coast Crab Figure 3).

Stock Assessment

Assessment complete:

Blue Swimmer Crab Pilbara - Yes

Mud Crab No

Assessment level and method:

Blue Swimmer Crab

Level 2 - Catch rate/Size Distributions

Breeding stock levels:

Blue Swimmer Crab Pilbara - Adequate

Mud Crab Unknown

Blue Swimmer Crab

The development of appropriate mesh sizes for use on commercial crab traps has eliminated the catch of juvenile crabs (< 80 mm carapace width) and significantly reduced the catch of undersize crabs < 120 mm carapace width, without impacting on legal catches. Improved work practices have also reduced the mortality of returned undersize and berried crabs caught in commercial traps to negligible levels.

The minimum legal size at first capture (127 mm carapace width for recreational fishers; 135 mm carapace width for commercial fishers based on industry agreement) for crab fisheries in the North Coast bioregion is set well above the size at first maturity of the resident stocks. Consequently, breeding stock levels are expected to be adequate to maintain stocks in all current fishing areas under normal environmental conditions. The breeding stocks along the Pilbara coast are also supported by the influence of the warmer waters that occur at these latitudes which extends the spawning period over the whole year, whereas spawning is restricted to the late spring and early summer months on the lower West Coast.

Catch rates from the Pilbara trap fishery provides an index of abundance that can be used to assess fishery performance from year-to-year. Blue swimmer crab trap catch rates in the Pilbara Developing Crab Fishery increased steadily during the first three years of exploratory fishing for blue swimmer crabs along the Pilbara coast. This reflected more efficient fishing of stocks in the Pilbara region, as the commercial operators' knowledge of the spatial distribution of resident stocks and localized environmental influences increased over time. The increase in catch rate can also be attributed to improvements to fishing gear and vessels. Favourable environmental conditions led to a significant increase in catch rates (~1.6-1.8 kg/trawl lift) from 2004/05 to 2006/07, before returning to longer-term mean catch rates (~0.7-1.0 kg/trawl lift).

The Pilbara Developing Crab Fishery recorded a mean catch rate for 2010/11 of 0.8 kg/trawl lift – a slight increase on the catch rate of 0.7 kg/trawl lift from the previous year.

Mud Crab

Historically catch and effort within the fishery rose steadily from 1100 kg in 2003 to 6300 kg in 2009. Catch per unit effort increased between 2003 and 2005 with greater knowledge of the fishery. The highest recorded catch peaked at 9300 kg in 2006; however this was attributed to the extensive exploratory efforts of a single fisher and therefore did not represent the efforts of the entire fishery for that year. The majority of commercial crabbing has occurred in the areas of Cambridge Gulf, Admiralty Gulf, York Sound and King Sound.

The minimum legal size at first capture is 150 mm carapace width (CW) for green mud crab (*Scylla serrata*) and 120mm CW for brown mud crab (*Scylla olivacea*). This is set well above the size at first maturity of 90-110mm CW for green and 86-89mm CW for brown mud crab fisheries in the North Coast bioregion.

Non-Retained Species

Bycatch species impact

Negligible

Blue Swimmer Crab

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

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

Discarded bycatch from trawl fisheries that retain crabs as a by-product is dealt with in those sections of this report specific to the trawl fisheries.

Mud Crab

Mud crab traps are purpose built to effectively target larger (legal sized) mud crabs. The overall trap design and large mesh size allows sub legal mud crabs and non-targeted bycatch species opportunity to escape the trap, preventing them from being retained. The gear needs to be pulled regularly, and undersized and berried crabs must be returned to the water.

Protected species interaction

Negligible

Blue Swimmer Crab

The crab trap longline system used in the targeted crab fisheries has little possibility of interacting with protected 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.

Mud Crab

As mud crab traps are purpose built to target mud crab species and are set for relatively short periods of time, the possibility of causing harm to threatened and protected species is minimal.

Ecosystem Effects**Food chain effects****Low****Blue Swimmer Crab**

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

Mud Crab

As the retained commercial catch of mud crabs is low, the commercial fishery represents a small proportion of the available biomass. Therefore secondary chain effects would not be likely to be significant within the surrounding ecosystem of the fishery.

Habitat effects**Negligible****Blue Swimmer Crab**

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

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

Mud Crab

Trap fishing in the shallow waters of associated mangrove tidal creeks and near shore embayments result in limited habitat disturbance. The large mesh size prevents capture of benthic organisms and only minor dragging of traps on the sea floor occurring in trap retrieval. The sheltered shallow mangrove environment is protected from wind and waves where the majority of traps are deployed, resulting in minimal habitat damage.

Social Effects**Blue Swimmer Crab**

During 2010/11, two people were employed as skippers and crew on vessels fishing for blue swimmer crabs along the Pilbara coast. Additional employment for several workers has been created in Point Samson through the development of post-harvest processing of the crab catch.

Mud Crab

Historically the mud crab fishery has had a high community value and a low commercial value. Commercial fishers travel vast distances due to the remoteness of their operations and stay in the vicinity for several weeks before returning to unload catch. In this scenario crabs are frozen and generally sold to local markets although live product may also be sold at premium prices.

During the 2011 season, this fishery employed 1 commercial operator and 1 aboriginal corporation. The combination of unusual weather including seasonal flooding and cyclone activity coupled with difficulty with retaining crew resulted in this lower than normal fishing level.

Economic Effects**Estimated annual value (to fishers)****Level 1 - < \$1 million****Blue Swimmer Crab**

Average beach prices for trap caught blue swimmer crabs in the North coast fisheries for the year were around \$5-\$6/kg. The frozen crabs landed by trawlers generally attract a slightly lower beach price than those landed from traps.

The crab catch from the Pilbara region was sold through local and interstate markets.

Fishery Governance**Target catch (or effort) range:****Blue Swimmer Crab Pilbara - Under Development****Mud Crab****N/A****Blue Swimmer Crab**

A review of these blue swimmer crab fisheries is being undertaken and target catch ranges will be set.

Current fishing (or effort) level:**Blue Swimmer Crab****Pilbara - N/A****Mud Crab****N/A****Blue Swimmer Crab**

While the Pilbara Developing Crab Trap Fishery has undergone a steady expansion since exploratory fishing for blue swimmer crab stocks between Onslow and Port Hedland began in 2001, effort levels in the fishery are considered acceptable. The large area covered by the fishery and the remote nature of much of this coastline provides significant logistical and financial challenges in returning the harvested catch to market in an acceptable time period. Improvements to fishing gear and vessels, along with a substantial increase in the understanding of localised environmental influences such as tide and wind, has allowed commercial fishers to maintain catch levels with reduced effort. Fishing effort in this region is further limited by very hot weather experienced during the summer months, which generally restricts fishing effort to between April and November.

Because of the logistical and financial difficulty in fishing this area, one licensee has not reapplied to fish under an exemption since the 2007/08 fishing season. Consequently, the number of traps in the Pilbara trap fishery has reduced from 600 down to 400.

NORTH COAST BIOREGION

New management initiatives

Blue Swimmer Crab (2011/12)

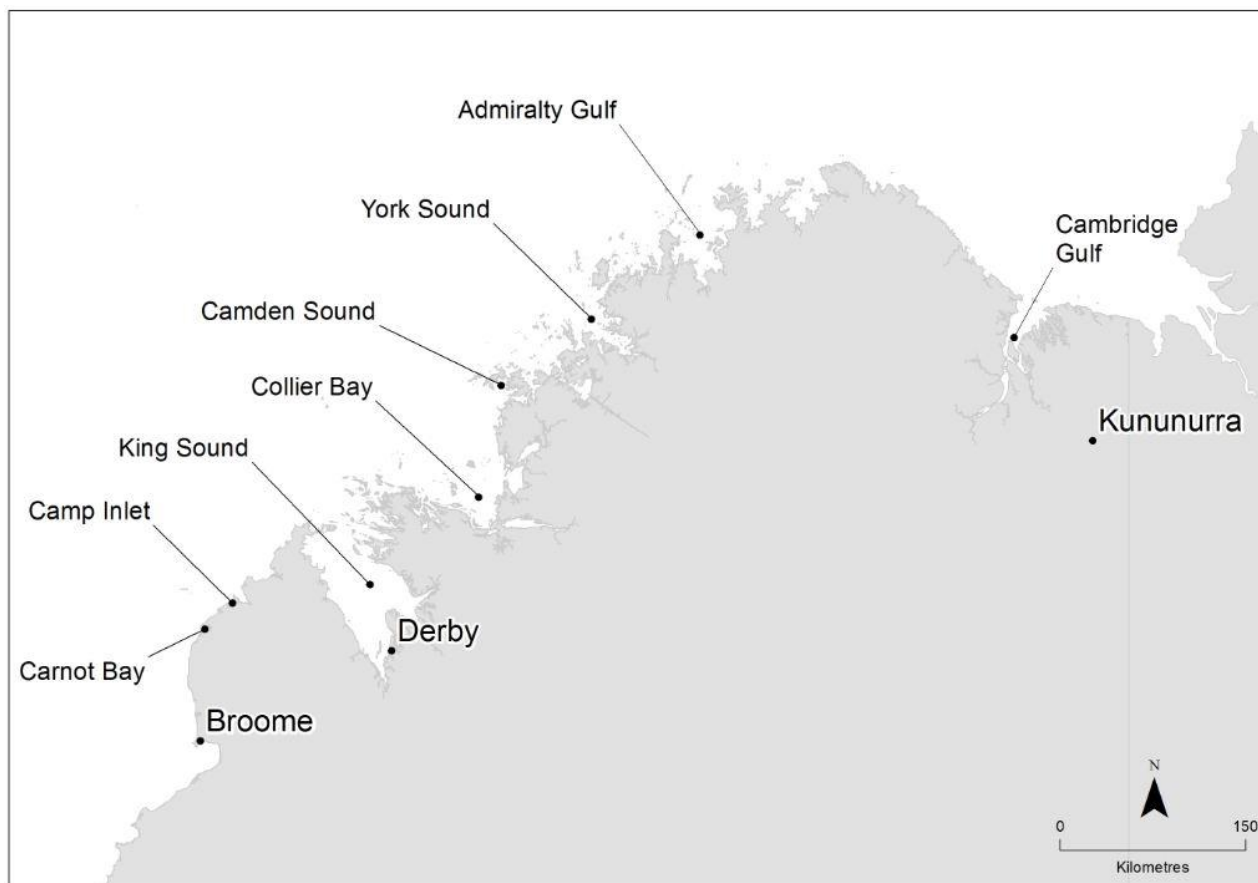
The Department proposes to bring the Pilbara Crab DNF under formal management arrangements in the near future.

Mud Crab (2011/12)

The Department proposes to bring the Mud Crab Fishery under formal management arrangements in the near future.

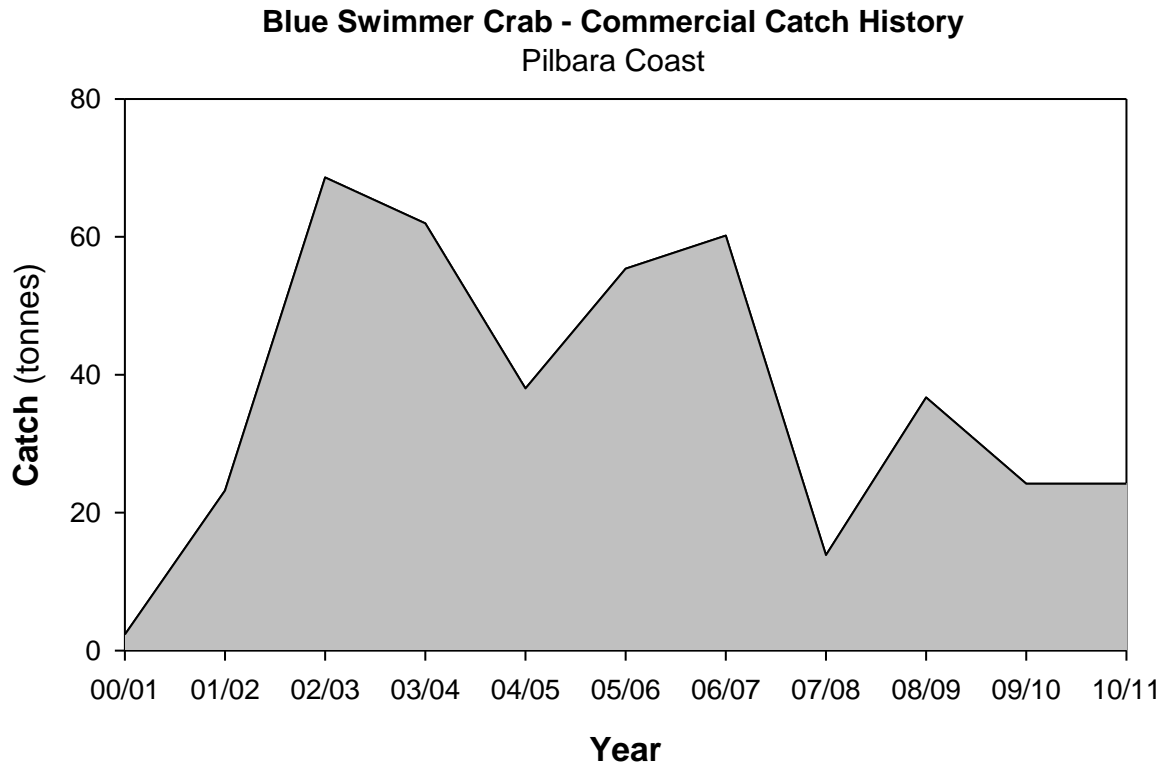
External Factors

Levels of recruitment to many of the crab fisheries fluctuate considerably. While the causes of these variations are not fully understood, it is considered most likely due to environmental influences on spawning success and larval survival through to recruitment. The relationship between environmental factors, recruitment and catch is being further evaluated as data becomes available.

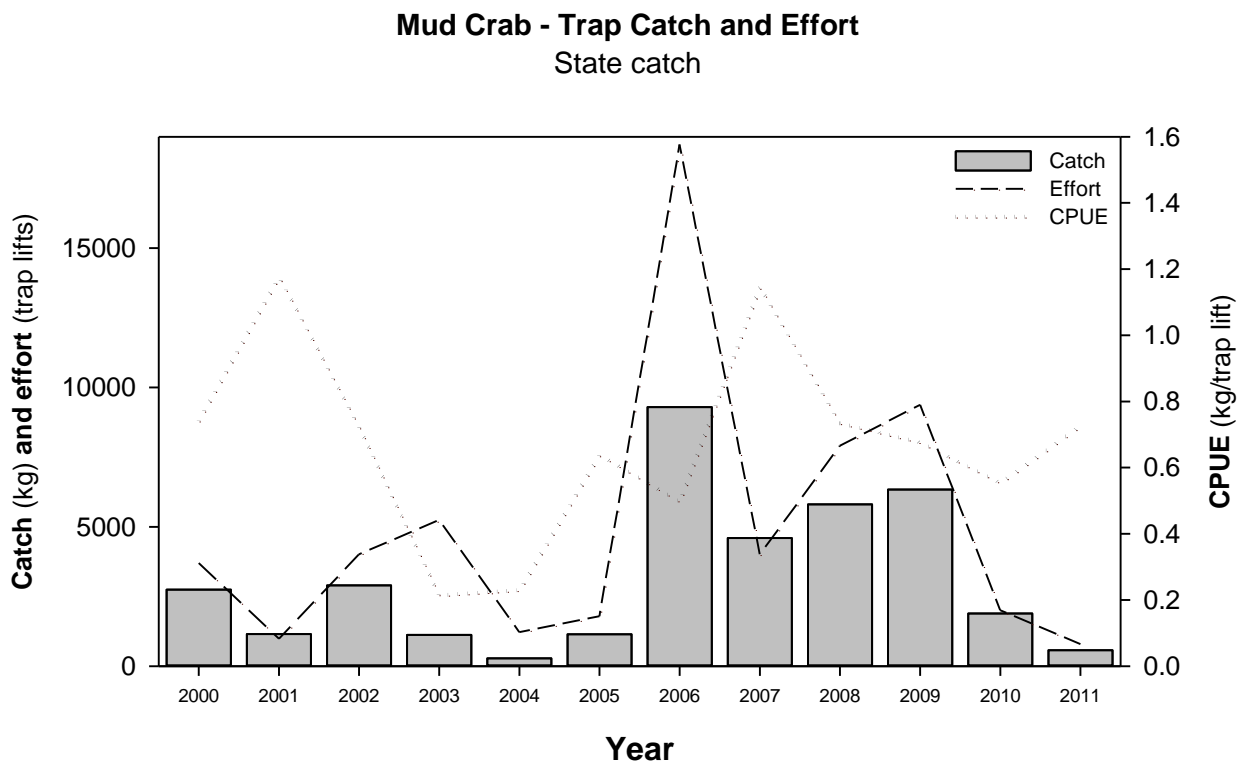


NORTH COAST CRAB FIGURE 1

Areas fished for mud crab along the Kimberley coast of Western Australia.

**NORTH COAST CRAB FIGURE 2**

Commercial catch history for the blue swimmer crab (*Portunus armatus*) in the North Coast bioregion since 2000/01.

**NORTH COAST CRAB FIGURE 3**

Annual catch history for the Western Australian commercial mud crab fishery since 2000.

AQUACULTURE

Regional Research and Development Overview

Aquaculture in the north coast bioregion is dominated by the production of South Sea pearls from the silver lip pearl oyster *Pinctada maxima*. This industry sector utilises both wild-caught and hatchery-reared oysters to produce cultured pearls. The wild-stock fishery is reported in the North Coast bioregion section of this volume.

The Department of Fisheries also has a major role in the management and regulation of pearl hatcheries, seeding activities and pearl oyster farm leases.

A Memorandum of Understanding (MOU) between the Western Australian and Northern Territory fisheries ministers, signed in June 2006, recognises that WA and the NT comprise the entire Australian south-sea pearling industry and that product from both jurisdictions supplies the same market.

The operator of a fish farm producing barramundi (*Lates calcarifer*) in Cone Bay is successfully increasing production following approval by the Environmental Protection Authority (EPA) to increase output to 2,000 tonnes per annum. The operator is planning to gradually increase its production capability to 5,000 tonnes per annum, subject to receiving the requisite environmental approval.

A demonstration project culturing marine microalgae for the production of bio-fuels, omega-3 lipid and protein biomass has started near Karratha. The company is planning for significant increases in scale and production capability in the future.

To assist in addressing the regulatory and approvals issues concerning aquaculture development in WA, the Department of Fisheries has received Government funding of \$1.85 million over 2½ years to establish two aquaculture zones in the Kimberley and Mid West regions. Through this project, the Department of Fisheries will secure strategic environmental approvals for the zones from the EPA, thereby streamlining the approvals processes for commercial projects within zoned areas and providing an “investment ready” platform for prospective investors.

The Department of Fisheries manages the operations of the Broome Tropical Aquaculture Park, which provides the basic resources and facilities for supporting aquaculture development and training.

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

COMPLIANCE AND COMMUNITY EDUCATION

The North Coast is one of the largest bioregions in WA – stretching from Onslow to the Western Australia/Northern Territory border with over 2600 kilometres of coastline.

The North Coast Bioregion has many biodiversity rich areas including the Rowley Shoals, Montebello Islands, Barrow Islands and hundreds of islands and atolls. These areas attract many people – especially for fishing.

Tourism is a major part of the coastal towns in the North Coast with over 600,000 additional people visiting the area each year. The transient population usually increases in the cooler months from May to October including international, interstate and intrastate tourists.

Many of the towns in this bioregion support mining communities where the majority of the population are fly in / fly out. Surveys have shown that a large proportion of mining community and tourists take part in fishing while visiting the bioregion.

Three district offices located in Kununurra, Broome and Karratha provide compliance and education across the region with eleven permanent Fisheries and Marine Officers and one Community Education officer. An additional two officer Recreational Mobile Patrols operates in the area throughout the year. Compliance is delivered to several sectors including commercial and recreational fisheries, pearling, aquaculture, fish habitat and bio-security.

The North Coast Region is sparsely populated in most areas with much of the terrain remote and difficult to access. Remote patrols are undertaken for up to two weeks at a time to get to these areas. Specialised equipment is required for patrols including four wheel drive vehicles and a variety of vessels for inshore coastal and inland waters, when offshore patrols are conducted a 23 metre vessel is utilised.

A range of compliance duties are carried out in the bioregion including investigations, catch, licence, gear, processor, retail and transport inspections. These are carried out through roadside checks, land & sea patrols and aerial surveillance.

FMOs not only spend time on compliance but also dedicate time to community education by maintaining a presence at a variety of expos, fishing competitions and community fairs. Annual fairs are held throughout the bioregion with the Department represented every year at most events.

The Community Education Officer develops programs and coordinates delivery of education activities to school-aged children and awareness raising activities with the broader community. In-school and school holiday programs are the main method of reaching students in both the Pilbara and the Kimberley, while attendance at shows and local events target the broader community. An increased emphasis has been placed on developing materials that focus on local issues and their dissemination through regional brochure stockists and local publications.

Activities during 2010/11

During 2010/11, the North Coast bioregion's FMOs delivered a total of 4,920 officer hours of active compliance patrol time (North Coast Compliance Table 1). – a significant

increase (2345 hours) from the previous year (North Coast Compliance Figure 1) due to the impact of the Northern Region Recreational Mobile Patrol. FMOs also achieved 13585 personal compliance contacts with the fishers and non-fishers across the recreational and commercial sectors.

In the commercial sector FMOs undertook prosecution action as a result of compliance operations in 2010/11. This resulted in 9 infringement warnings, 13 infringement notices being issued and 7 matters resulting in prosecution action.

Compliance inspections were also carried out on Pearl oyster fishing and seeding operations, during transport of Pearl oysters and at various Pearl oyster lease sites. Considerable travel time is required to reach many of the lease sites, due to their remote locations.

In the recreational sector 149 infringement warnings were issued, 190 infringement notices and 33 matters resulted in prosecution action.

Initiatives in 2011/12

The Department's office in Kununurra will continue to carry out Patrols with staff from other agencies such as Department of Environment and Conservation and the Department of Transport. This will greatly enhance the ability of the Department to conduct education and compliance activities in the East Kimberley.

The Northern Region Mobile Patrol, comprising of two FMO's will continue to focus entirely on recreational fisheries compliance and education throughout the Northern Region.

A newly established Fremantle based Statewide Mobile Patrol Unit will be based in the Pilbara District from July to September and will focus on recreational fishers operating in the area.

The North Coast bioregions FMOs will continue to use a risk assessment based approach to fisheries compliance to ensure areas and activities of a high risk of non-compliance are targeted.

FMOs will continue to assist with ongoing checks of bio-security of vessels entering the states' waters for introduced marine pests.

An additional Community Education Officer for the region (with a focus on the Pilbara) will see increased education and communication opportunities and initiatives.

Improved engagement with short and long term visitors to the Pilbara and the Kimberley through a targeted education program.

Improved engagement with the resource sector in the Pilbara through targeted educational programs and improved access to information and increased education in remote community schools.

NORTH COAST BIOREGION

NORTH COAST COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the North Coast bioregion during the 2010/11 financial year

PATROL HOURS DELIVERED TO THE BIOREGION	4,920 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	154
Infringement warnings	9
Infringement notices	13
Prosecutions	7
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	13,092
Infringement warnings	149
Infringement notices	190
Prosecutions	33
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	493
Fishwatch reports***	18
VMS (Vessel Days)****	7,136

* Pearling contacts are excluded from these totals and detailed in North Coast Compliance Table 2.

** Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational.

The "other fishing related contacts within the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category. This table includes contacts made by *PV Walcott*. Contacts made by PVs *Hamelin* and *Houtman* are included in West Coast Compliance Table 1.

*** This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors.

**** VMS (Vessel Days) represents the number of vessel days recorded in this bioregion. That is, a count for each day that each vessel was polled within the bioregion.

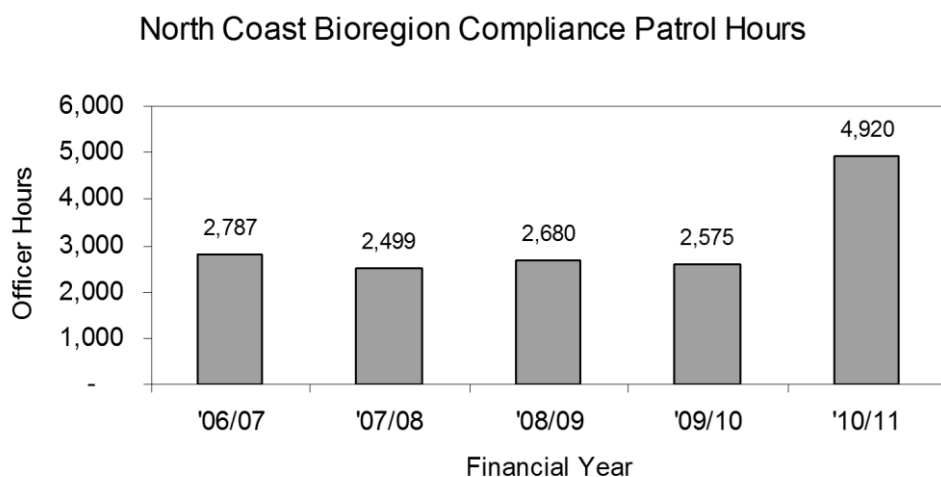
NORTH COAST COMPLIANCE TABLE 2

This table gives summary statistics for pearling compliance in all bioregions in the 2010/11 fishing season.

Total compliance hours*	244 Officer Hours
Field contacts by Pearling Officers	32
Letters of Warning issued**	0
Prosecutions	1

* Includes all time spent on compliance-related tasks by District Staff, e.g. investigations, prosecutions, etc. but does not include pearling activities by PV Walcott.

** No legislative capacity to issue infringement notices

**NORTH COAST COMPLIANCE FIGURE 1***

This figure gives the “On Patrol” officer hours showing the level of compliance patrol activity delivered to the North Coast bioregion over the previous five years. The 2009/10 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1 and Table 2. The totals exclude time spent on other compliance-related tasks, e.g. travel time between patrol areas, preparation and planning time.

*Does not include “on-patrol” hours delivered by PV Walcott (4,688 in 2010/11).

The total on-patrol hours for each of the Department’s 3 large patrol vessels is reported in the compliance summary of the most relevant bioregion: *PV Walcott* in North Coast, *PV Houtman* and *PV Hamelin* in West Coast.

SOUTH COAST BIOREGION

ABOUT THE BIOREGION

The continental shelf waters of the South Coast bioregion are generally temperate but low in nutrients, due to the seasonal winter presence of the tail of the tropical Leeuwin Current and limited terrestrial run-off. Sea surface temperatures typically range from approximately 15°C to 21°C, which is warmer than would normally be expected in these latitudes due to the influence of the Leeuwin Current. The effect of the Leeuwin Current, particularly west of Albany, limits the winter minimum temperatures away from terrestrial effects along the beaches to about 16 to 17°C.

Fish stocks in the region are predominantly temperate, with many species' distributions extending right across southern Australia. More tropical species are occasionally found which are thought to have been brought into the area as larvae, but are unlikely to form breeding populations.

The south coast is a high-energy environment, heavily influenced by large swells generated in the Southern Ocean. The coastline from Cape Leeuwin to Israelite Bay is characterised by white sand beaches separated by high granite headlands. East of Israelite Bay, there are long sandy beaches backed by large sand dunes, until replaced by high limestone cliffs at the South Australian border. There are few large areas of protected water along the south coast, the exceptions being around Albany and in the Recherche Archipelago off Esperance.

Along the western section of the coastline that receives significant winter rainfall, there are numerous estuaries fed by winter-flowing rivers. Several of these, such as Walpole/Nornalup Inlet and Oyster Harbour, are permanently open, but most are closed by sandbars and open only seasonally after heavy winter rains. The number of rivers and estuaries decreases to the east as the coastline becomes more arid. While these estuaries, influenced by terrestrial run-off, have higher nutrient levels (and some, such as Oyster Harbour and Wilson Inlet, are suffering eutrophication), their outflow to the ocean does not significantly influence the low nutrient status of coastal waters.

The marine habitats of the south coast are similar to the coastline, having fine, clear sand sea floors interspersed with occasional granite outcrops and limestone shoreline platforms and sub-surface reefs.

A mixture of seagrass and kelp habitats occurs along the south coast, with seagrass more abundant in protected waters and some of the more marine estuaries. The kelp habitats are diverse but dominated by the relatively small *Ecklonia radiata*, rather than the larger kelps expected in these latitudes where waters are typically colder and have higher nutrient levels.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

The major commercial fisheries of the South Coast bioregion are the abalone fishery, the purse seine fishery targeting pilchards and other small pelagics, and a demersal gillnet fishery for sharks. Other smaller commercial fisheries are the long-standing beach seine fishery for western Australian salmon and herring, a trap fishery targeting southern rock lobsters and deep-water crabs, and the intermittent scallop fishery. There is also a commercial net fishery for finfish operating in a number of south coast estuaries. South coast commercial fishing vessel operators often hold a number of licences to create a viable year-round fishing operation.

As much of the south coast is remote or difficult to access, recreational beach and boat fishing tends to be concentrated around the main population and holiday centres. The major target species for beach and rock anglers are salmon, herring, whiting and trevally, while boat anglers target pink snapper, queen snapper, Bight redfish, a number of shark species, samson fish and King George whiting. The third major component of the recreational fishery is dinghy and shoreline fishing of estuaries and rivers, focused in the western half of the bioregion. Here the main angling targets are black bream and whiting (including King George whiting). Recreational netting, primarily targeting mullet, also occurs in these estuaries.

The predominant aquaculture activity undertaken on the south coast is the production of mussels and oysters from Oyster Harbour at Albany. This activity is restricted to this area where there are sufficient nutrient levels related to terrestrial run-off to provide the planktonic food necessary to promote growth of filter-feeding bivalves.

Other forms of aquaculture (e.g. sea cage farming) are restricted on the south coast by the high-energy environment and the very limited availability of protected deep waters typically required by this sector. As a consequence, most recent development activity has focused on land-based 'raceway' culture of abalone, using pumped sea water.

ECOSYSTEM MANAGEMENT

The inshore marine habitats of the south coast are largely unaffected by human activities. While there are few permanent closures to trawling in this region, the actual level of such activities is very small with about 98% of the region not affected by these activities.

The estuaries and near-shore marine embayments where there is restricted water exchange, for example Princess Royal and Oyster Harbours and Wilson Inlet, have experienced eutrophication events associated with high nutrient loads from adjacent land-based activity.

The Walpole–Nornalup Marine Park was declared on the 8th May 2009 and is the first marine protected area on the south coast. There are three existing fishing closures under s.43 of the Fish Resources Management Act 1994 surrounding the wreck of the ‘Perth’ (Albany), wreck of the ‘Sanko Harvest’ (east of Esperance), and Esperance Jetty.

The Commonwealth Government’s Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) has also undertaken a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark Bay. The federal minister for the environment has recently announced the final reserve network proposed for the south-west which spans the West Coast and South Coast bioregions.

The Department of Fisheries continues to provide advice to the Environmental Protection Authority on development proposals, which if implemented, have the potential to impact on the aquatic environment. The Department also continues to actively engage with the natural resource management groups for the south coast to promote sustainable use of the aquatic environment. New proposals currently being progressed for the South Coast include ones for mineral resource development and associated port facilities, and for petroleum exploration.

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets using the EBFM framework

Under the Integrated Marine and Coastal Regionalisation for Australia scheme, the South Coast bioregion has been divided into 2 meso-scale regions: WA South Coast, Eucla (IMCRA, V 4.0, 2006). This sub-regional scale of management has now been adopted by the Department through the implementation of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher, *et al.*, 2010) see How to Use section for more details.

In terms of ecological assets, the Department has recognised the following ecological values for the IMCRA regions within the South Coast Bioregion:

- Ecosystem structure and biodiversity (on a meso-scale basis);

- Captured fish species;
- Protected species (direct impact – capture or interaction);
- Benthic habitats; and
- External impacts.

For some issues a finer level of division of the IMCRA ecosystems is used by the Department. This relates to recent management initiatives necessary to recognise different suites of exploited fish and invertebrates across the continental shelf. These sub-components are defined by depth contours (Estuarine, Nearshore 0-20m; Demersal 20-250m and Pelagic). The full set of ecological assets identified for ongoing monitoring are presented in South Coast Ecosystem Management Figure 1.

Risk Assessment of Regional Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined South Coast Ecosystem Management Figure 1 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (South Coast Ecosystem Management Table 1) provides an overview and cumulative assessment of the current risks to the ecological assets of the South Coast Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department’s Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

Currently there are no marine pest monitoring programs being undertaken by the Marine Biosecurity Research group in the South Coast bioregion. However, ongoing research includes an assessment of the likelihood of a marine pest being introduced into ports and quantification of the risk associated with recreational vessels for the introduction and translocation of marine pests into this bioregion. Further detail may be found in the Appendix section entitled “Activities of the Marine Biosecurity Research Unit during 2011/12”.

SOUTH COAST ECOSYSTEM MANAGEMENT TABLE 1
RISK LEVELS FOR EACH ASSET.

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level components. Low and Moderate values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, was not generated by fishing activities.

Ecosystem Structure and Biodiversity

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Estuarine	Marine	MODERATE (non fishing)	The most likely cause of changes to community structure in estuarine regions is changing rainfall levels and the manual opening or closing of bars at river mouths.
Marine	Marine	LOW	The recent assessment by Hall and Wise (2011) ¹ of finfish community structure using commercial data for the past 30 years found no evidence of any concerning trend in mean trophic level, mean length or FIB. Few other species are captured in this region.
Eucla	Marine	NEGLECTIBLE	As above

Captured fish species

Fish species	Aquatic zone	Risk	Status and Current Activities
Finfish	Estuarine	MODERATE	The catch and catch rate of this suite has been reasonably stable for 10 years.
	Nearshore	HIGH	The capture of herring has been in decline for some years. A study is currently underway to determine if this is related to stock issues or merely marketing problems
	Demersal	HIGH	There is some concern that there could be an increase in targeting of demersal fishing on the south coast in the near future. The stock status is now to be the focus of an NRM/FRDC project..
	Pelagic	LOW	While the spawning biomass of sardines has returned to appropriate levels, their capture levels and that of other pelagic fish has not returned to pre-virus levels due to market problems and changed fish behaviour.
Crustaceans	Shelf	MODERATE	The catch levels of lobsters and crabs remains at relatively low but consistent levels.
Molluscs	Nearshore	MODERATE	The stocks of abalone are maintained at appropriate levels
	Shelf	NEGLECTIBLE	The stocks of scallops varies annually and fishing only occurs when stocks are abundant

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.

Protected species

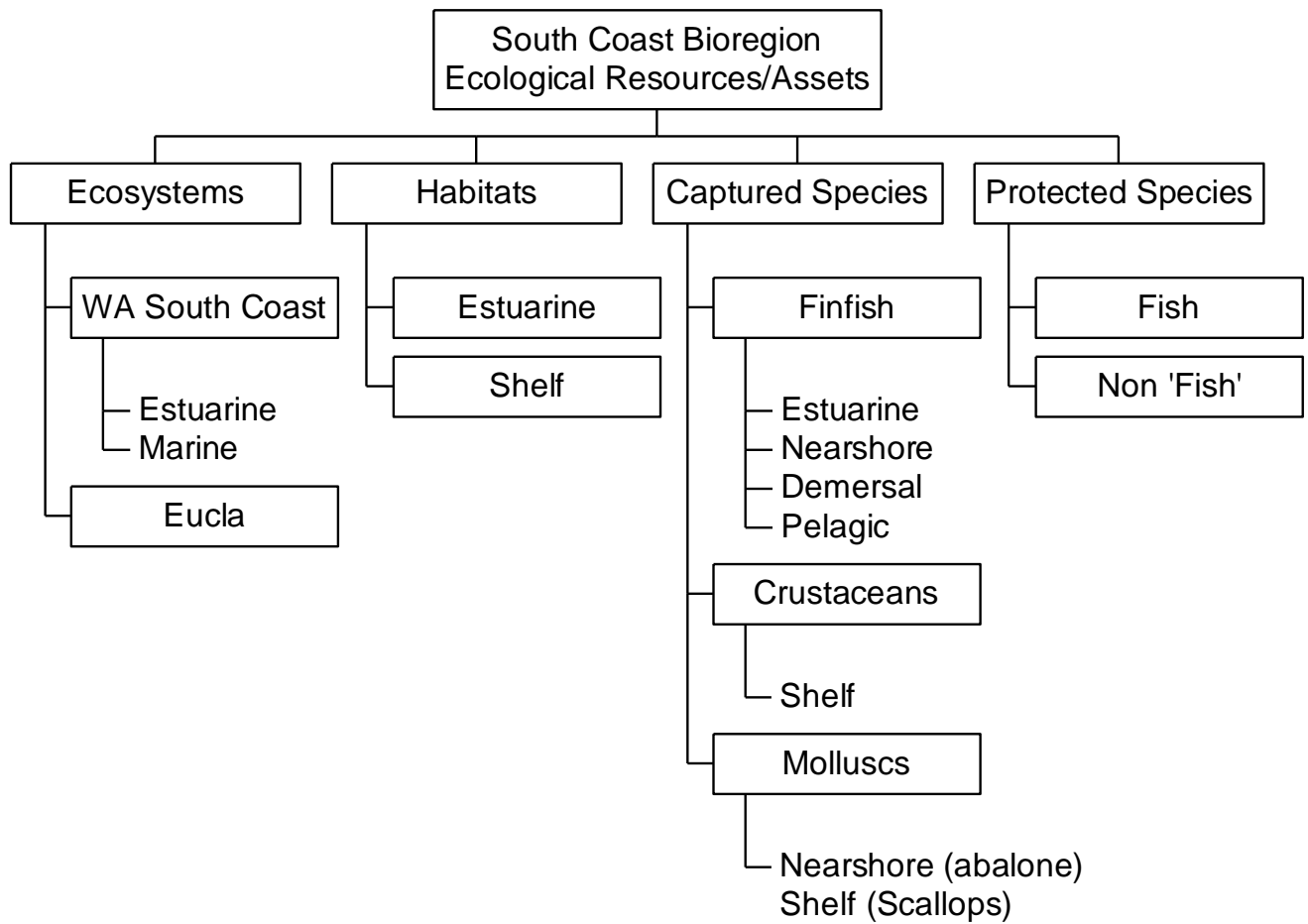
Protected fish species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Non fish (birds)	MODERATE	The capture of shearwaters in purse seine operations has been addressed by a code of conduct
	Mammals	MODERATE	The potential for the capture of sealions and seals by all fishing operations in this region, but especially gill nets has been the subject of a number of recent studies.
Protected 'Fish' Species	Fish	NEGLIGIBLE	There are few risks to the protected fish species in this region

Benthic habitat

Benthic Habitat	Risk	Status and Current Activities
Estuaries/ Nearshore	LOW (non fishing)	There are few fishing activities that would impact on nearshore or estuarine habitats. There may be risks at some locations due to coastal development activities.
Shelf	NEGLIGIBLE	The shelf region in this bioregion has very little habitat disturbance. Less than 3% of the area is trawled and there are no other activities that would materially impact on the habitats in these areas.

External Drivers (Non Fishing)

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	HIGH	The recent location of the pest algae <i>Codium fragile</i> in Albany highlights the issues that now face many ports in Australia
Climate	LOW	This area is not as likely to be impacted by climate change in the near future as West Coast and Gascoyne areas of WA.



SOUTH COAST ECOSYSTEM MANAGEMENT FIGURE 1

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

FISHERIES

South Coast Crustacean Fisheries Report: Statistics Only

J. How and M. Stadler

Fishery Description

The 'south coast crustacean fisheries' comprise four pot-based fisheries, which operate from Augusta to the South Australian border. They include the Windy Harbour/Augusta Rock Lobster Managed Fishery, the Esperance Rock Lobster Managed Fishery (ERLF), the Southern Rock Lobster Pot Regulation Fishery operating in the Albany and Great Australian Bight sectors, and the South Coast deep-sea crab fishery (South Coast Crustacean Figure 1).

The fisheries are multi-species and take southern rock lobsters (*Jasus edwardsii*) and western rock lobsters (*Panulirus cygnus*) as well as deep-sea crab species including giant crabs (*Pseudocarcinus gigas*) crystal crabs (*Chaceon albus*) and champagne crabs (*Hypothalassia acerba*).

Southern rock lobsters comprise the majority of the catch in the eastern areas of the fishery, with crab species becoming more prevalent in the south-western region (South Coast Crustacean Figure 2). Western rock lobsters are a significant component of the catch in the Windy Harbour/Augusta Rock Lobster Managed Fishery (not reported here due to confidentiality provisions relating to the small number of licensees).

Boundaries

Management boundaries for the south coast crustacean fisheries are shown in South Coast Crustacean Figure 1. The 'boundaries' of the deep sea crab component of the fishery (managed by Fishing Boat Licence Condition 105) include all the waters of these fisheries deeper than 200 metres, excluding those of the ERLF, where crabs may only be taken by licensees in the ERLF.

Management arrangements

Commercial

These commercial fisheries are managed primarily through input controls in the form of limited entry, pot numbers, size limits and seasonal closures.

The season for fishing for rock lobsters throughout all south coast crustacean fisheries mirrors the previous West Coast Rock Lobster Managed Fishery season (prior to the 2010/11 season i.e. 15 November to 30 June). Fishing for deep-sea crabs can currently occur all year, but during the rock lobster season operators fishing under the authority of a Southern Rock Lobster Pot Regulation Licence must only use the number of pots endorsed on their authorisation. There is currently no limit on the number of deep sea crab pots that can be used by holders of Fishing Boat Licence Condition 105. Catch statistics for the fisheries are based on the period from 1 November to 31 October inclusive.

In 2010/11 there were two Windy Harbour/Augusta Rock Lobster Managed Fishery Licences; eight licences in the ERMF (6 vessels reported catch); 28 licences in the Southern

Rock Lobster Pot Regulation Fishery (15 vessels reported catch) and 23 holders of Fishing Boat Licence Condition 105 (seven vessels reported catch).

Recreational

Recreational fishers generally only target rock lobsters. They are restricted to the use of 2 pots per person and divers are only permitted to take rock lobster by hand, or with the use of a loop or other device that is not capable of piercing the rock lobster.

Size limits, bag limits and seasonal closures apply and all recreational fishers are required to hold a current recreational fishing licence authorising them to take rock lobster.

Landings and Effort

Commercial

Southern rock lobster	52.1 tonnes
Deep-sea crab	18.2 tonnes
Western rock lobster	not reported
due to confidentiality policy (too few operators)	

The 2010/11 season total catch of southern rock lobsters was 52.1 t, an increase of 9% from the 2009/10 season. A catch of 28.2 t of southern rock lobsters was taken in the ERLF in 2010/11 – an increase of 18% on the catch taken in the 2009/10 season (23.8 t). This is showing an increasing trend over the last few seasons from low catches in 2008/09 (South Coast Crustacean Figure 2).

The combined catch for the Southern Rock Lobster Pot Regulation Fishery (Great Australian Bight (GAB) and Albany zones) in 2010/11 was 23.3 t, a 1% reduction in the catch taken in 2009/10. The catch in the Albany zone was 4.8 t, a reduction of 21% compared to the 2009/10 season, however, the catch in the GAB zone increased by 6% to 18.5 t (South Coast Crustacean Figure 2a). These catches have remained relatively stable since mid-2000, though there have been some fluctuations between the relative contribution from each region (South Coast Crustacean Figure 2a).

As a secondary target of the rock lobster fisheries, a total of 18.2 t of deep sea crabs was caught. The Albany zone is where the majority of crab catch is taken (South Coast Crustacean Figure 2b and 3) and included 3.9 t of giant crabs (a decrease of 0.8 t from the 2009/10 season) 5.1 t of champagne crabs (an increase of 1.4 t from the 2009/10 season) and 4 t of crystal crabs (a decrease of 11.3 t from the 2009/10 season). In the ERLF, 0.8 t of giant crabs were landed (a decrease of 1.6 t from the 2009/10 season).

The fishing effort in the ERLF increased by 8% in 2010/11 to 36,779 potlifts compared to the 33,952 potlifts in 2009/10. Conversely, the effort decreased by 15% in the Albany zone, however, it is not possible to split the effort of targeting lobsters from that of targeting deep-sea crabs.

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Recreational

Southern rock lobsters

<5 tonnes

Estimates from mail surveys sent to a randomly selected sample of rock lobster licence holders (approx 10%) suggests that the recreational catch of southern rock lobsters on the south coast is less than 5 t per year.

The number of recreational rock lobster licence holders that catch southern rock lobsters are small and estimating the recreational catch more accurately would require a dedicated survey or at least a different sampling strategy to the current mail survey. The small quantities taken on the south coast, provide a small risk to overall sustainability of the stock, and therefore do not make a more detailed survey a priority.

Fishery Governance

Target commercial catch range:

Southern rock lobsters

50 – 80 tonnes

In 2010/11, the south coast catch of 52.1 t was within the target range. However, this target catch range is currently being reviewed as a part of the overall review of the management for this fishery.

Current Fishing (or Effort) Level

Acceptable

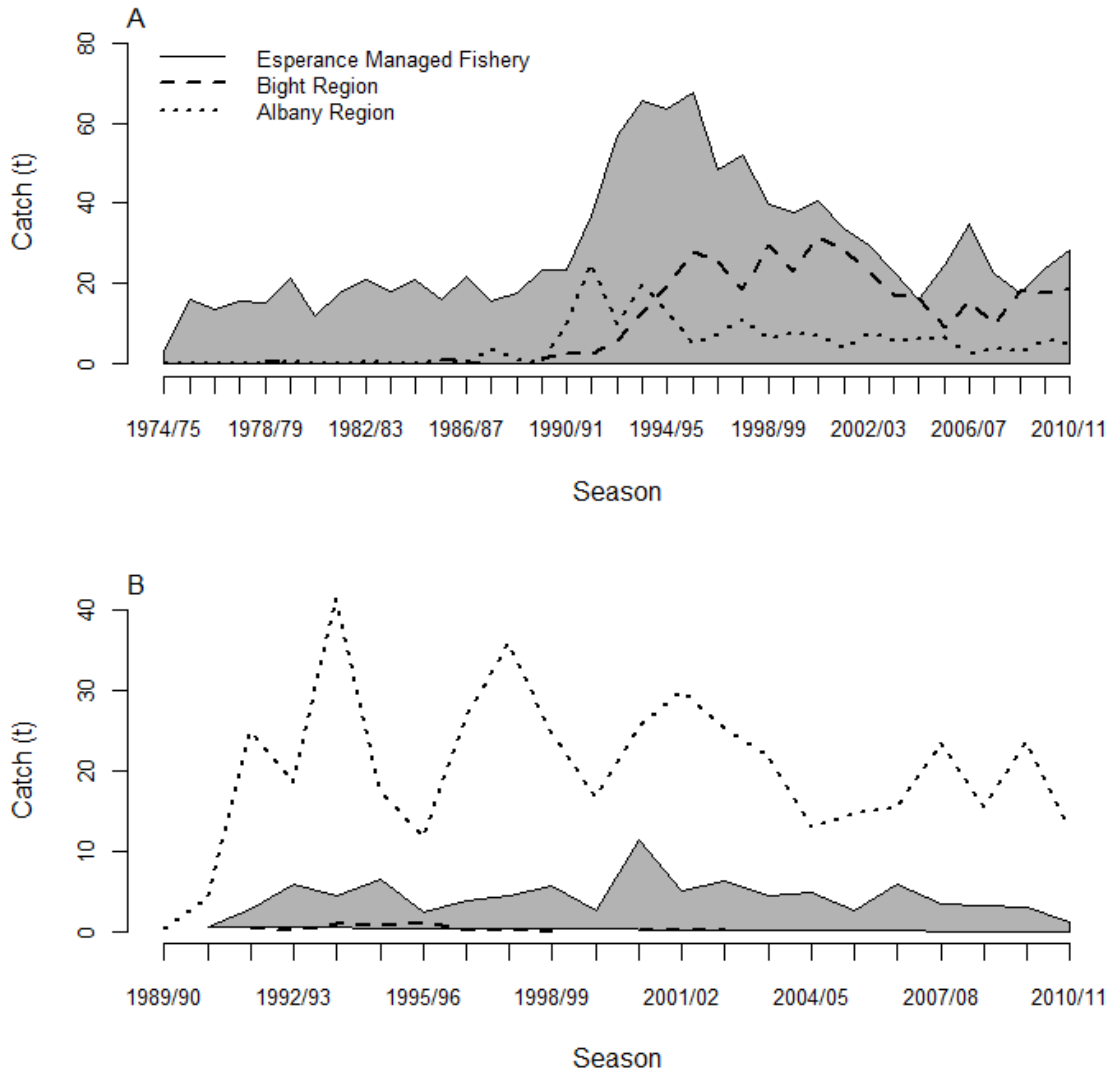
New management initiatives (2011/12)

In January 2009 the Department released Fisheries Management Paper 232 entitled, 'The South Coast Crustacean Fishery: A Discussion Paper'. This public discussion paper provided a review of the management arrangements and history behind the four south coast crustacean fisheries, as well as making a number of recommendations on the future management of each fishery. Two key recommendations included that one management plan cover all four crustacean fisheries and that an independent panel make recommendations on access and allocation of entitlement in the new fishery. An independent access and allocation panel has recently been formed and the outcomes of this process will be reported in next seasons update.



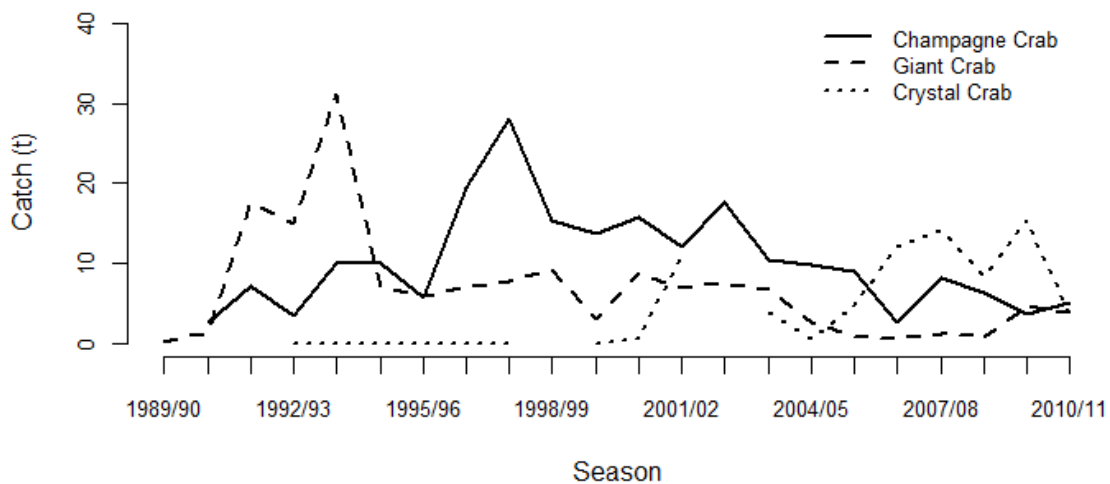
SOUTH COAST CRUSTACEAN FIGURE 1

Management boundaries in the South Coast crustacean fisheries.



SOUTH COAST CRUSTACEAN FIGURE 2

Seasonal catches of a) southern rock lobster and b) deep sea crab by management area.



SOUTH COAST CRUSTACEAN FIGURE 3

Seasonal catches of deep sea crab species since 1989/90 in the Albany region.

Greenlip/Brownlip Abalone Fishery Status Report

A. Hart, F. Fabris and Kim Walshe

Main Features			
Status		Current Landings	
Stock level	Adequate	Commercial	
		Total	202 t
Fishing level	Acceptable	Greenlip	166 t
		Brownlip	36 t
		Recreational	3-4% of total catch

Fishery Description

The Western Australian greenlip and brownlip abalone fishery is a dive fishery that operates in the shallow coastal waters off the south-west and south coasts of Western Australia. The fishery targets 2 large species of abalone: greenlip abalone (*Haliotis laevis*), and brownlip abalone (*H. conicopora*), both of which can grow to approximately 200 mm shell length.

Abalone divers operate from small fishery vessels (generally less than 9 metres in length). The principal harvest method is a diver working off 'hookah' (surface supplied breathing apparatus) or SCUBA using an abalone 'iron' to prise the shellfish off rocks – both commercial and recreational divers employ this method.

Governing legislation/fishing authority

Commercial

Abalone Management Plan 1992

Abalone Managed Fishery Licence

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

Recreational

Fish Resources Management Act 1994; *Fish Resources Management Regulations 1995* and other subsidiary legislation.

Recreational Abalone Fishing Licence

Consultation process

Commercial

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

Recreational

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

Boundaries

Commercial

The Abalone Management Plan covers all Western Australian coastal waters, which are divided into eight management areas. Commercial fishing for greenlip/brownlip abalone is managed in three separate areas (Greenlip/Brownlip Abalone Figure 1).

Recreational

The recreational abalone fishery regulations relate to three zones: the Northern Zone (from Greenough River mouth to the Northern Territory border), the West Coast Zone (from Busselton Jetty to Greenough River mouth) and the Southern Zone (from Busselton Jetty to the South Australian border). Greenlip and brownlip abalone are only fished in the Southern Zone.

Management arrangements

Commercial

The commercial greenlip/brownlip abalone fishery is part of the overall Abalone Managed Fishery which is managed primarily through output controls in the form of Total Allowable Commercial Catches (TACCs), set annually for each species in each area and allocated to licence holders as Individual Transferable Quotas (ITQs).

The overall TACC for 2011 was 213 t (whole weight). The TACC is administered through 16,100 ITQ units, with a minimum unit holding of 450 units. The licensing period runs from 1 April to 31 March of the following year.

The legal minimum length for greenlip and brownlip abalone is 140 mm shell length, although the commercial industry fishes to self-imposed size limits of 155 mm, 150 mm and 145 mm in various parts of the main stocks. In 'stunted stocks' areas, greenlip can be fished from 120 mm under special exemptions with such fishing strictly controlled to pre-arranged levels of catch and effort.

Recreational

The recreational component of the fishery for greenlip and brownlip abalone is managed under a mix of input and output controls and occurs primarily on the south and south-west coasts. Recreational fishers must purchase a dedicated abalone recreational fishing licence. Licences are not

restricted in number, but the recreational fishing season is limited to 7.5 months – from 1 October to 15 May.

The combined daily bag limit for greenlip and brownlip abalone is five per fisher, and the household possession limit (the maximum number that may be stored at a person's permanent place of residence) is 20.

General

A comprehensive ESD assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issues identified through this process were the breeding stock levels of greenlip and brownlip abalone. Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

Current research is focused on stock assessment using catch and effort statistics, meat weight indices, and length-frequency sampling. Commercial abalone divers are required to provide daily catch information on the weight and number of abalone collected, the hours fished, the date and location of harvest and the name of the person(s) harvesting. The divers also supply a random selection of abalone shells from each fishing day, and these are measured and used to estimate fishing mortality.

An annual standardized catch per unit effort (CPUE) index was developed that takes into account diver, sub-area and month of fishing as well as technological improvements that aid fishing efficiency. This index forms the basis of the revised decision-rule framework for the quota setting in each area of the fishery.

Current research initiatives include the use of digital video imagery assessment by industry divers, who survey selected sites with an underwater video camera, fishery-independent survey data collected from 140 sites across the fishery, and mark-recapture analysis of growth and mortality in brownlip abalone.

The telephone diary survey estimates the statewide catch of greenlip and brownlip abalone at regular intervals. For the last survey, in 2007, around 500 licence holders were randomly selected from the licensing database, with selection stratified by licence type (abalone or umbrella) and respondent location (country or Perth metropolitan area). The licence holders were sent a diary to record their fishing activity and were contacted every 3 months by telephone for the duration of the abalone season.

Research on stock enhancement continued in 2011/12, under the externally funded Seafood CRC project titled "*Bioeconomic evaluation of commercial scale stock enhancement in abalone*". Results from this project will inform industry and management on the viability of stock enhancement as a management tool for this fishery.

Retained Species

Commercial landings (season 2011): 202 tonnes

In 2011 the greenlip/brownlip catch was 202 tonnes whole weight (Greenlip Brownlip Abalone Table 1), which was similar to the 2010 catch of 205 t. The Area 1 (Nullarbor fishery) exploratory quota remained at 1.2 t but was not fished in 2011.

The greenlip catch of 165.9 t whole weight from a total quota of 173.3 t, was very similar to the 2010 catch of 165.6 t. The brownlip catch of 36 t whole weight for the 2011 season was 8% lower than the 2010 catch of 39 t, and represents 91% of the quota of 39.9 t (Greenlip Brownlip Abalone Table 1).

Recreational catch (season 2007): 8 tonnes

Recreational catch: 3 – 4% of total catch

The estimate of recreational catch of greenlip and brownlip abalone, based on the telephone diary survey of recreational licence holders in 2007, was 8 t (range: 0 – 16 t), which is similar to the 2006 estimate of 7 t. Given the catch estimates from 2004, 2006 and 2007, the recreational catch corresponds to approximately 3 – 4% of the total (commercial and recreational) catch (Greenlip Brownlip Abalone Table 2) and it is unlikely that this catch level would have differed greatly in 2011.

Fishing effort/access level

Commercial

Total fishing effort on the main stocks in 2011 was 1,224 days. This was 2% higher than 2010 (1,196 days).

Recreational

For the 2011 season, 17,300 licences were issued allowing abalone fishing (Greenlip/Brownlip Abalone Figure 2). This was the first year in which only abalone specific licenses were available to those wishing to fish for abalone. Umbrella recreational licenses, which allow for the catch of multiple species, have been phased out (Greenlip/Brownlip Abalone Figure 2).

Effort estimates for recreational abalone fishing on the west coast (excluding the Perth metropolitan area), from the 2007 telephone diary survey, was 6,300 days (3,800 – 8,800 days), while the estimated effort on the south coast was 4,900 days (1,700 – 8,000 days) (Greenlip Brownlip Abalone Table 2).

Stock Assessment

Assessment complete: Yes

Assessment level and method: Level 3

Standardised catch rates / Fishing mortality

Breeding stock levels: Adequate

A stock assessment of the greenlip/brownlip abalone fishery was undertaken for the 2011 fishing season, based on commercial catch and effort statistics, length-frequency and shell morphometry sampling, biological growth studies, and some fishery-independent surveys.

Standardised catch per unit effort (SCPUE): As a result of a recent review¹, the SCPUE for the greenlip fishery is now used as the principal indicator of the abundance of

¹ Hart A, Fabris F, Caputi N (2009). Performance indicators, biological reference points and decision rules for Western Australian abalone fisheries (*Haliotis* sp.): (1) Standardised catch per unit effort. Fisheries Research Report No. 185. Department of Fisheries, Western Australia. 32p.

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legal-sized abalone and the basis for the decision-rule framework. Raw CPUE data (kg whole wt per diver per day) is also presented for comparative purposes.

In 2011, the SCPUE for the combined greenlip stocks was 35 kg whole weight per hour (Greenlip Brownlip Abalone Table 1). This was a slight decrease from the 2010 value of 37 kg per hour (Greenlip Brownlip Abalone Table 1).

Fishing mortality (F): This analysis determines the proportion of the available abalone stock that is being harvested. Fishing mortality of greenlip abalone increased between 2010 and 2011 for the Augusta region, declined on the South Coast of Area 3, and was stable in the Area 2 fishery (Greenlip Brownlip Abalone Figure 3a). Average *F*, based on a 3-yr running mean (2009-2011) was 0.44 (Augusta), 0.48 (Area 3 South Coast) and 0.50 (Area 2).

Fishing mortality of brownlip abalone in Area 3 decreased between 2010 and 2011, but no data were available from Area 2 (Greenlip Brownlip Abalone Figure 3b). Average *F*, based on a 3-yr running mean (2009-2011) was 0.31 (Area 3) and 0.30 (Area 2).

Breeding stock: Greenlip abalone mature between 80 and 110 mm shell length, and brownlip abalone mature between 90 and 130 mm shell length. These are both below the legal minimum size limit set across the fishery (140 mm shell length) with individual abalone expected to have spawned at least twice before reaching legal size.

Industry-imposed length limits that are larger than the minimum legal limits have been set in areas of fast-growing stocks. In Area 2, there is a general 145 mm minimum length across the fishing grounds. In Area 3, fishers have imposed a minimum size limit of 155 mm shell length for the faster-growing portions of the fishing grounds, and 150 mm for the remainder.

In 2011, the average sizes of greenlip and brownlip caught were 190 g and 242 g respectively which are both well above the minimum breeding sizes of 140 g for greenlip and 160 g for brownlip respectively.

For brownlip, the assessment showed that the TACC was being caught at a lower average meat weight (declined from 286 g in 2006 to 242 g in 2011). TACC was therefore reduced to 39.9 t in 2011 (Greenlip Brownlip Abalone Table 1).

The main performance measures for the fishery relate to the maintenance of adequate breeding stocks in each area of the fishery. This is assessed using a combination of measures that reflect the average size of breeding individuals and the overall biomass of breeding stock.

In 2011, the average sizes of greenlip and brownlip caught were 190 g and 242 g respectively. These were well above the minimum breeding sizes of 140 g for greenlip and 160 g for brownlip. The effort (days fished) required to take the quota (1,224 days) was within the set range that indicates sufficient biomass of breeding stock for the fishery overall (907 – 1,339 days – see 'Fishery Governance' section).

Non-Retained Species

Bycatch species impact:

Negligible

Divers have the ability to target abalone of choice (species, sizes and quality of abalone) and do not inadvertently harvest bycatch in their normal fishing activities.

Protected species interaction:

Negligible

The only protected species interaction occurring in this fishery is with the white shark (*Carcharodon carcharias*), which has been known to attack divers. Most divers now use diving cages or electronic shark deterrent devices for their personal protection. Divers are now recording their encounters with white sharks and these will be documented in future reports.

Ecosystem Effects

Food chain effects:

Negligible

Commercial abalone diving occurs over a small proportion of the total abalone habitat of the Western Australian coastline. In view of the relatively low exploitation rates and consequent maintenance of a high proportion of the natural biomass of abalone, it is considered unlikely that the fishery has any significant effect on the food chain in the region.

Habitat effects:

Negligible

The fishing activity makes minimal contact with the habitat, which typically consists of hard rock surfaces in a high wave-energy environment. As abalone are drift algae feeders, their removal is considered to result in little change in algal growth cover in areas fished.

Social Effects

There are 14 vessels operating in the greenlip/brownlip commercial fishery, employing approximately 35 divers and deckhands. The dispersed nature of the greenlip and brownlip abalone fishery means that small coastal towns from Busselton to the South Australian border receive income from the activity of divers.

Recreational diving for greenlip and brownlip abalone is a small but active sector, with dive shops and vessel manufacturers' benefiting from this activity. The recreational fishery provides a major social benefit to those sectors of the community that appreciate the abalone as a delicacy. There were 17,300 licenses issued that would have allowed fishers to participate in the recreational abalone fishery, although most of these would have targeted the Roe's abalone fishery in the Perth metropolitan area.

Economic Effects

Estimated annual value (to fishers) for 2011:

Level 3 - \$5 - 10 million (\$8.3 million)

The estimated average price received by commercial fishers was \$112/kg meat weight (\$42/kg whole weight) for greenlip and \$90/kg meat weight (\$36/kg whole weight) for brownlip

abalone, resulting in a fishery valued at \$8.3 million, compared to \$7.8 million in 2010 and \$7.7 million in 2009.

Greenlip prices in 2011 were higher than 2010 (\$103/kg), and were the highest since 2007, but still low compared to 10 years ago due to increasing value of the Australian dollar.

Fishery Governance

Target effort range: 907 – 1,339 days

Current effort level: Acceptable

To assess whether the catch quota set is appropriate (sustainable) relative to the stock available, the effort required to take a full season's quota (213 t in 2011) from the main stocks should fall within the effort range (907 – 1,339 diver days) derived from the 5-year period 1994 – 1998. This range reflects the acceptable variation in catch rates for the main stocks due to weather and natural recruitment cycles.

The fishing effort in 2011 was 1,224 days (main stocks), which is within the governance range and indicates that the fishery as a whole is performing satisfactorily.

New management initiatives (2010/11)

Consultation also took place with industry on relatively minor operational changes to the Abalone Management Plan 1992. These matters are currently being progressed.

External Factors

In the last few years there have been a number of changes which impact on fishery governance, and particularly on catch rates. Lease divers are becoming more common and industry size limits have been varied substantially above the legal minimum sizes. The value of the abalone has decreased over the past few years, although increased for the first time in 2011.

In addition, environmental effects, such as weather conditions, and the effect of technology changes, continue to have significant effects on diver efficiency.

GREENLIP/BROWNLIP ABALONE TABLE 1Greenlip and brownlip abalone catch and effort¹ by quota period.

Quota period ²	Greenlip TAC kg whole weight	Greenlip caught kg whole weight (all stocks)	Brownlip TAC kg whole weight	Brownlip caught kg whole weight ⁴	Combined catch kg whole weight	Diver days (main stocks only) ³	Greenlip Raw CPUE kg whole (meat) ⁴ wt per diver day)	Greenlip standardised CPUE (kg whole weight) per diver hour
1989		229,619	–	36,977	266,596	1,324	158 (59)	
1990	126,500	118,395	–	19,118	137,514	696	164 (62)	
1991	148,500	132,194	–	14,658	146,852	816	158 (59)	
1992	192,500	170,608	–	30,404	201,012	1,120	152 (57)	37
1993	197,450	173,397	–	31,153	204,550	1,238	140 (53)	37
1994	200,750	171,820	–	32,222	204,042	1,337	129 (48)	36
1995	187,264	145,467	–	27,061	172,528	1,087	134 (50)	32
1996	189,750	171,337	–	21,932	193,269	904	177 (66)	40
1997	207,350	182,317	–	26,297	208,614	1,059	172 (65)	35
1998	200,750	181,810	–	22,197	204,006	1,031	166 (62)	36
1999	184,023	175,765	28,000 ⁵	28,047	203,812	922	182 (68)	39
2000	194,691	189,511	34,875	34,179	223,690	1,029	178 (67)	41
2001	194,691	187,459	33,075	31,091	218,550	1,002	165 (62)	37
2002	194,691	166,828	33,075	27,458	194,286	1,027	134 (50)	34
2003	202,521	180,730	37,453	33,449	214,179	1,144 ³	136 (51)	33
2004	190,520	170,385	35,000	34,196	204,581	1,154 ³	129 (48)	34
2005	171,755	169,285	38,500	38,745	208,030	1,252	131 (49)	31
2006	171,755	168,752	39,750	37,265	206,017	1,161	133 (50)	31
2007	171,755	166,647	39,750	38,660	205,307	1,139	137 (51)	34
2008	163,220	157,224	41,900	39,515	196,739	1,144	135 (51)	34
2009	171,221	160,156	41,900	39,050	199,206	1,205	130 (49)	34
2010	171,221	165,558	41,900	39,006	204,564	1,196	138 (52)	37
2011	173,355	165,927	39,950	36,274	202,201	1,224	136 (51)	35

1. Data source: quota returns.

2. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.

3. Effort (diver days): main stocks are separated from stunted stocks, which are subject to controlled fishing regimes and not directly comparable.

4. Greenlip conversion factor (meat weight to whole weight) is 2.667. Brownlip conversion factor for meat weight to whole weight is 2.5.

5. Brownlip allocations not fixed across Areas 2 and 3 (ex-Zone 1 and 2) prior to 1999. Brownlip TAC fixed for the first year in 1999.

GREENLIP/BROWNLIP ABALONE TABLE 2

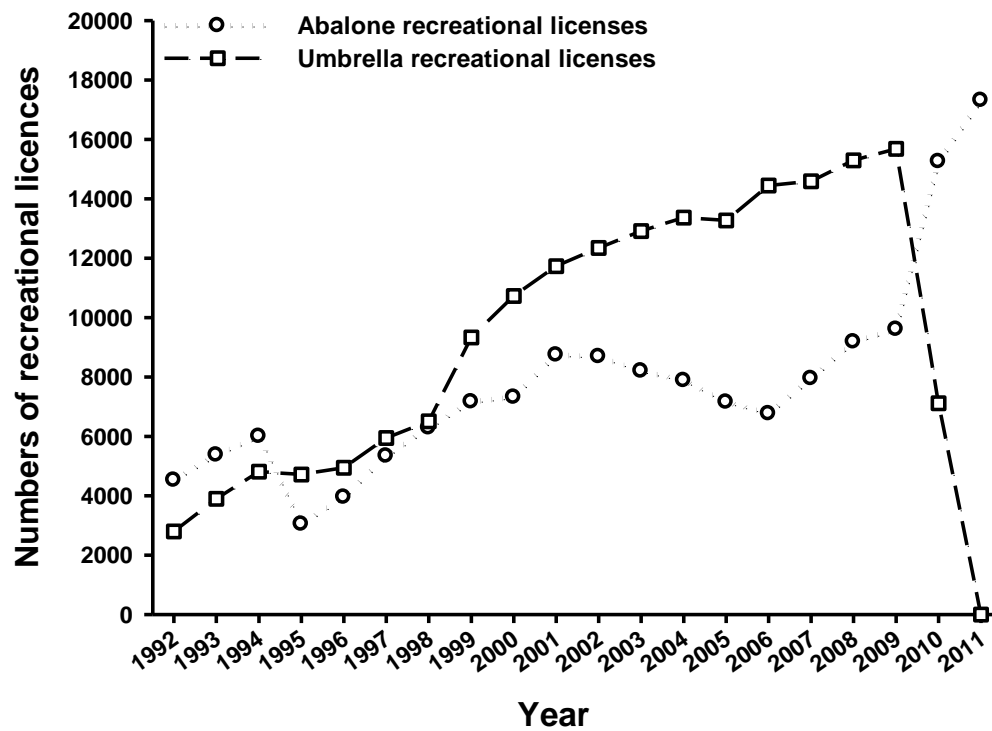
Summary of telephone diary surveys of recreational effort (fisher days), catch rate (abalone per fisher day) and catch (tonnes whole weight) for the greenlip and brownlip abalone fisheries in 2004, 2006, and 2007.

Location	Year	Effort	Greenlip		Brownlip	
			Catch Rate	Catch (tonnes)	Catch Rate	Catch (tonnes)
West Coast	2004	10,100 (6,500 – 13,600)	0.6	4 (2–6)	0.4	3 (1–5)
	2006	8,000 (4,700 – 11,300)	0.3	2 (0–3)	0.4	3 (0–5)
	2007	6,300 (3,800 – 8,800)	0.7	3 (0–6)	0.1	<1 (0–1)
South Coast ¹	2004	2,700 (1,700 – 3,700)	2.4	2 (1–5)	<0.1	<1 (0–1)
	2006	2,800 (1,600 – 3,900)	1.6	2 (0–4)	0.5	1 (0–2)
	2007	4,900 (1,700 – 8,000)	1.8	4 (0–8)	0.2	<1 (0–1)

1. Survey area is South Coast bioregion (i.e. east of Black Point).

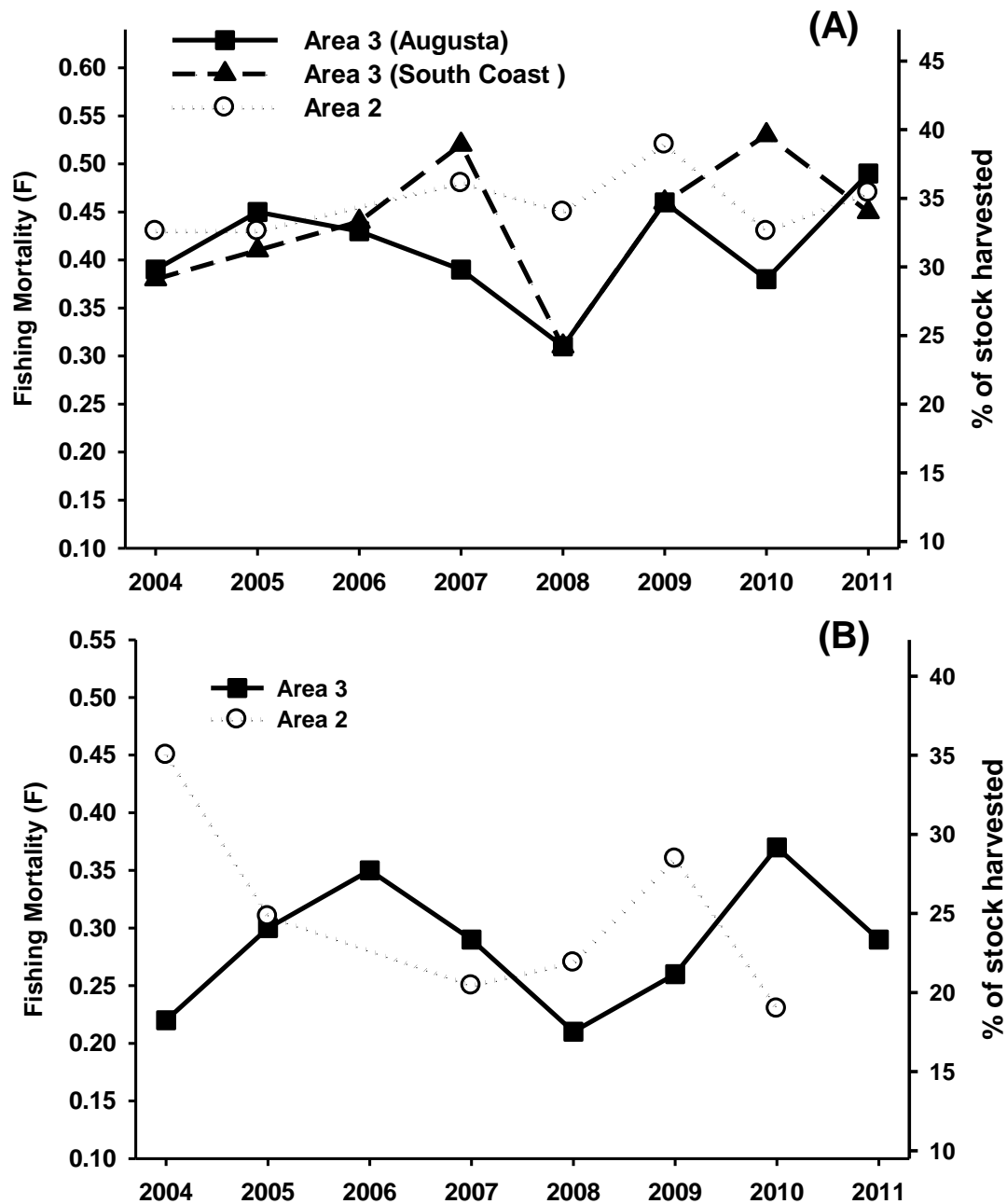
**GREENLIP/BROWNLIP ABALONE FIGURE 1**

Maps showing the distribution of (a) greenlip and (b) brownlip abalone in Western Australia, and (c) the management areas used to set quotas for the commercial fishery. Area 4 currently has no quota allocated.



GREENLIP/BROWNLIP ABALONE FIGURE 2

The number of licences issued in the recreational abalone fishery, by licence type, for the period since 1992. Data are license counts at the end of the Perth metro abalone season (mid-December). Note umbrella licences were discontinued in 2010.

**GREENLIP/BROWNLIP ABALONE FIGURE 3**

Fishing mortality for greenlip (A) and brownlip (B) abalone. Estimates of fishing mortality (F) apply only to harvest-size animals, and are derived from catch-curve analysis using length-frequency data, and annualised growth increments based on following growth models. West Coast Greenlip: $L_{\infty}=185$ mm, $K = 0.30$; South Coast Greenlip: $L_{\infty}=179$ mm, $K = 0.30$; Brownlip: $L_{\infty}=198$ mm, $K = 0.32$. Natural mortality (M) is assumed to be 0.25.

South Coast Nearshore and Estuarine Finfish Resources Status Report

K. Smith, J. Brown, A. Howard and M. Stadler

Main Features			
Status		Current Landings (2011)	
Stock levels:		Commercial total	466 t (finfish only)
Australian herring	Uncertain	South Coast Salmon Fishery	163 t (salmon only)
Western Australian salmon	Adequate	South Coast herring trap net fishery	84 t (herring only)
Black bream (Stokes Inlet)	Adequate	South Coast Estuarine Fishery	201 t (finfish only)
Black bream (Beaufort Inlet)	Adequate	Other commercial	18 t (finfish only)
Black bream (Wilson Inlet)	Adequate		
Black bream (Oyster Harbour)	Adequate		
Black bream (Walpole-Nornalup Inlet)	Not assessed	Recreational	not available for current year.
Cobbler (Wilson Inlet)	Adequate	Most recent survey was in 2000/01.	
Cobbler (Oyster Harbour)	Adequate	2000/01 finfish catch	368 t (key species only)
Fishing Level (all stocks)		Acceptable	

Fishery Description

Commercial - Nearshore

Beach-based commercial fishers in nearshore waters of the South Coast Bioregion catch various finfish species, mainly using trap nets (herring only), beach seines, haul nets and gill nets. The main target species are western Australian salmon (*Arripis truttaceus*) and Australian herring (*Arripis georgianus*), with small quantities of southern sea garfish (*Hyporhamphus melanochir*) and sea mullet (*Mugil cephalus*) also taken.

Western Australian salmon form large migratory schools, particularly during the autumn spawning season, that move along the coast in nearshore waters between South Australia and Kalbarri (WA). The species is targeted in WA by two commercial fisheries – the South Coast Salmon Managed Fishery and the South-West Coast Salmon Managed Fishery (see later in this report). Fishers target schools of migrating fish mainly during late summer and autumn. Western Australian salmon fishing is conducted by teams of fishers setting beach seine nets using either row boats or small jet-powered boats.

Most of the commercial catch of Australian herring¹ in WA is taken on beaches along the South Coast using herring trap nets (also known as ‘G’ trap nets). Trap nets are used principally during the autumn migration of this species. Beach seine nets, gill nets and haul nets in the South Coast and West Coast Bioregions take the majority of the remaining commercial Australian herring landings.

Commercial - Estuarine

Approximately 25 major estuaries exist in the South Coast Bioregion, extending from Black Point in the west, to the WA/SA border to the east. Thirteen estuaries are conditionally open to commercial fishing as part of the South Coast Estuarine Managed Fishery (SCEMF). This is a multi-species fishery targeting many estuarine finfish species, with the main fishing methods being gill net and haul net. The main target species are cobbler (*Cnidogobius macrocephalus*), black bream (*Acanthopagrus butcheri*), sea mullet and Australian herring.

Recreational

Most finfish caught recreationally in South Coast Bioregion estuaries and nearshore waters are taken by line fishing. Shore and boat-based fishing are both popular. The most commonly captured recreational species include Australian herring, various species of whiting (Sillaginidae), trevally (*Pseudocaranx* spp.), black bream (estuaries only), western Australian salmon and southern sea garfish.

A relatively small amount of recreational net fishing occurs in the South Coast Bioregion, mainly targeting sea mullet.

Governing legislation/fishing authority

Commercial

South Coast Estuarine Fishery Management Plan 2005

South Coast Estuarine Managed Fishery Licence

Fisheries Notice No. 478 of 1991 (Herring ‘G’ nets)

Fishing Boat Licence Condition 42 (Herring ‘G’ nets)

¹ Note – The stock assessment for Australian Herring is presented in the West Coast Nearshore and Estuarine Fisheries Report

South Coast Salmon Fishery Management Plan 1982

South Coast Salmon Managed Fishery Licence

Proclaimed Fishing Zone Notice (South Coast) 1975

Salmon Block Net Prohibition Notice 1996

Salmon and Snapper Purse Seining Prohibition Notice 1987

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

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation

Consultation processes

Commercial

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

Recreational

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

Boundaries

Commercial - Nearshore

In the South Coast Bioregion, Australian herring can be taken commercially by holders of an unrestricted fishing boat licence. The use of trap nets is restricted to holders of fishing boat licences with Condition 42, who can only operate at 10 specific beaches along the south coast.

The South Coast Salmon Managed Fishery covers WA waters from Cape Beaufort to the eastern boundary of the State on the south coast of Western Australia.

Commercial - Estuarine

The South Coast Estuarine Managed Fishery encompasses 'the waters of all estuaries on the south coast of Western Australia between Cape Beaufort and 129° east longitude, including Princess Royal Harbour and Oyster Harbour, and all the rivers, streams and all the tributaries that flow into those estuaries.' The areas that are open to commercial fishing are (from west-to-east) Broke Inlet, Irwin Inlet, Wilson Inlet, Princess Royal Harbour, Oyster Harbour, Waychinicup Inlet, Beaufort Inlet, Gordon Inlet, Hamersley Inlet, Culham Inlet, Jerdacuttup Lakes, Oldfield Inlet and Stokes Inlet.

Recreational

Recreational line fishing is permitted in most areas within estuaries and nearshore waters of the South Coast Bioregion. Some spatial closures exist, including closures around dive wrecks.

A limited number of areas within certain estuaries and nearshore waters of the South Coast Bioregion are open to recreational netting. Recreational net fishers must hold a licence. Recreational set nets are prohibited in all ocean

waters of the South Coast at all times. Recreational net fishing regulations are complex – please refer to the 'Recreational Net Fishing Guide' for details.

Management arrangements

Commercial

The South Coast nearshore and estuarine commercial fisheries are managed primarily through input controls in the form of limited entry and gear restrictions, as well as seasonal and time closures, area closures and size limits.

The South Coast Salmon Fishery Management Plan 1982 provides for licence holders to operate from assigned beaches between Shoal Cape and Cape Beaufort, with each fishing team having access to a single nominated beach only.

The Herring Trap Net Notice (Order 478 of 1991) prohibits the use of herring trap nets except by licensed commercial fishers using a fishing boat with the appropriate fishing boat licence condition (Condition 42). Holders of fishing boat licences with this condition may take Australian herring using 'G' trap nets on 10 separately nominated south coast beaches. There is a closed season for the use of 'G' trap nets (10 February to 25 March each year) that closely matches the peak western Australian salmon migration season along the south coast. Australian herring may also be commercially caught by beach seine, set net and line methods by any licensed commercial fisher holding an unrestricted Fishing Boat Licence, provided the use of this method is permitted in the particular area and the waters being fished are not subject to other fishery management arrangements.

Recreational

Recreational fishers in South Coast Bioregion estuaries and nearshore waters take a diverse array of finfish species. South Coast Bioregion size and possession limits apply to these species. Refer to the 'Recreational Fishing Guide - South Coast Bioregion' for details. A State-wide Recreational Fishing from Boat Licence (RFBL) was introduced on 2 March 2010. A RFBL is required to undertake any general fishing activity (including crabbing) conducted with the use of a powered boat anywhere in the State.

As many of the recreationally targeted species are also targeted by the commercial sector, resource-sharing issues are a consideration in these fisheries.

Indicator species

The Department of Fisheries has selected indicator species for monitoring and assessing the status of the finfish resources in the South Coast Bioregion (DoF 2011¹). Western Australian salmon, black bream and cobbler are indicators for this Bioregion's nearshore and estuarine finfish suites. Australian herring and sea mullet are also significant components of fishery landings in this Bioregion (see West Coast Nearshore and Estuarine Finfish Resources Report for the status of these stocks).

Australian herring and sea mullet are currently assigned to the 'low risk' category (mixed species daily bag limit of 40

¹ Department of Fisheries (DoF). 2011. Resource Assessment Framework (RAF) for Finfish Resources in Western Australia. Fisheries Occasional Publication No. 85. Department of Fisheries, Perth.

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applies to recreational fishers). Western Australian salmon and black bream are assigned to the 'medium risk' category (individual species bag limits of 8 and 4, respectively). Cobbler is assigned to the 'high risk' category (daily bag limit of 4).

Research summary

Monitoring of fisheries and fish stocks in estuaries and nearshore waters of the South Coast Bioregion is based on commercial catch and effort statistics (CAES) from compulsory monthly returns, recreational catch and effort data from voluntary recreational fisher log books (Research Angler Program) and recreational fishing surveys and fishery-independent surveys to monitor annual juvenile recruitment of various fish species (including Australian herring, western Australian salmon, whiting, mullet and cobbler).

While commercial fishery catch levels are determined annually from data reported in compulsory monthly commercial returns, recreational catch levels are estimated only occasionally when recreational fishing surveys are conducted.

The interpretation of trends in recruitment, catch and catch rates is assisted by the substantial amount of biological information already available for key nearshore and estuarine species.

Regular monitoring of the age structure of fishery landings has recently been implemented for Australian herring, cobbler (Wilson Inlet only) and western Australian salmon. In future, this information will be used to monitor levels of fishing mortality in these stocks, which will be used in conjunction with trends in recruitment and catch rates to assess stock status.

Retained Species

Total commercial finfish landings (2011):

265 tonnes in nearshore waters

201 tonnes in estuarine waters

Commercial landings by fishery (2011):

South Coast Salmon 163 tonnes (salmon only)

Herring trap net 84 tonnes (herring only)

South Coast Estuarine 201 tonnes (finfish only)

Commercial finfish catches (South Coast Nearshore and Estuarine Table 1) are taken by estuarine fisheries and beach-based nearshore fisheries using trap nets (herring only), gill nets, haul nets and beach seines. Minor quantities of the same species that are taken by other methods (e.g. fish traps and line) are generally not included in this report, although catches by all methods and all fisheries are included in the total catches reported for key species and are taken into account in stock assessments.

In 2011, the total commercial catch of finfish by estuarine and beach-based fisheries in the South Coast Bioregion was 467 t and included at least 38 species. The majority of the catch consisted of western Australian salmon (36% by weight) caught by the South Coast Salmon Managed Fishery,

Australian herring (24%) caught primarily by the trap net fishery, cobbler (14%) and black bream (9%) caught by the South Coast Estuarine Managed Fishery.

In 2011, the nearshore finfish catch was comprised predominantly of western Australian salmon (62% by weight) and Australian herring (35%). The estuarine finfish catch was comprised mainly of cobbler (33%), black bream (22%), sea mullet (15%) and Australian herring (9%).

Since 2000, 95% of landings by the South Coast Estuarine Managed Fishery have been finfish. The non-fish component is dominated by blue swimmer crabs (*Portunus pelagicus*), which ranged from 1 t in 2006 to 39 t in 2001. In 2011, 15 t of blue swimmer crab was reported by this fishery. The majority of estuarine finfish landings were taken by gill nets (91%), with smaller amounts taken by haul nets and fish traps.

Key finfish species - nearshore

Western Australian salmon: This species is targeted commercially in Western Australia and South Australia. Since 2000, 68% of total commercial landings of western Australian salmon in WA have been taken in the South Coast Bioregion, with the remaining 32% taken in the West Coast Bioregion. Within the South Coast Bioregion, the South Coast Salmon Managed Fishery took almost 100% of landings.

Annual commercial landings of western Australian salmon in WA have been highly variable since the commercial fishery commenced in 1944. Peaks in total annual landings occurred in 1968 (4,223 t), 1984 (3,543 t) and 1995 (4,046 t) (South Coast Nearshore and Estuarine Figure 1). Total landings have been declining since 1995, with the decline becoming more pronounced after 2005. In 2011, the total WA catch was 171 t, which was the lowest since the 1940s. The decline since 1995 reflects the trend in the South Coast Bioregion, where the annual catch steadily declined from a peak of 2,728 t in 1995 to 165 t in 2011. Commercial fishery landings of western Australian salmon in South Australia have followed a similar trend since 1995¹. The historically low catch levels in recent years are believed to be due to a combination of factors – lack of targeting in response to low market demand and reduced availability of fish in some years due to low recruitment and environmental factors affecting catchability.

In the West Coast Bioregion landings of salmon have been in the range 0-1363t. In 2011, 6 t of western Australian salmon was reported (South Coast Nearshore and Estuarine Figure 1). Landings of salmon in the West Coast Bioregion are strongly influenced by the Leeuwin Current and water temperature. Low or nil catches typically occur during years of strong Leeuwin Current (resulting in warmer water along the West Coast).

¹ Knight MA and Tsollos A. 2012. South Australian Wild Fisheries Information and Statistics Report 2010/11. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2008/000804-4. SARDI Research Report Series No. 612. 57pp.

Unusual oceanographic conditions associated with a 'heatwave' event affected the distribution and catchability of salmon and limited the catch in both Bioregions in 2011 (Pearce *et al.* 2011¹).

Key finfish species - estuarine

Cobbler: Commercial targeting of cobbler in WA is almost entirely restricted to estuaries. Each estuary hosts a discrete stock of cobbler, which is genetically distinct to other estuarine populations and also distinct to cobbler populations in adjacent ocean waters. From 2000 to 2011, 95% of commercial landings of cobbler were caught in estuaries of the South Coast Bioregion, with 5% taken from estuaries of the West Coast Bioregion. Less than 1% has been taken from ocean waters. Over this period, total annual landings in the South Coast Bioregion ranged from 40 t (in 2004) to 95 t (in 2003), with 79% of these landings caught in Wilson Inlet, 9% from Irwin Inlet, 8% from Oyster Harbour and 3% from Princess Royal Harbour.

In 2011, 65 t of cobbler was caught in the South Coast Estuarine Managed Fishery. The majority (50 t or 78%) of this catch was taken in Wilson Inlet. Wilson Inlet has historically produced the vast majority of South Coast Bioregion landings of cobbler.

In Wilson Inlet, annual cobbler landings steadily increased after the 1940s (minimal catch at this time) until the mid 1980s. Since 1985, annual landings have varied substantially but the overall trend has been stable. Annual landings reached an historical peak of 79 t in 1985 and again in 2003. Fluctuations in landings are believed to mainly reflect variations in the availability of cobbler due to variations in recruitment.

Black bream: Commercial targeting of black bream is restricted to estuaries. Each estuary hosts a different stock of black bream. From 2000 to 2011, 93% of commercial landings of black bream in WA were caught in the South Coast Bioregion, with the remaining 7% from the West Coast Bioregion. In the South Coast Bioregion, total landings over this period were mainly taken in Beaufort Inlet (34% of landings), Stokes Inlet (31%), Wilson (15%) and Oyster Harbour (11%). Minor black bream landings were reported in all other estuaries open to commercial fishing over this period.

Since 2000, total annual South Coast Bioregion landings of black bream have ranged from 30 t (in 2000) to 65 t (in 2010). The 2010 catch was the highest recorded in the South Coast Bioregion since 1993 (when the catch was 70 t), mainly due to high landings within Stokes Inlet. In 2011, a total of 44 t of black bream was landed in the South Coast Bioregion.

Since 1980, Stokes Inlet has contributed the greatest proportion of black bream landings of any single South Coast estuary and had the most stable trend in annual landings (average 12 t per year 1980-2011). In 2010, landings rose abruptly to an historical peak of 37 t. In 2011, the catch was

12 t.

Minimal landings of black bream were taken in Beaufort Inlet prior to 1993. From the late 1990s to 2005, landings gradually increased and have remained relatively high in subsequent years. Since 2005, annual landings have ranged from 10 to 26 t. Annual landings of black bream in Wilson Inlet and Oyster Harbour also followed an increasing trend after the late 1990s. Wilson Inlet landings peaked at 18 t in 2005 and Oyster Harbour landings peaked at 12 t in 2008. The catches in these estuaries then declined gradually, reaching 3 t and 5 t, respectively, in 2011. These catch trends appear to be the result of strong recruitment by black bream in Beaufort Inlet, Wilson Inlet and Oyster Harbour in the mid-1990s.

Recreational catch estimate (2011): NA

Most recent catch estimate (2000/01)

Nearshore + estuarine: 368 tonnes
(key finfish species only)

Most recent catch estimate (2002/03)

Estuarine only 50 tonnes
(key finfish species only)

Recreational catch levels of finfish in nearshore and estuarine waters of the South Coast Bioregion were not estimated in 2011. The most recent nearshore estimates are from the National Recreational and Indigenous Fishing Survey conducted in 2000/01 (South Coast Nearshore and Estuarine Table 2). The most recent estuarine estimates are from a creel survey in 2002/03 (South Coast Nearshore and Estuarine Table 3). While the dominant species in the catch are probably similar to those caught in recent surveys, the catch and effort levels by recreational fishers may have changed substantially. Therefore, the current total catch level cannot be estimated.

Overall, the most abundant species in the retained catch (nearshore and estuarine combined for the South Coast Bioregion) in 2000/01 were Australian herring (45% by number), King George whiting (*Sillaginodes punctata*) (12%), skipjack trevally (10%), whiting (various species, excluding King George) (8%), black bream (7%) and western Australian salmon (3%). The nearshore and estuarine waters in the region from Denmark to Esperance contributed 90% of all South Coast Bioregion catches. Shore fishers caught 73% of retained fish in nearshore waters and 28% in estuaries.

In nearshore waters, the most abundant species in the retained catch in 2000/01 were Australian herring (52% by number), skipjack trevally (11%), King George whiting (10%), whiting (various species, excluding King George) (9%) and western Australian salmon (3%). In estuarine waters, the most abundant species in the retained catch in 2000/01 were black bream (39% by number), King George whiting (23%), Australian herring (11%), mullet (*Mugilidae*) (6%) and skipjack trevally (4%).

The 2002/03 survey involved 17 estuaries, including 11 of the 13 estuaries open to commercial fishing (no commercial catches were taken in the remaining 2 estuaries during the study period). The most commonly reported species were King George whiting, black bream, Australian herring,

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.

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skipjack trevally (*Pseudocaranx georgianus*), pink snapper (*Pagrus auratus*), flathead (Platycephalidae), tarwhine (*Rhabdosargus sarba*) and garfish, comprising approximately 80% of all fish (by number) retained by recreational fishers during the survey.

In the commercially-fished estuaries, the recreational catch of these 8 species was estimated to be approximately 29% (by weight) of the combined recreational and commercial catch of these species during the survey period. A total of 48 species were reported in the recreational catch from south coast estuaries. However, the total recreational catch (by weight) of all species could not be estimated in 2002/03 due to uncertainties associated with small samples of less abundant species and limited data on the average size of fish in the catch.

With the inclusion of less abundant species and catches taken in estuaries closed to commercial fishing, the recreational catch share of recreationally-targeted finfish species in South Coast Bioregion estuaries is estimated to be 30-40%. If the landings of non-recreational species (cobbler, sea mullet and yellow-eye mullet) are also included, the recreational catch share of total finfish landings is estimated to be approximately 20%.

In 2002/03, the highest recreational fishing catch and effort of any south coast estuary was reported from the Walpole/Nornalup Inlet, which is closed to commercial fishing. The main species taken in this estuary was black bream, with an estimated recreational catch of 15 t during the survey period.

A comprehensive Statewide Recreational Fishing from Boat survey was undertaken in 2011. Analyses of the survey results from up to 23,000 interviews of recreational boat fishers are due to be completed by the end of 2012. However, catch and effort data from shore-based fishers, who are believed to take the majority of the recreational nearshore and estuarine finfish catch, will not be estimated by this survey. The Department of Fisheries recently conducted a pilot study of shore-based fishers in the Perth Metropolitan area in an attempt to determine the best method to quantify recreational fishing catch and effort from this sector (Smallwood *et al.* 2011¹).

Recreational catch share

The recreational catch share of total finfish landings in nearshore and estuarine waters of the South Coast Bioregion cannot be determined for the current year and given there has been no survey for over five years it is not appropriate to estimate the current catch share.

Fishing effort/access level

Commercial

Since 1990, the number of licences in nearshore and estuarine commercial fisheries has been substantially reduced via a Voluntary Fishery Adjustment Scheme (VFAS) (i.e. licence

buy-backs). The removal of licences has eliminated a significant amount of latent effort (inactive licences) that previously existed in these fisheries.

Fishing effort in nearshore and estuarine fisheries is sometimes reported as the number of units of access (vessels, teams, licensees, etc). These measures of effort provide a general indication of effort changes over time and are often the only types of effort data available throughout the history of each fishery. Where possible, effort is also calculated as the number of days fished by each method. It is considered that 'method days fished' generally provides a more accurate measure of the effort undertaken in each fishery.

The commercial method of fishing for western Australian salmon and Australian herring (i.e. beach-based netting) includes a considerable amount of time spent observing or searching for fish ('spotting'). Hence effort in these fisheries is difficult to accurately quantify. The number of licensed teams that operate during each fishing season provides an approximate measure of effort in these fisheries.

South Coast Estuarine Fishery: Declines in total fishery effort over the past decade reflect a reduction in the number of licensees in the fishery due to a VFAS. This resulted in the number of licensees being reduced from 66 in 1987 to 25 in 2002.

The total annual reported fishing days peaked at 6,747 days in 1992 and then steadily declined until about 2004. Similarly, the average number of boats fishing per month peaked at 42.9 in 1992 and then declined. Total effort assessed as both the number of fishing days and the average number of boats fishing per month has followed a stable trend in recent years. In 2011, the fishery reported a total of 3,320 fishing days and an average of 18 boats fished per month.

In 2011, 48% of effort (method days) occurred in Wilson Inlet, 16% in Oyster Harbour, 14% in Princess Royal Harbour, 8% in Irwin Inlet, 5% in Broke Inlet, 5% in Beaufort Inlet and 4% in Stokes Inlet. The remaining effort (<1%) occurred in Oldfield River, Jerdacuttup Lakes and Culham Inlet. Three estuaries (Gordon Inlet, Hamersley River and Waychinicup Inlet) were not fished during 2011.

Herring trap net fishery: The total number of licensed teams reached a peak of 30 in 1984, and has since been reduced by a VFAS to the current level of 11 (operating from 10 beaches). In 2011, only 2 teams recorded effort during the season. This is a continuation of the low participation level in this fishery in recent times. Commercial fishers report that these historically low effort levels are in response to the lack of markets and low wholesale prices paid for Australian herring.

South Coast Salmon Fishery: Since 1999, there have been 18 licensed teams in this fishery. Some teams are inactive each year. Effort (number of active teams) has followed a declining trend since 2002. In 2011, western Australian salmon landings were reported by 5 of the 18 licensed teams.

Recreational

Current estimates of recreational effort for the South Coast Bioregion are unavailable.

The 2000/01 National Recreational and Indigenous Fishing Survey, which included all methods and Bioregions, provided the most recent information on total recreational fishing

¹ Smallwood CB, Pollock KH, Wise BS, Hall NG and Gaughan DJ. 2011. Quantifying recreational fishing catch and effort: a pilot study of shore-based fishers in the Perth Metropolitan area. Fisheries Research Report 216. Department of Fisheries, Perth.

effort in the South Coast Bioregion. About 90% of the nearshore and estuarine 'fishing events' that were targeting finfish during the survey used line fishing (bait or lure). About 85% of all line fishing events occurred in nearshore waters. The estimated nearshore line fishing effort in 2000/01 comprised 223,158 shore-based and 50,368 boat-based fishing events during the 12-month survey period. In estuaries, the line fishing effort comprised 21,800 shore-based and 30,087 boat-based fishing events.

Recreational fishing effort in 17 south coast estuaries was estimated by a creel survey conducted in 2002/03. Total effort during the survey period was estimated at 254,171 fisher hours or 86,482 fisher days. This total included boat-based (202,658 hours), shore-based (47,816 hours) and house boat (3,698 hours) fishing. Recreational netting and charter boat effort was not quantified in this survey, but was considered to have been negligible (less than 2% of total effort).

In the 2002/03 survey, recreational fishing effort was estimated to have occurred mainly in Walpole/Nornalup Inlet (33% of total effort), Oyster Harbour (29%), Princess Royal Harbour (12%), Wilson Inlet (12%) and Wellstead Estuary (6%).

The 2011 Statewide Recreational Boat Fishing Survey will provide recreational boat fishing effort data for the South Coast Bioregion in 2012.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Level 2 - Catch rates

Breeding stock levels:

Australian herring¹	Uncertain
Western Australian salmon	Adequate
Black bream (Stokes Inlet)	Adequate
Black bream (Beaufort Inlet)	Adequate
Black bream (Wilson Inlet)	Adequate
Black bream (Oyster Harbour)	Adequate
Black bream (Walpole-Nornalup Inlet)	Not assessed
Cobbler (Wilson Inlet)	Adequate
Cobbler (Oyster Harbour)	Adequate

Indicator species - nearshore

Western Australian salmon: Western Australian salmon form a single breeding stock across southern Australia. Spawning occurs mainly along the lower west coast of WA. The Leeuwin Current disperses eggs and larvae to coastal nurseries distributed from the West Coast Bioregion to Victoria. Adult western Australian salmon undertake a westward migration along the southern coast of Australia to

the West Coast Bioregion, where they spawn during autumn. Western Australian salmon then migrate back to the South Coast Bioregion (but not to South Australia or Victoria) after spawning. Traditionally, commercial fishers in WA have targeted western Australian salmon during the autumn (mainly March/April) pre-spawning migration, with approximately 95% of South Coast landings and 100% of West Coast landings taken during the January-June period each year. On the South Coast, this percentage has been declining since 1995, reaching a historical minimum of 46% in 2011. The temporal shift in the distribution of South Coast landings appears to be due to the combined effects of market demand (declining demand during January-June) and changes in fish behaviour due to environmental factors. In 2011, a 'heatwave' event in coastal waters reduced the catchability of fish during January-June (Pearce *et al.* 2011²).

Total landings of western Australian salmon in WA have been declining since 1995, with the decline becoming more pronounced after 2005. This trend has been primarily driven by declining landings in the South Coast Bioregion, where the majority of the annual catch is traditionally taken. The South Coast Bioregion commercial catch and catch rate have been declining since 1995 (South Coast Nearshore and Estuarine Figures 1 and 2). In 2011, the catch (165 t) and catch rate (8 t per team) reached their lowest levels since the commencement of the South Coast fishery in the 1940s. Reduced targeting of western Australian salmon by commercial fishers is believed to be the main reason for declining South Coast catches and catch rates, due to the lack of markets and low wholesale prices paid for this species. Reduced availability of fish due to low recruitment and environmental factors may have also contributed to low catches in some years.

In contrast to the South Coast, catches and catch rates of western Australian salmon on the West Coast have followed a more stable trend and have remained within their historical ranges in recent years. In 2011, a relatively low catch (6 t) and catch rate (<1 t per team) was reported. However, low annual catches and catch rates have occurred several times in the past in the West Coast Bioregion, and so 2011 levels were not exceptional (South Coast Nearshore and Estuarine Figure 1).

Low catches of salmon in the West Coast Bioregion typically occur during years of strong Leeuwin Current (resulting in warmer water along the West Coast). The low catch in 2011 was likely due to a 'heatwave' event during the spawning period, when a strong Leeuwin Current and unusually high water temperatures discouraged the northward migration of western Australian salmon. This behavioural response, resulting in low catches, was also observed in 2000 when a strong Leeuwin Current resulted in above average water temperatures on the West Coast.

Annual recruitment by juvenile (less than 1 year old) western Australian salmon has been variable since recruitment surveys commenced in 1994 but the long-term trend has been

¹ The stock assessment for Australian Herring is presented in the West Coast Nearshore and Estuarine Fisheries Report

² Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M. 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.

SOUTH COAST BIOREGION

stable. Relatively high recruitment in 2008 and 2009 was followed by relatively low recruitment in 2010 and 2011 (South Coast Nearshore and Estuarine Figure 3). Low recruitment in 2011 is attributed to the effects of the 'heatwave' event. Levels of annual recruitment provide an indication of future breeding stock level and are likely to influence catch rates 3-4 years later when each year class recruits to the fishery.

Indicator species - estuarine

Cobbler: Commercial targeting of cobbler in WA is restricted to estuaries. Each estuary hosts a discrete stock of cobbler, which is genetically distinct to other estuarine populations and also distinct to cobbler populations in adjacent ocean waters. Historically, commercial targeting of cobbler in the South Coast Bioregion has mainly occurred in Wilson Inlet and in the estuaries around Albany (Oyster Harbour, Princess Royal Harbour).

Commercial catch rates suggest a stable long-term trend in the availability of cobbler in Wilson Inlet and Oyster Harbour since 1980 (South Coast Nearshore and Estuarine Figure 4). Catch rates suggest a slight increase in availability in these estuaries after 2000. The Department of Fisheries has conducted annual fishery-independent surveys of juvenile recruitment of cobbler in Wilson Inlet since 2006. Information from these surveys will assist in interpreting variations in catch and catch rates. Regular monitoring of the age structure of fishery landings was recently implemented in Wilson Inlet. In future, this information will be used to monitor levels of fishing mortality in this stock, which will be used in conjunction with trends in recruitment and catch rates to assess stock status.

Black bream: Black bream are restricted to estuaries. Each estuary hosts a discrete stock of black bream, which is genetically distinct to other estuarine populations.

The majority of commercial black bream landings in the South Coast Bioregion are taken in four main estuaries - Stokes Inlet, Beaufort Inlet, Wilson Inlet and Oyster Harbour. From 1980 to 1995, commercial catch rates in these estuaries were relatively low and followed a stable trend, then steadily increased until about 2005 (South Coast Nearshore and Estuarine Figure 5). Since 2005, catch rates have remained relatively high in Beaufort Inlet, Oyster Harbour and Stokes Inlet. The catch rate has been declining since 2005 in Wilson Inlet, although recent levels are still high relative to historical levels.

Black bream landings vary in response to environmental factors in individual estuaries. The simultaneous increases in catch rates in numerous South Coast Bioregion estuaries from 1995 to 2005 suggest that a widespread factor, such as rainfall, has influenced black bream availability and recruitment across the region.

The current status of black bream in Walpole-Nornalup Inlet (closed to commercial fishing) cannot be assessed due to lack of recent data.

Non-Retained Species

Bycatch species impact: **Low**

The small-scale commercial fisheries in nearshore and estuarine waters mainly use gill, seine and haul nets that are deployed in a targeted manner. Few non-target species are

taken. Mesh size regulations ensure that target species caught by these methods are within an appropriate size range. Minimal discarding occurs because virtually all fish taken can be retained and marketed.

Recreational fishers mainly use line-based methods in nearshore and estuarine waters. This method can result in the capture and release of a significant number of non-target species and undersized fish. The risks associated with post-release mortality vary considerably among species. In general, fish in nearshore and estuarine waters are captured from shallow depths and suffer less barotrauma-related injuries than deep water species.

Protected species interaction: **Negligible**

It is compulsory for commercial fishers to report all interactions with protected listed marine species. New Zealand fur seals and Australian sea lions are occasionally surrounded by beach seine nets used in the South Coast nearshore and estuarine fisheries, but are released immediately by the fishers. This is possible because seine netting is a labour-intensive operation and the fishing team will immediately notice a seal in the net. Fishers are able to release a seal from their seine net without injury to the animal.

The abundance of fur seals on the south coast has steadily increased over the last 15 years, resulting in an increasing level of interaction with fishers, especially in estuaries of the Albany region (R. Campbell, pers. comm.). There have been no reports of incidental mortalities of seals in these fisheries and it is believed that the present level of interaction (direct and indirect) is not a significant threat to the populations of fur seals and sea lions. An assessment of the impact of interactions is performed on an annual basis and, if required, appropriate management plans will be devised to mitigate these interactions.

Very low numbers of estuarine birds sometimes interact with fishing nets but the risks to these populations are negligible. One duck was reported in 2011 and this was released alive.

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

Ecosystem Effects

Food chain effects: **Low**

Excessive removal by commercial and recreational fisheries of certain species, such as Australian herring or western Australian salmon, from the food chain could potentially impact on prey and predator species including larger fish, cetaceans and seabirds. However, commercial fishing effort directed towards these species in recent years has been relatively low and declining. Recreational fishing effort directed towards Australian herring is relatively high.

Habitat effects: **Negligible**

The operation of gill nets and haul nets over predominantly sand and mud bottoms is unlikely to have any impact on these habitats in estuaries and nearshore waters. Similarly, the line fishing methods used by recreational fishers have a

negligible impact on the bottom substrates. Anchoring by recreational fishing vessels may have localised impacts on habitats such as seagrass.

Haul nets may be deployed over low or medium density seagrass. This type of net tends to 'roll' over the surface of seagrass beds without removing attached leaves or uprooting plants. At times, haul nets may collect floating vegetation including seagrass leaves or algae.

Social Effects

Commercial

In 2011, there were approximately 18 commercial fishers involved in the South Coast Salmon Fishery and approximately 8 commercial fishers involved in the South Coast herring trap net fishery. In 2011, the South Coast Estuarine Managed Fishery employed an average of 22 fishers per month. Additional employment is created by these fisheries in the processing and distribution networks and retail fish sales sectors.

Australian herring and western Australian salmon fisheries in the South Coast Bioregion supply WA bait and human consumption markets. The South Coast Estuarine Fishery is an important source of fresh local fish to regional centres. Additionally, a small proportion of estuarine landings are sold to zoos across Australia as animal food.

The use of trap nets and seine nets by Australian herring and western Australian salmon fishers may temporarily impact on beach access by members of the public.

Recreational

The 2000/01 National Recreational and Indigenous Fishing Survey estimated that approximately 12% of the State's total recreational fishing effort occurred in the South Coast Bioregion (Henry and Lyle 2003¹, Barhathah 2006²). Fish resources in estuaries and nearshore waters of the Bioregion are a focus for recreational fishers and have a high social value in the region.

Within the South Coast Bioregion, approximately 21% of the recreational fishing effort is estimated to occur in estuaries and rivers. A high proportion of people who fish in each South Coast estuary are non-residents, travelling from Perth, other WA regions or interstate. Consequently, fishing in South Coast estuaries has a great benefit to local tourism.

Australian herring is the most common finfish species retained by recreational fishers in the South Coast Bioregion (and in WA) and therefore has high social value. In 2000/01 Australian herring were estimated to comprise 15% of all finfish retained by South Coast recreational fishers.

Interviews conducted during the 2011/12 Statewide Recreational Boat Fishing Survey will provide important new data on the social aspects of boat-based fisheries in the South Coast Bioregion (results due in late 2012).

¹ Henry GW and Lyle JM. 2003. The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

² Barhathah T. 2006. Department of Fisheries community survey 2005. Fisheries Occasional Paper No. 33. Department of Fisheries, Perth.

Economic Effects

Estimated annual value (to fishers) for 2010/11:

South Coast Estuarine Fishery

(finfish landings only) Level 1 - < \$1 million

South Coast Salmon + Herring trap net fisheries

Level 1 - < \$1 million

Fishery Governance

Commercial

Current Fishing (or Effort) Level

South Coast Estuarine Fishery **Acceptable**

Herring trap net fishery **Under Review**

South Coast Salmon Fishery **Under Review**

Target commercial catch range:

South Coast Estuarine Fishery **200 – 500 tonnes**

South Coast herring **475 – 1,200 tonnes**

Salmon (South Coast + South West Fisheries)
1,200 – 2,800 tonnes

The 2011 South Coast Estuarine Managed Fishery total catch of finfish (201 t) was within the target range of 200-500 t.

The 2011 South Coast Bioregion commercial catch of Australian herring (84 t) was below the target range. Low catches in 2011 are due to the combined effects of low availability of fish in the South Coast Bioregion due to ongoing low recruitment and lack of targeting due to weak market demand. The South Coast herring catch has now been below the target range for 8 consecutive years.

The total catch of western Australian salmon (West Coast and South Coast landings combined) in 2011 (171 t) was below the target range. The salmon catch has now been below the target range for 5 consecutive years. Low catches are believed to be due to the combined effects of lack of targeting due to weak market demand, low catchability due to environmental factors (relatively high water temperatures) and low availability of fish due to recruitment variation (South Coast Nearshore and Estuarine Figure 4).

The performance measure for the South Coast Salmon Fishery relates to annual salmon commercial catch, which is taken predominantly during the spawning season and is therefore an indicator of breeding stock levels. In 2011, the catch was below the target range. However, the low catch was primarily due to limited targeting due to weak market demand, low recruitment and low catchability due to environmental factors. Collectively, all available information suggests that the total breeding stock level was adequate in 2011.

Recreational

Current Fishing (or Effort) Level: **Not available**

Target catch range: **Not developed**

SOUTH COAST BIOREGION

New management initiatives (for the next year)

The Department has no new management initiatives planned for the South Coast Bioregion nearshore or estuarine fisheries. Should the research projects mentioned in this section provide information suggesting an increased risk to sustainability, the Department will consult with the fishing sectors and introduce the appropriate arrangements as required.

External Factors

Climate change is expected to have impacts on nearshore and estuarine ecosystems. Changes in environmental variables such as ocean temperature, currents, winds, nutrient supply, rainfall, ocean chemistry and extreme weather conditions are expected to have major impacts on marine ecosystems (Hobday *et al.* 2008¹). These impacts are expected to create both difficulties and opportunities for fisheries.

In 2011, a very strong Leeuwin Current resulted in unusually warm ocean temperatures in coastal waters of the southern West Coast Bioregion and the western South Coast Bioregion (Pearce *et al.* 2011²). This 'heatwave' event resulted in atypical distributions of various species (e.g. tropical species occurring in temperate waters) and unusual fish behaviour. The event altered the distribution and behaviour (eg. spawning activity, migration) of western Australian salmon and Australian herring, which reduced catch levels of these species in 2011 and may continue to affect them in subsequent years (due to effects on recruitment).

It is likely that annual variation in coastal currents (particularly the Leeuwin and Capes Currents) influences the recruitment patterns of larvae of nearshore species such as Australian herring and western Australian salmon and thus their subsequent recruitment into each region. Coastal currents also influence the distribution and catchability of adult fish. For example, warmer beach water temperatures are associated with lower catchability of western Australian salmon.

On the south coast, an increased abundance of fur seals (R. Campbell, pers. comm.), which consume Australian herring and western Australian salmon, could have impacted on stock levels in recent years. Western Australian salmon also consume Australian herring.

Fluctuating market demand is a significant factor affecting the annual commercial catch level of many species. Limited demand and low wholesale prices paid for Australian herring and western Australian salmon in recent years have limited commercial catch and effort levels. By purchasing only a limited quantity of Australian herring and western Australian salmon each year, fish processors effectively restrict catch levels. Commercial fishers sometimes elect not to capture a school of fish, or release part of their catch, when a market is not available.

Variations in the abundance of target species in South Coast Bioregion estuaries are largely driven by environmental factors, independent of fishing. These factors, which are outside the control of the Department of Fisheries, often have a dominant influence on the commercial catch and effort from year-to-year. For example, high rainfall may contribute to higher catches of black bream.

Catchment processes, such as clearing of vegetation, flow regulation and nutrient input, can have major downstream effects on estuary condition and on fishery production. Attempts to quantify the influence of these complex, interacting factors on fishery production are difficult with the limited biological and environmental monitoring data that are available from South Coast Bioregion estuaries.

The influence of environmental factors on recruitment to estuaries is further complicated by the practice of human intervention to breach estuarine sandbars, mostly for reasons related to estuarine amenity coupled with ecosystem 'health'.

¹ Hobday, A.J., Poloczanska, E.S. and Matear, R.J. (eds) (2008). Implications of Climate Change for Australian Fisheries and Aquaculture: a preliminary assessment. Report to the Department of Climate Change, Canberra, Australia. August 2008.

² 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.

SOUTH COAST NEARSHORE AND ESTUARINE TABLE 1

Total annual catches of finfish (except sharks and rays) from the estuarine and beach-based nearshore commercial fisheries in the South Coast Bioregion, 2007 to 2011.

Species	Scientific name	Catch (tonnes)				
		2007	2008	2009	2010	2011
Western Australian salmon	<i>Arripis truttaceus</i>	246.2	545.1	258.0	291.3	164.9
Australian herring	<i>Arripis georgianus</i>	192.2	236.3	151.3	182.7	110.1
Cobbler	<i>Cnidogobius macrocephalus</i>	68.1	77.4	86.6	69.8	64.9
Black bream	<i>Acanthopagrus butcheri</i>	46.2	37.8	50.0	65.5	43.8
Sea mullet	<i>Mugil cephalus</i>	52.9	21.8	26.3	32.2	29.6
Southern sea garfish	<i>Hyporhamphus melanochir</i>	18.0	16.8	7.6	13.7	10.8
King George whiting	<i>Sillaginodes punctata</i>	8.0	9.1	6.8	7.0	7.8
Flathead	Platycephalidae	9.1	9.2	5.2	3.0	3.6
Leatherjacket	Monacanthidae	6.7	5.5	2.9	5.6	4.8
Silver bream (Tarwhine)	<i>Rhabdosargus sarba</i>	3.1	5.3	2.7	2.8	6.1
Yellow-eye mullet	<i>Aldrichetta forsteri</i>	3.0	4.6	3.4	2.6	3.7
Trevally	Carangidae	3.1	2.4	2.9	2.1	2.0
Snapper	<i>Pagrus auratus</i>	3.2	3.6	1.9	0.9	1.3
Snook	<i>Sphyraena novaehollandiae</i>	2.4	2.9	2.4	1.3	1.7
Grunter (Trumpeter)	Teraponidae	2.5	0.3	1.7	0.3	1.6
Flounder	Pleuronectidae	1.7	1.1	0.2	1.5	1.3
Scaly Mackerel	<i>Sardinella lemuru</i>	1.1	0.5	0.9	0.4	0.3
Yellowtail scad	<i>Trachurus novaezelandiae</i>	1.1	0.3	0.2	0.6	0.8
Mulloway	<i>Argyrosomus japonicus</i>	0.2	0.5	0.3	0.4	0.7
Yellow fin whiting	<i>Sillago schomburgkii</i>	0.1	1.1	0.2	0.2	0.2
Other finfish	Teleostei	3.7	3.7	3.5	3.9	6.2
TOTAL		672.7	985.4	615.3	687.8	466.2

SOUTH COAST NEARSHORE AND ESTUARINE TABLE 2

Estimated total recreational catches of key species in nearshore and estuarine waters in the South Coast Bioregion in 2000/01 (Henry and Lyle 2003¹).

Species	Scientific name	2000/01 Catch (tonnes)
Western Australian salmon	<i>Arripis truttaceus</i>	117
Trevally	<i>Pseudocaranx</i> spp.	93
Australian herring	<i>Arripis georgianus</i>	79
King George whiting	<i>Sillaginodes punctata</i>	40
Black bream	<i>Acanthopagrus butcheri</i>	28
Whiting	<i>Sillago</i> spp.	11
TOTAL		368

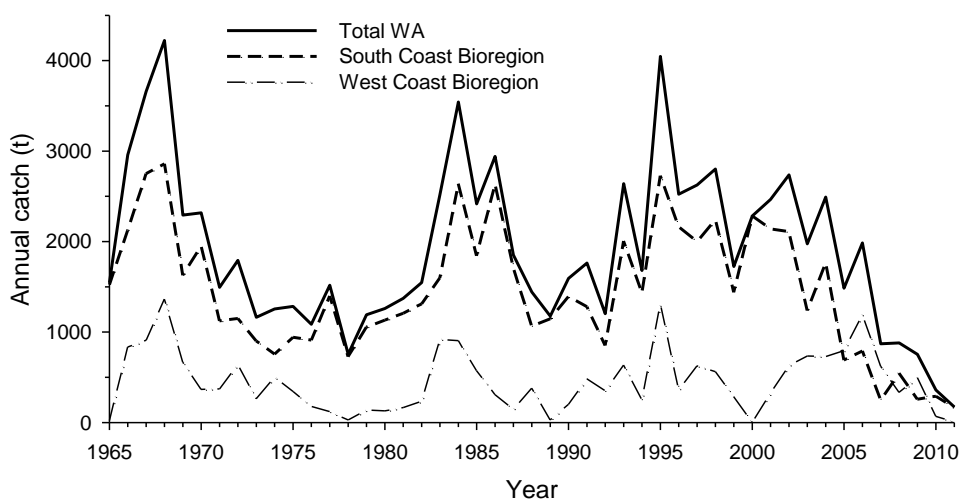
SOUTH COAST NEARSHORE AND ESTUARINE TABLE 3

Estimated total recreational catches of key species in estuaries in the South Coast Bioregion in 2002/03 (Smallwood and Sumner 2007²).

Species	Scientific name	2002/03 Catch (tonnes)
Black bream	<i>Acanthopagrus butcheri</i>	23.3
King George whiting	<i>Sillaginodes punctata</i>	10.9
Trevally	<i>Pseudocaranx</i> spp.	6.1
Australian herring	<i>Arripis georgianus</i>	4.1
Southern blue-spotted flathead	<i>Platycephalus speculator</i>	2.6
Pink snapper	<i>Pagrus auratus</i>	2.6
Tarwhine	<i>Rhabdosargus sarba</i>	0.5
Southern sea garfish	<i>Hyporhamphus melanochir</i>	0.2
TOTAL		50.3

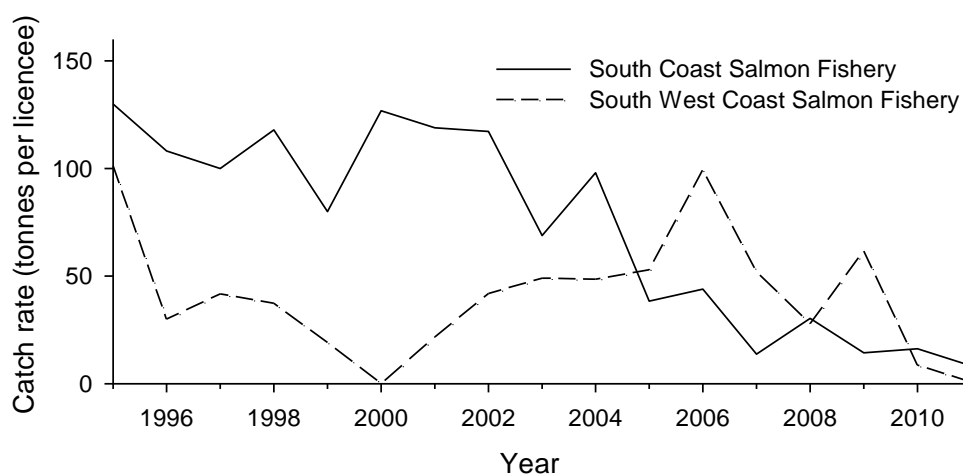
¹ Henry GW and Lyle JM. 2003. The National Recreational and Indigenous Fishing Survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48.

² Smallwood CB and Sumner NR. 2007. A 12-month survey of recreational estuarine fishing in the South Coast bioregion of Western Australia during 2002/03. Fisheries Research Report 159. Department of Fisheries, Perth.



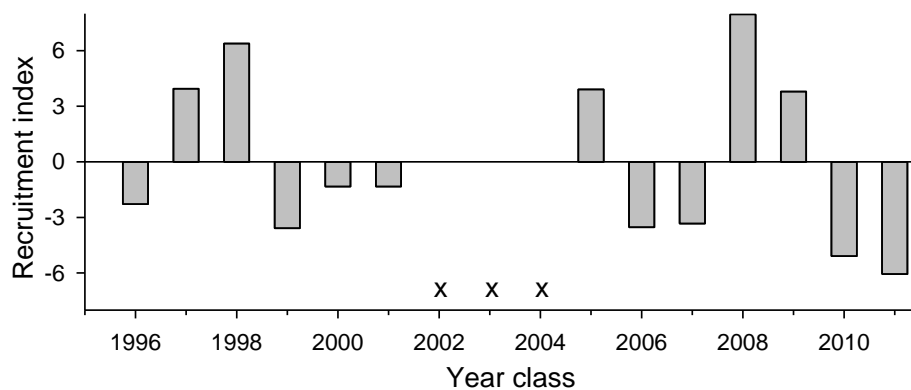
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 1

Total annual commercial catches of western Australian salmon in the South Coast and West Coast Bioregions, 1965 – 2011.



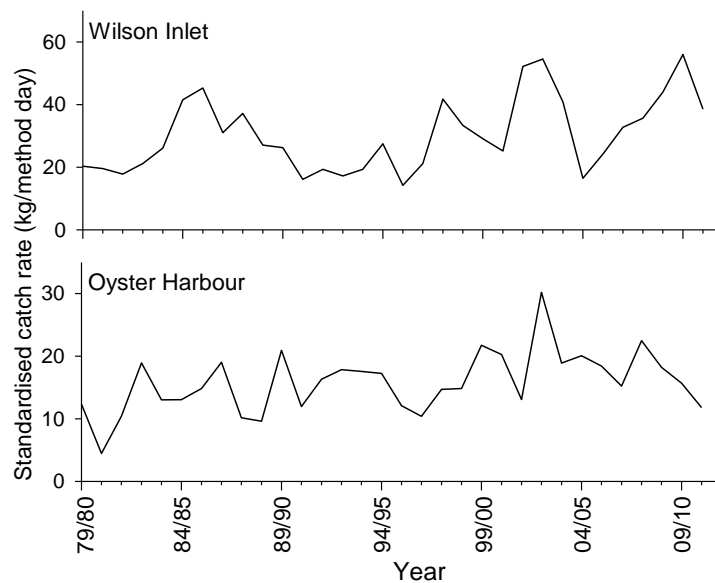
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 2

Total annual commercial catch rate (tonnes per licensee per year) of western Australian salmon in the South Coast Salmon Fishery (South Coast Bioregion) and the South West Coast Salmon Fishery (West Coast Bioregion), 1995 – 2011.



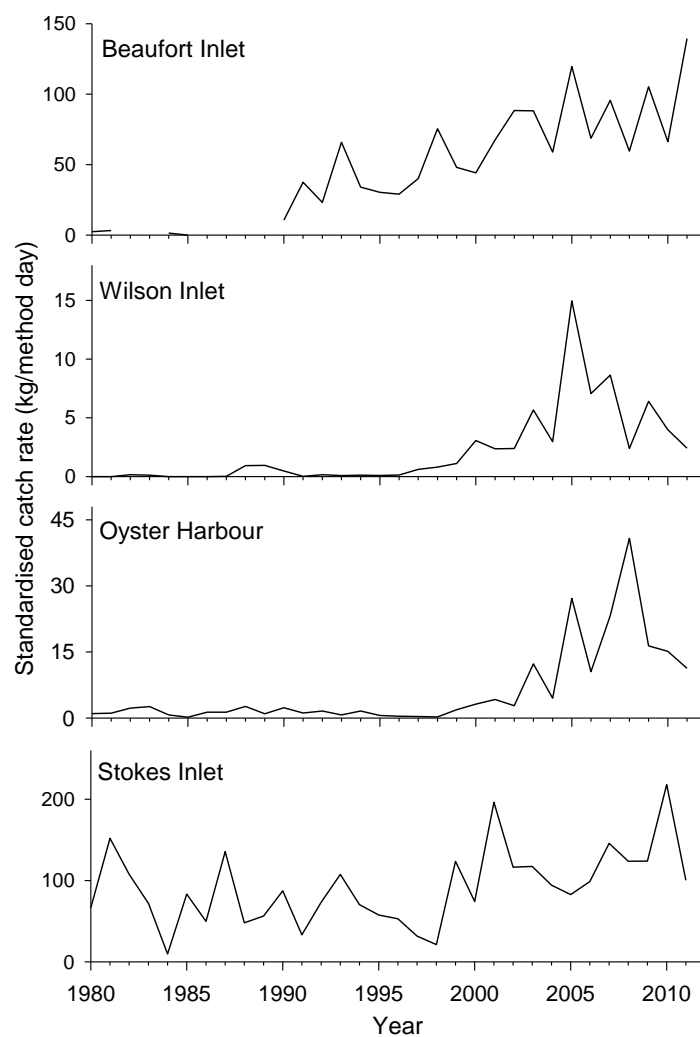
SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 3

Annual fishery-independent relative recruitment index for western Australian salmon in the South Coast Bioregion, 1996 – 2011. (x – no sampling conducted in that year). Bars above the line reflect better than average number of recruits.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 4

Annual commercial catch rates of cobbler in Wilson Inlet and Oyster Harbour, 1979/80 – 2010/11.



SOUTH COAST NEARSHORE AND ESTUARINE FIGURE 5

Annual commercial catch rates of black bream in Beaufort Inlet, Wilson Inlet, Oyster Harbour and Stokes Inlet, 1980 – 2011.

South Coast Purse Seine Fishery Report: Statistics Only

B. Molony, E. Lai and M. Stadler

Fishery Description

The South Coast Purse Seine Managed Fishery (SCPSF) is based on the capture of pilchards (*Sardinops sagax*) by purse seine nets in the waters between Cape Leeuwin and the Western Australia/South Australia border. The South Coast Purse Seine Management Plan 1994 also covers the take of yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*), scaly mackerel (*Sardinella lemuru*), sandy sprat (*Hyperlophus vittatus*) blue sprat (*Spratelloides robustus*) and maray (*Etrumeus teres*).

Boundaries

The SCPSF consists of five Management Zones (South Coast Purse Seine Fishery Figure 1). Zone 1 extends from Peak Head to Vancouver Peninsula (the waters in and around King George Sound, Albany). Zone 2 extends from Point D'Entrecasteaux to Cape Knob. The Bremer Bay Zone (Zone 3) extends from Cape Knob to longitude 120°E. The large Esperance Zone (Zone 4) extends from 120°E to the WA/SA border. An additional zone (Zone 5) exists between Cape Leeuwin and Point D'Entrecasteaux but has not been significantly fished to date. The Zones are broken down into finer spatial scale blocks for reporting of catch and effort in the mandatory Catch and Effort Disposal forms but for this report catches are reported for the major zones (Zones 1 and 2 combined; Zone 3 and Zone 4 separately) plus the total catches (South Coast Purse Seine Fishery Figure 2).

Management arrangements

This SCPSF is primarily managed through output controls in the form of individual transferable quota (ITQ) units. Four of the five zones in the fishery (i.e. zones 1 – 4) have been allocated a set amount of ITQ units whose values are determined by dividing the total allowable catch (TAC) for that zone by the total number of units allocated to that zone. The TAC has been relatively stable over the past 10 years and will be reviewed on an as needs basis but is primarily dependant on the status of fish stocks. The total number of units allocated across each of the four zones in the fishery amount to 890 and remained unchanged from the previous season. The quota season for the SCPSF runs from 1 July to 30 June each year. The Albany zone has an annual TAC of 2683 tonnes, while both the Bremer Bay and Esperance zones each have an annual TAC of 1500 tonnes. Zone 5 of the fishery is considered a development zone and can only be fished by a licence holder in the SCPSF with a minimum holding in another zone, it has no specific TAC or units and has not been fished for a number of years.

Landings and Effort

Effort in the SCPSF was lower in 2010/11, with a total of 1,186 days of fishing (2009/10: 1,450 days). Effort was lower in Albany Zones (Zones 1 and 2), similar in the Esperance Zone (Zone 4), with an increase in effort reported from the Bremer Bay Zone (Zone 3).

Commercial pilchard catches during the 2010/11 was 2,272 t, lower than in 2009/10 (2,647 t) but still trending upward

since the late 1990s (South Coast Purse Seine Figure 2), further underlining the recovery in biomass since the pilchard virus. The 2010/11 catch was the second highest since 1998. Less than 5 t of other pelagic species were also landed, dominated by yellowtail scad.

Most of the commercial catches were reported from the Albany Zones (1,241 t). However, overall effort and catches remain below those recorded during the late 1980s and 1990s.

Fishery Governance

Target commercial effort range: **Not available**

For the 2010/11 season, the total pilchard catch (2,272 t) was well below the total TAC for the entire fishery (5,683 t) (South Coast Purse Seine Fishery Table 1) with catches from each of the Management Zones remaining well below their respective TACs. The fleet and infrastructure for this fishery continues to rebuild but reports of below market size fish (i.e. small fish) in Bremer Bay and Esperance influence how much of the TAC is caught. These factors, combined with the variability in unit holdings within the fishery and resultant variability in fishing behaviour by different operators, mean that it is not possible to estimate a target effort range for the fishery.

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

Based on the most recent assessment (completed in 2006) and the recent history of the fishery, the level of spawning biomass in each Management Zone is likely to be appropriate and the current level of fishing is acceptable. Further, catches in other jurisdictions are also increasing further supporting the continued increase and recovery of the biomass of pilchards across southern Australia.

New management initiatives (2011/12)

In 2006 the SCPSF industry met to develop a strategy to manage bycatch of flesh-footed shearwaters (*Puffinus carneipes*) in the Fishery, focussing on Zone 1 (King George Sound, Albany) where interactions with these birds was occurring. A bycatch committee, with representation from the Conservation Council of WA, Department of Environment and Conservation, the WA Fishing Industry Council, SeaNet, Department of Fisheries and operators in the SCPSF was formed to address the issue. This led to the establishment of the SCPSF protected species bycatch mitigation program.

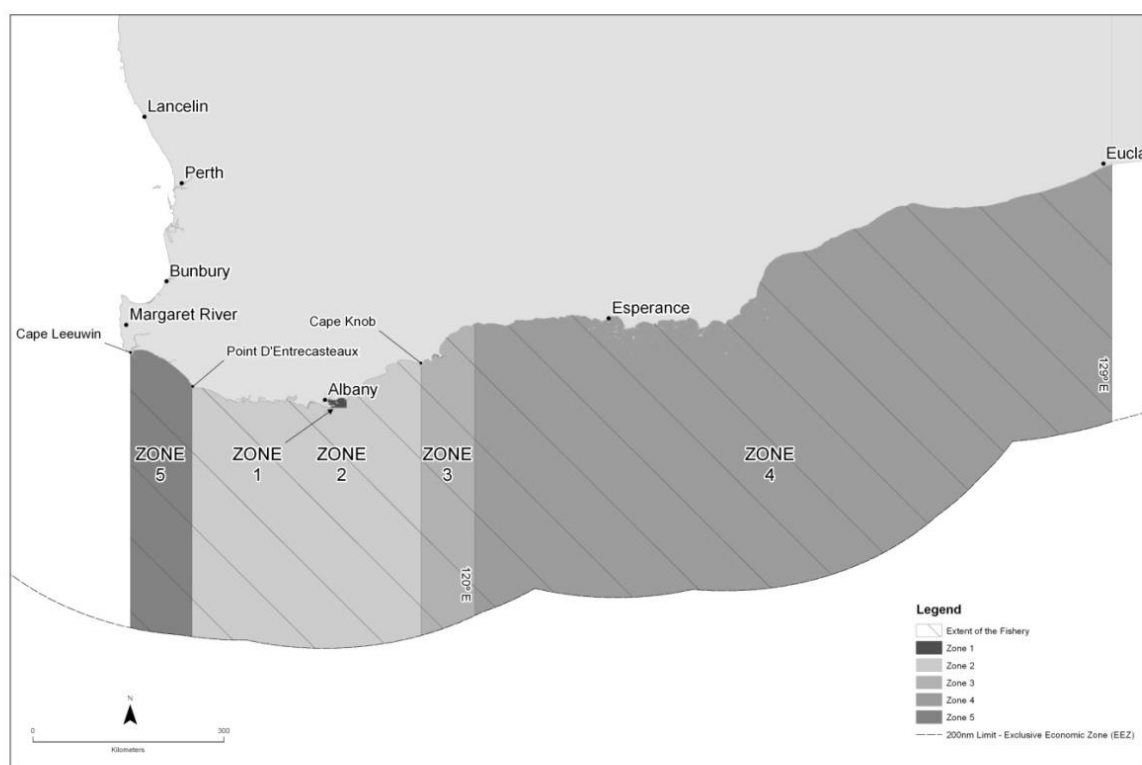
From the 2006 /07 season to present, the SCPSF protected species bycatch mitigation program has undertaken a range of measures to monitor and mitigate shearwater bycatch during the peak interaction period between 1 March to April 30. Bycatch mitigation measures are reviewed annually and continually being refined and improved.

There are no significant legislative management changes planned for this fishery.

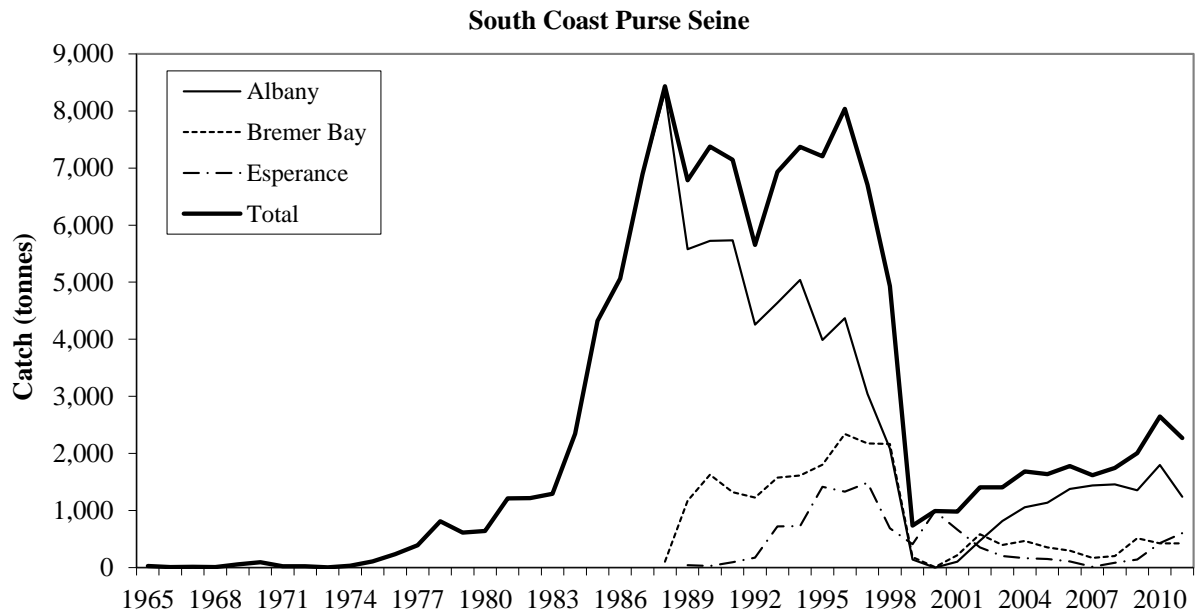
SOUTH COAST PURSE SEINE FISHERY TABLE 1

2010/11 pilchard catches and TACs in tonnes (t) for each of the major Management Zones. * less than 5 vessels operated in each of these zones in 2010/11 and cannot be reported.

Management Zone	TAC (t)	2009/10 catch (t)	2009/10 catch as percent of TAC
Albany (Zones 1 and 2)	2,683	1,241	46.3%
Bremer Bay (Zone 3)	1,500	*	-
Esperance (Zone 4)	1,500	*	-
Total for Fishery	5,683	2,272	40.0 %

**SOUTH COAST PURSE SEINE FISHERY FIGURE 1**

Map of the extent of the Mackerel Managed Fishery.



SOUTH COAST PURSE SEINE FISHERY FIGURE 2

Annual catches of pilchards along the south coast, by major fishing zone, 1965 – 2010/11.

Temperate Demersal Gillnet and Demersal Longline Fisheries Status Report

R. McAuley and F. Rowland

Main Features			
Status		Current Landings (2010/11)	
Stock level		Demersal Gillnet and Demersal Longline Fishery	
Gummy shark	Adequate	Total sharks and rays	1,031 t
Dusky shark	Recovering	Scalefish	175 t
Sandbar shark	Inadequate	Indicator species	
Whiskery shark	Adequate	Gummy shark	375 t
Fishing Level		Dusky shark	255 t
JASDGLDF Zone 1	Acceptable	Sandbar shark	71 t
JASDGLDF Zone 2	Acceptable	Whiskery shark	127t
WCDGLDF	Acceptable	Catch of sharks and rays by other commercial fisheries (2010/11)	
		3 t	
		Recreational catch (2005/06)	<5% of commercial catch

Fishery Description

The Temperate Demersal Gillnet and Demersal Longline Fishery (TDGLDF) is comprised of the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGLDF) and the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGLDF). These fisheries operate in continental shelf waters along the south and lower west coasts respectively. The majority of operators employ demersal gillnets and power-hauled reels to target sharks, with scalefish also being a legitimate component of the catch. Demersal longline is also a permitted method of fishing, but is not widely used.

The main shark species targeted in the TDGLDF are gummy shark (*Mustelus antarcticus*), dusky shark (*Carcharhinus obscurus*), sandbar shark (*Carcharhinus plumbeus*) and whiskery shark (*Furgaleus macki*). On the south coast operators primarily target gummy and dusky sharks, while dusky and sandbar sharks are targeted on the west coast. Whiskery sharks are an important component of both fisheries catch. These four species have been selected as indicators for the status of the temperate shark 'suite' as they account for approximately 80% of the fisheries' shark catch and represent the range of life history strategies of the other shark species caught by these fisheries.

As their stocks span multiple bioregional boundaries, dusky, sandbar and whiskery sharks are assessed and monitored as indicators of the Statewide inshore demersal suite of shark species. Gummy sharks, however, have a more limited southern range and are an indicator species of the South Coast Bioregion inshore demersal shark species suite. The two fisheries are reported together here because extensive research has demonstrated that they share these key unit

stocks.

Governing legislation/fishing authority

South Coast

Joint Authority Southern Demersal Gillnet and Demersal Longline Management Plan 1992

Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery Licences

West Coast

West Coast Demersal Gillnet and Demersal Longline (Interim) Management Plan 1997

West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery Permits

Consultation processes

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

Boundaries

The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery spans the waters from 33° S latitude to the WA/SA border and comprises three management zones (Demersal Gillnet and Longline Figure

1). Zone 1 extends southwards from 33° S to 116° 30' E longitude off the south coast. Zone 2 extends from 116° 30' E to the WA/SA border (129° E). A small number of Zone 3 units permit fishing throughout Zone 1 and eastwards to 116° 55' 40" E. For the purposes of this report, Zone 3 catch and effort data are amalgamated into Zone 1 or Zone 2 as appropriate.

The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery technically extends northwards from 33° S latitude to 26° S longitude (Demersal Gillnet and Longline Figure 1). However, the use of shark fishing gear has been prohibited north of 26° 30' S (Steep Point) since 1993. Demersal gillnet and longline fishing inside the 250 metre depth contour has been prohibited off the Metropolitan coast (between latitudes 31° S and 33° S) since November 2007.

Management arrangements

The Southern and West Coast fisheries are regulated through two complementary management plans. The JASDGLF (Joint Authority jurisdiction fishery) became managed under WA state law in 1988 and since then the fishery has been managed by the Western Commonwealth Government on behalf of a Joint Authority comprising the Western Australian and Commonwealth Governments. The WCDGDLF (a state jurisdiction fishery) is managed by the Western Commonwealth Government under an interim management plan introduced in 1997.

Both fisheries are managed via input controls in the form of transferable time/gear effort units, with additional restrictions on mesh and hook sizes, net height ('drop') and maximum net length. Historically, each unit has permitted the use of a specified length of net or an equivalent number of hooks for one month. However, in 2009, the Department transitioned the fishery to a more explicit hourly effort management system, with the objectives of removing excessive latent effort capacity and restricting effort within each management zone to 2001/02 levels. All units now permit the use of 27 m of gillnet or 9 longline hooks for 288 hours in the WCDGDLF, 264 hours in Zones 1 and 3 of the JASDGLF or 380 hours in Zone 2 of the JASDGLF. In addition to these effort controls all boats operating in the TDGDLF are closely monitored by the Department's satellite-based Vessel Monitoring System.

- A suite of shark management arrangements in target and non-target fisheries have been in effect since the 2006/07 season to ensure sustainable catches of target, byproduct and bycatch species, to assist in the recovery of historically over-exploited whiskery, dusky and sandbar shark stocks and to maintain acceptably low risks to threatened, endangered and protected (TEP) species. These include: the State-wide commercial protection of all sharks and rays;
- a general prohibition of metal trace wire and large hooks (except in the Northern Shark and Mackerel Fisheries), which had previously been used to target large whaler sharks;
- a significant increase in penalties for illegally possessing sharks or rays; and
- a two month closure (16 August to 15 October), during the main whiskery shark pupping season, of inshore

waters to 200m depth throughout all of the WCDGDLF and the waters of the South Coast west of 118° E (in the JASDGLF) to assist in the recovery of the over-exploited whiskery shark stock.

In addition, to further assist in the protection of medium-high risk dusky stocks, a 70 cm maximum (inter-dorsal fin) size limit for all whaler sharks taken by recreational fishers within the waters of the South Coast and West Coast Bioregions, was introduced in February 2009.

The metropolitan zone between latitudes 31° S and 33° S (inshore of 250 metres depth) was closed to most commercial fishing activities, including those of the WCDGDLF, in November 2007. To offset the Metropolitan Area Closure and mitigate potential impacts of effort displacement to northern grounds of the fishery, the Government established a Voluntary Fisheries Adjustment Scheme that bought back 36% of WCDGDLF entitlement.

The TDGDLF was first declared as an approved Wildlife Trade Operations (WTO) in February 2006. The fishery was reassessed in 2008 and re-accredited in April 2009, under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The accreditation allows continued export of product from these fisheries for a period of three years. The current WTO expires on 31 March 2012 and the Department is in the process of applying for reassessment of TDGDLF.

Following the outcomes of the Wetline Review, the Government made a commitment to address the long-term sustainability of demersal scalefish on the West Coast by reducing both commercial and recreational demersal scalefish catches by at least 50% of 2005/06 levels. Demersal scalefish are an important component of the TDGDLF catch and the fisheries are being closely monitored to ensure the combined catch of demersal scalefish taken from the commercial sector does not exceed the target (see West Coast Demersal Scalefish Fishery Status Report).

Research summary

Major FRDC-funded studies of the shark fishery on the south and west coasts of Western Australia, undertaken over the period 1993–2004, have provided a detailed basis for monitoring and assessing the fisheries. The extensive biological and fishery information gained from these studies have been reported in three FRDC final reports, numerous international journal publications and have been used to develop stock assessment models for the fisheries' key target stocks to determine their likely responses to current levels of exploitation and to test alternative harvest regimes. A new three year FRDC-funded study of the movements of the fisheries' four indicator shark stocks commenced in 2011. Results from that study will be used to reassess the status of these stocks with greater reference to their spatial and temporal dynamics.

Current research monitoring involves analysis of fishing returns data and periodic biological sampling of commercial and fishery-independent catches. To support the fishery management arrangements introduced from 2006 and to, improve assessments of key stocks and facilitate the more detailed reporting requirements of the fisheries' export accreditation under the Commonwealths Environment Protection and Biodiversity Conservation (EPBC) Act, new

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statutory daily/trip catch and effort logbooks were introduced in 2006/07. To resolve initial instances of missing, misreported and confounded catches in the logbook data, an extensive data recovery and correction exercise was undertaken between 2009 and 2010. As well as rectifying previously misreported fishing returns data, this exercise generally improved reporting standards and has provided the basis for development and implementation of new catch and effort data validation protocols.

In addition to research on the fisheries' target stocks, some tactical research has been completed on Threatened Endangered and Protected (TEP) species bycatch. Two National Heritage Trust funded projects investigated movements and aggregation locations of grey nurse sharks (*Carcharias taurus*) and a recent FRDC-funded project examined the relative spatial risks of Australian sea lion (*Neophoca cinerea*) interactions with demersal gillnets. A further FRDC-funded study to estimate quantitative rates of sea lion encounters with demersal gillnets was undertaken in 2010-11. WA Government funded research into white shark (*Carcharodon carcharias*) movements around the south-west of Western Australia may also yield information on the ecology and population structure of this protected species.

Retained Species

Commercial landings (seasons 20010/11)¹:

All sharks (and rays):	1,031 tonnes
Indicator shark species:	828 tonnes
Gummy:	375 tonnes
Dusky²:	255 tonnes
Whiskery:	127 tonnes
Sandbar:	71 tonnes

Other finfish (i.e. non shark) catch: In addition to their primary catch of sharks, the JASDGLF and WCDGLF land a variety of scalefish species, which totalled 175 t in 2010/11 (Demersal Gillnet and Longline Figure 3). This catch included 53 t of demersal scalefish species taken in the West Coast Bioregion and 99 t of demersal scalefish taken in the South Coast Bioregion and a total of 24 t of non-demersal scalefish species (Demersal Gillnet and Longline Table 1). For details of other fisheries' demersal scalefish catches in those bioregions, see Demersal Scalefish Fishery Status Report and South Coast Wetline Fishery Report.

Shark catches in other fisheries: Sharks were also historically caught off the south and west coasts in a variety of other commercial fisheries. However, due to the very poor standard of reported species identification of non-targeted shark catches and those catches' contribution to identified sustainability risks to some stocks (eg. dusky shark), the retention of sharks and rays was prohibited in most non-target fisheries throughout the State by commercially protecting all sharks and rays (elasmobranchs) in November

2006. Reported elasmobranch catches by vessels operating in other managed fisheries between North West Cape and the South Australian border subsequently declined to less than 5 t per year (2.7 t in 2010/11).

Recreational catch estimate (season 2005/06):

< 5% of total catch

The recreational catch of sharks by fishers operating from trailer-boats between Augusta and Kalbarri was estimated from two Department of Fisheries surveys conducted in 1996/97 and 2005/06. The total recreational shark catch was estimated to have declined from ca. 7,000 sharks per year in 1996/97 to ca. 5,500 sharks per year in 2005/06, although only about half of these were reported to have been retained. The reported species composition of the retained catch in 2005/06 was similar to that of the Demersal Gillnet and Demersal Longline fisheries. Whaler shark species were the most commonly retained group (31%), followed by hound sharks (gummy, whiskery, etc.; 28%), wobbegongs (14%) and hammerheads (10%). Assuming an average weight of 5 kg per shark, then the recreational take of sharks in the west coast bioregion would have been about 13.5 t or approximately 3% of the bioregion's commercial shark catch in 2005/06. A new State-wide recreational fishing boat survey that commenced in 2011 will provide updated estimates of the recreational take of sharks across the State in 2012.

Fishing effort/access level

There are 57 licences in the JASDGLF (24 in Zone 1 and 33 in Zone 2) and 20 WCDGLF permits, which can be used collectively in conjunction with a fishing boat licence. Only 7 Zone 1, 14 Zone 2 and 4-6 WCDGLF vessels reported active fishing returns during 20010/11, similar to the levels of participation in the fisheries over the last four years.

As gillnetting is by far the dominant method employed in the fisheries, the historically small amount of longline fishing effort is standardised as equivalent gillnet effort by transforming longline shark catches by gillnet Catch Per Unit Effort (CPUE). Although standardised fishing effort has previously been reported in units of kilometre gillnet hours (km gn.hr), the hourly component of effort reported in monthly fishing returns prior to 2006/07 is known to be a poor indication of the time nets actually spend fishing (i.e. 'soak time'). With the transition from monthly to hourly effort entitlement units and the introduction of a daily catch and effort logbooks in 2006/07, actual soak times have been more accurately reported over the last five years. Thus, the hourly components of fishing effort reported in monthly and daily fishing returns are not directly comparable. To allow for historical comparison and assessment of effort and CPUE trends in the fisheries, the entire 35 year time series of effort data have been recalculated in comparable units of kilometre gillnet days (km gn.d; Demersal Gillnet and Longline Figure 4). For these same reasons, fishing effort is also monitored against 2001/02 target levels in units of km.gn.d.

Fishery and zone-specific limits on demersal gillnet and demersal longline fishing effort, equivalent to their 2001/02 levels, were agreed for the start of the 2006/07 season by specifying the number of days that monthly units could be

¹ All reported weights are live weight

² Dusky shark catches include catches of bronze whaler (*Carcharhinus brachyurus*), which cannot be accurately separated in catch returns data prior to 2006/07.

fished in each management zone. These (daily) effort limits are considered likely to deliver sustainable catches of target, byproduct and bycatch species and acceptably low risks to TEP species. Effort limits were subsequently re-defined and legislated as hourly units of entitlement using conversion rates of 24 hours day-1 in Zones 1 and 3 of the JASDGLF, 20 hours day-1 in Zone 2 and 24 hours day-1 in the WCDGLF. Thus, specified fishing effort limits for each management zone of the fishery are:

JASDGLF Zones 1 and 3:	84,075 km gn.hr (3,503 km gn.d)
JASDGLF Zone 2:	144,102 km gn.hr (7,205 km gn.d)
WCDGLF ¹ :	67,692 km gn.hr (2,832 km gn.d)

Expended effort in 20010/11 was 62,817 km gn.hr (3,464 km gn.d) in Zone 1; 109,806 km gn.hr (6,126 km gn.d) in Zone 2 and 25,522 km gn.hr (1,117 km gn.d) in the WCDGLF. Overall, 67% of the fisheries' effort capacity was utilised in 20010/11 (75% in Zone 1, 76% in Zone 2 and 38% in the WCDGLF).

Stock Assessment

Assessment complete: Yes

Assessment level and method:

Gummy shark Level 2 - CPUE
(annual -relative to previous Level 5 assessment)

Dusky shark Level 2 - CPUE
(annual -relative to previous Level 4 assessment)

Sandbar shark Level 2 - CPUE
(annual -relative to previous Level 4 assessment)

Whiskery shark Level 5 - Age Structured Model

Breeding stock levels:

Gummy shark Adequate

Dusky shark Recovering

Sandbar shark Inadequate

Whiskery shark Adequate

Stock assessments are carried out for the four indicator shark species caught by the fishery using a combination of catch and effort data, periodic empirical estimates of fishing mortality rates, biological information and dynamic biomass and demographic simulation models. For assessment purposes, monthly catch and effort data are corrected to account for missing fishing returns prior to 1989/90, inaccurately reported species compositions and an increasing

effort efficiency of 2% yr-1 prior to 1995/96, to account for major advances in gear technology (eg. monofilament nets and GPS) and vessel development (i.e. introduction of larger vessels). Missing, misreported and confounded catches submitted in daily/trip logbook returns between 2006/07 and 2008/09 were recovered or corrected using fishers' personal records, fish processor returns, face to face and phone interviews with fishers or were derived from average fish weights in accurately-reported logbook records or from previously observed size frequency data and available length weight relationships.

Trends in the relative abundance of the fisheries' four indicator species are inferred from each species' annual 'effective' Catch Per Unit Effort (CPUE) data. Effective CPUE is calculated by dividing the corrected gillnet-only catch by the equivalent gillnet effort from the regions of the fisheries that overlap each species' primary distribution (as defined below). Due to the introduction in 2006 of an annual two month closure to protect near-term pregnant whiskery sharks and the prohibition of demersal gillnet fishing in the metropolitan region in November 2007, catch and effort data reported from west of 118°E during August, September and October and between latitudes 31°S and 33°S in all months are excluded from the effective CPUE time series.

Gummy shark: The best (median) estimate from age-structured modelling indicated that in 1997/98 the Western Australian gummy shark stock was 42.7% of its virgin biomass, slightly above its minimum acceptable level of 40% of its virgin level. As gummy shark catches are almost exclusively comprised of adults, the upward trend in effective CPUE from the area off the south coast between longitudes 116°E and 129°E between the mid 1990s and 2005/06, suggested that breeding biomass steadily increased following reductions in demersal gillnet fishing effort commencing in 1992 (Demersal Gillnet and Longline Figure 5). Although recent CPUE estimates have been higher than at any time since records began, the unprecedented spike and subsequent decline in effective CPUE over the last five years is inconsistent with previous estimates and will be considered in more detail during development of a new stock assessment model that incorporates contemporary catch, effort, size and movement information that is due to be developed over the next three years.

Dusky shark: Due to the size selectivity characteristics of the mesh sizes permitted in the fishery and its area of operation, dusky shark catches have historically consisted of neonate (young of the year) and one to two year old fish, which collectively accounted for 89% of the observed catch during the 1990s. Due to the age-selective nature of the fishery and longevity of the species, which takes about 30 years to reach maturity and may live for more than 50 years, the available time series of catch and effort data are insufficient for developing a dynamic population simulation model for this stock (as has been used for gummy and whiskery sharks). The status of the Western Australian dusky shark stock was therefore assessed using stochastic demographic modelling techniques to evaluate the sustainability of empirically-estimated fishing mortality rates of sharks born between 1994 and 1996.

The most recent demographic assessment for this stock was conducted in 2005 and subsequent assessments have relied on analyses of catch and CPUE data from south of 28°S latitude to 120°E longitude off the south coast, in relation to the

¹ The WCDGLF limit is adjusted to 64% of the 2001/02 effort level to account for the reduction in entitlement units arising from the 2008 Voluntary Fishery Adjustment Scheme.

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demographic rates estimated by that model. This analysis confirmed that demersal gillnet and longline fishing mortality rates were likely to have been sustainable for the cohorts of sharks born in 1994/95 and 1995/96. However, the model also predicted that very low levels of fishing mortality (1–2% yr⁻¹) applied to sharks older than 10 years of age would result in negative rates of population growth. Although the area of the WCDGDLF between 26° 30' S and North West Cape was closed in 1993 to protect adult dusky sharks, they are known to have been caught by various fisheries operating within and outside WA jurisdiction. Previous assessments therefore concluded that the declining trend observed in the effective CPUE series between the mid 1990s and 2004/05 (Demersal Gillnet and Longline Figure 6) could indicate that breeding biomass had been gradually depleted by these poorly-quantified sources of fishing mortality.

There has been an increasing trend in the effective CPUE over the past six years. While the effects of reduced gear competition in the WCDGDLF resulting from the reduction in fishing units due to the VFAS and a general reduction in fishing effort could have contributed to the increasing trend, the average effective CPUE for the past five years has been higher than any time since 1984–1985. This suggests that recruitment has been increasing strongly since measures were introduced to protect adult sharks and constrain effort in the TDGDLF. Combined with the recent catches of juvenile sharks of this species having been reduced to approximately half of the quantity determined to be sustainable in 1994/95 and 1995/96, along with the comprehensive measures to mitigate cryptic mortality of older dusky sharks that have been introduced from 2006¹, the current management arrangements are considered suitably precautionary to ensure that fishing mortality is now at a level such that recovery of this stock is occurring.

Whiskery shark: Previous age structured modelling of the whiskery shark stock (based on hourly CPUE data) concluded that total biomass was depleted to less than 40% of its virgin level by the early 1990s but the stock had shown preliminary signs of recovery to slightly above 40% of virgin biomass by the late 2000s. Using the new series of daily effective CPUE data from south of 28°S latitude to 129°E longitude off the south coast (Demersal Gillnet and Longline Figure 8) in the model, results support the conclusion that total biomass was heavily depleted during the 1980s. However, this model implementation indicates that total biomass at the commencement of mandatory catch and effort reporting in 1975/76 was less certain than previous assessments suggested (95% confidence intervals that biomass was between 69% and 100%). Significantly, the model also suggests (with 95% confidence) that biomass may only have fallen as low as 45.4% in 1995/96. The best (median) estimates of total biomass have indicated only very modest increases and that current biomass was 52.1% of B₀ it's virgin level in 2009/10 (95% confidence intervals of 46.4

to 56.8%). Further analyses of CPUE data are currently being undertaken in conjunction with exploration of alternative model assumptions, in an attempt to better understand these model results. Nevertheless, as these and previous model outputs suggest that whiskery shark biomass currently exceeds the minimum acceptable level and all recent modelling indicates that total and mature female biomass trends are increasing, the status of the WA whiskery shark stock is now considered to be acceptable.

Furthermore, accelerated rates of whiskery stock recovery are expected to become evident in catch and CPUE data when sharks born since the introduction of the annual closed season (see management arrangements above) begin recruiting to the fishery (around 2012/13).

Sandbar shark: Due to the sandbar shark's longevity and age-specific nature of fishing mortality in the target fisheries, stock assessment was undertaken using empirically-derived estimates of fishing mortality and demographic modelling techniques, similar to those used for dusky shark. FRDC-funded research undertaken between 2000 and 2005 confirmed that sandbar sharks taken in the TDGDLF were the same unit stock as was being targeted in the Northern Shark Fisheries. The model indicated that combined levels of fishing mortality in the target TDGDLF and Northern Shark Fisheries, as well as in non-target commercial fisheries and the recreational fishing sector were increasingly unsustainable between 2001 and 2004 and had probably been so since at least 1997/98. As those mortality rates corresponded to combined reported catches of 250–440 tonnes year⁻¹, the combined catch of 918 tonnes reported by the target sector in 2004/05 (762 tonnes of which was reported by the northern shark fisheries) is considered to have been highly unsustainable. This conclusion is supported by fishery-independent survey data collected from the area between northern Shark Bay and Eighty Mile Beach where mature sandbar sharks are prevalent, which indicate there was a significant decline in breeding stock abundance between 2002 and 2005.

Subsequent assessments of stock status have used analyses of the combined catches by the TDGDLF and northern shark fisheries (see Northern Shark Fisheries Status Report), relative to those fisheries' catches during the assessment period. Although an effective CPUE region has been identified as south of 26°S latitude to 118°E longitude off the south coast (Demersal Gillnet and Longline Figure 9), the full extent of expected reductions in recruitment caused by previous excessive catches of breeding stock, are unlikely to be reflected in CPUE data until cohorts born since 2004/05 enter the fishery between 6 and 9 years of age (i.e. over the coming three years). Although the significant declines in WCDGDLF fishing effort may mask the magnitude of reductions in those cohorts' abundance, TDGDLF sandbar shark catches since 2008/09 have been at levels that should allow a gradual recovery of the breeding stock. With the breeding stock likely to be close to the minimum acceptable limit (40% of virgin biomass), the WCDGDLF will need to be carefully monitored over coming years to ensure that catch levels of sandbar sharks are maintained consistent with continued stock recovery.

Other sharks: The four indicator species of the temperate shark 'suite' account for approximately 80% of the fisheries' and bioregional shark catch and represent the range of life history strategies of other shark species caught by the

¹ i.e. commercial protection of sharks in most non-target fisheries, total protection of all whaler sharks with an inter-dorsal fin length greater than 70 cm in the South and West Coast Bioregions, 70 cm maximum (inter-dorsal fin) size limit for dusky sharks in the TDGDLF, implementation of bycatch reduction devices in trawl fisheries, prohibition of metal snoods in most commercial fisheries.

fisheries. Thus, the status of indicator stocks is believed to generally reflect the status of other sharks in the South and West Coast bioregion.

Non-Retained Species

Bycatch species impact: **Low**

The catch composition of the fishery was examined in detail for the period 1994 to 1999. There is some discarded bycatch of unsaleable species of sharks, rays and scalefish. During ESD risk assessment of these fisheries in 2002, all impacts on stocks of bycatch species were determined to be low risk. As maximum potential fishing effort is now explicitly capped at less than 70% of the mid to late 1990s levels, bycatch in all management zones is expected to have been proportionally reduced. Recent multi-fisheries bycatch risk assessment has identified the Port Jackson shark among the higher risk bycatch species in the West Coast Bioregion. Although this species is one of the largest components of the demersal gillnet and demersal longline fisheries bycatch and is recorded as bycatch in other commercial fisheries, cumulative risks were assessed as low-moderate.

Protected species interaction: **Negligible-Low**

Historical on-board observer programs have shown that protected species interactions were very low throughout the fishery. The Demersal Gillnet and Longline Table 2 details individual interactions between the fishery and all protected species since 2006/07.

Recently completed analyses of potential encounter rates of sea lions with demersal gillnet gear and interpretation of those rates in the light of historical observer data have supported Department's Negligible-Low risk rating and suggested that sea lion captures in these fisheries are likely to be extremely low frequency events.

It should also be noted that demersal gillnet and longline fishing is not permitted between Steep Point (26°30' S) and a line drawn north of North West Cape (114°06' E), or within 3 nautical miles of the Abrolhos Islands baselines, where populations of turtles and sea lions are present.

Ecosystem Effects

Food chain effects: **Low**

The recent analysis of potential changes in ecosystem structure of finfish on the south and west coast bioregions (Hall & Wise, 2011)¹ found no evidence of any systematic change in species diversity, richness or trophic index indicating that this fishery is not having a material impact on food chain or trophic structure.

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.

Habitat effects: **Negligible**

The level of effort is such that the gear is deployed infrequently over approximately 40% of the fisheries' operational area (Demersal Gillnet and Longline Figure 1) and under normal circumstances the physical impact of the gear on the bottom is minimal. Moreover the very small footprint of each net would combine to make a very small percentage (< 5%) of the area that would be contacted by this gear on an annual basis.

Social Effects

Direct: Fishing returns reported that between 80 and 100 skippers and crew were employed in the JASDGLDF and over 20 were employed in the WCDGLDF during 2010/11. As sharks are generally not targeted by recreational fishers in Western Australia, their direct social importance to this group is negligible.

Indirect: Sharks are viewed as a menace by some members of the community due to their perceived danger to humans and their predation of recreationally caught fish. However, others consider them to be important components of marine ecosystems that need to be conserved.

Economic Effects

Estimated annual value (to fishers) for 2010/11:

JASDGLDF: Level 2 - \$1 - 5 million

WCDGLDF: Level 2 - \$1 - 5 million

* As fishers do not specify the value of fins on their catch returns, fin values were calculated at an average of 3% of sharks' whole weight and value was conservatively estimated using a price of \$35/kg. Categories of shark which do not have saleable fins were excluded from fin valuation.

Fishery Governance

Target commercial catch range:

Key shark species 725–1,095 tonnes

Individual target catch ranges for the key shark species in 2010/11 were as follows:

Gummy shark 350–450 tonnes

Dusky shark 200–300 tonnes

Sandbar shark < 120 tonnes

Whiskery shark 175–225 tonnes

Current Fishing Level

JASDGLDF Zone 1 Acceptable

JASDGLDF Zone 2 Acceptable

WCDGLDF Acceptable

Maximum acceptable effort levels for each management zone have been based on their respective 2001/02 (daily) levels. These levels are considered likely to deliver sustainable harvests of the fisheries' target and byproduct species and acceptably low levels of bycatch and protected species

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interactions. Under explicit hourly-gear input control arrangements, effort should not exceed these limits.

Gummy shark catches exceeded the upper limit of their acceptable range between 2003-04 and 2009-10, and reached a historically high level in 2007-08 (755 t). As the steadily increasing CPUE trend observed between the early-mid 1990s and 2005/06 is believed to have been a result of increasing stock abundance, the consistently high catches reported in recent years are not of concern. However, until the implications of the unprecedented recent spike in effective CPUE can be ascertained and a new stock assessment model developed, CPUE will be closely monitored to ensure that it remains at expected levels and the downwards trajectory of the last three years does not continue.

Dusky shark catches have been within their acceptable range since 2000-01, except for 2006/07 when they were 5 tonnes below the minimum limit. The dusky shark catch in 2010/11 was 255t which is within the target range of 200-300t. However, the fishery has not utilised its full entitlement during 2010/11 and as such the Department will carefully monitor the catch levels to ensure they do not increase above sustainable levels. The acceptable catch range will require re-evaluation if catches increase in coming years.

Whiskery shark Total catches of whiskery shark have steadily declined since the mid-1990s although, until 2010/11 had been maintained slightly above or below the minimum acceptable level. The 127t catch in 2010/11 was nearly 50t less than that minimum level and was the fisheries' lowest annual catch since 1975/76. The low catches of recent years mostly reflect the outcomes of management measures to recover this stock, in particular, the introduction of the seasonal 'pupping' closure. As these measures are intended to increase catch rates in coming years the acceptable catch range will need to be adjusted upwards as the magnitude and rate of stock recovery can be determined.

Sandbar shark catches exceeded their maximum acceptable level until effort declined dramatically in the WCDGLF in 2008/09 and catches declined to more sustainable levels of 81 t in 2008/09, 107 t in 2009/10 and 71t in 2010/11. At these levels, recruitment to the breeding stock should improve in coming years and gradually allow the mature biomass to recover from more than a decade of excessive catches in the northern shark fisheries (see Northern Shark Fisheries Status Report).

New management initiatives (for 2011/12)

The review of the whiskery shark 'pupping' closure will commence in late 2011 with a view to making a determination by mid year for the 2012 arrangements. At this time the Department will assess the status of the whiskery shark in relation to the long-term sustainability of the species. Since 2009, the whiskery shark pupping closure has been reviewed on an annual basis and at this stage it is still too early to determine if pre-natal survival resulting from the previous 5 years of seasonal closure has delivered full benefits to the recovery of the whiskery shark stock. Evidence to determine the measure of the benefit to whiskery

shark stock will not be available in catch data until cohorts born since 2006 recruit to the fisheries in around 2012/13 (at approximately 5-6 years of age). With the long term sustainability of the species in mind the closure into the 2010 and 2011 fishing seasons has been maintained (with majority industry support).

The FRDC funded desktop study that began in August 2010 to estimate potential interaction rates of Australian sea lions with demersal gillnets in the TDGDLF is expected to be completed and accepted by FRDC in early 2012. The model developed as part of the project will be used to conduct a (partial) reanalysis of existing independent observer data from the TDGDLF to assist in evaluating management options to ensure interactions with Australian sea lions are maintained with acceptable levels.

The current WTO for the TDGDLF expires on 31 March 2012. The Department is currently preparing for reassessment of the TDGDLF and expects to submit the application in early 2012. It is intended that the above mentioned model will assist in addressing Condition 5 of the current WTO export approval which directly relates to estimating the risk of interactions between fishers in the TDGLF and Australian sea lions.

The release of the Commonwealth Southwest Marine Bioregional Plan (SWMBP) (including a proposed marine reserve zoning scheme) originally expected to be released in 2010/11 has been delayed. It is now expected that this Bioregional Plan which has significant potential to impact on the operation of the TDGDLF, will be announced in early 2012. It is likely that the announcement of the SWMBP will coincide with the release of the Commonwealth North West Marine Bioregional Plan. It is expected that the State Ngari Capes Marine Park, which is likely to have some impact on Zone 1 of the JASDGLF, will also be announced in early 2012.

External Factors

As the TDGDLF key target species span multiple regional boundaries there are a number of factors outside of the control of the fishery which can negatively impact the performance of key temperate shark stocks. In particular, the potential for ongoing catches of breeding stock of sandbar sharks across the northern shark fisheries (from Western Australia, Northern Territory and northern Queensland and Commonwealth managed fisheries) remains cause for concern. Other potential factors affecting key temperate shark stocks include targeted fishing for gummy shark by Commonwealth managed vessels that occurs to the east of Zone 2 of the JASDGLF (although the fishery is tightly managed via quota controls) and incidental catches of dusky and gummy sharks in other State and Commonwealth Government-managed fisheries. While the risks associated with these outside influences are largely unqualified they must be taken into account in the stock assessment for individual species (and the TDGDLF 'suite') to ensure appropriate management strategies are implemented that address the long-term sustainability of the shark stocks.

DEMERSAL GILLNET AND LONGLINE TABLE 1

Summary of 2010/11 catch (t live wt.) by the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Data are given by management zone and also by Bioregion (italicised). Indicator species and catches are highlighted in bold.

Name	Species or taxon	JASDGLF		WCDGDLF	Bioregion		Total
		Zone 1	Zone 2		South Coast	West Coast	
Sharks and rays							
Gummy	<i>Mustelus antarcticus</i>	25.1	348.7	1.0	354.4	20.4	374.8
Dusky whaler	<i>Carcharhinus obscurus</i>	125.1	97.7	32.5	121.0	134.3	255.2
Whiskery	<i>Furgaleus macki</i>	30.5	90.6	5.6	100.0	26.6	126.7
Sandbar	<i>Carcharhinus plumbeus</i>	22.2	2.7	46.2	12.7	58.3	71.0
Hammerheads	F. Sphyrnidae	25.2	36.4	6.0	42.6	25.0	67.6
Spinner (long nose grey)	<i>Carcharhinus brevipinna</i>	35.9	12.1	12.4	14.6	45.7	60.4
Wobbegongs	F. Orectolobidae	16.3	9.0	5.0	14.5	15.8	30.3
Rays	Batoidea	4.6	1.0	4.3	2.1	7.9	10.0
Common saw shark	<i>Pristiophorus cirratus</i>	0.4	9.5		9.5	0.4	9.9
School	<i>Galeorhinus galeus</i>		9.2	<0.1	9.2	0.1	9.3
Other elasmobranchs		6.2	3.5	6.2	4.5	11.4	15.9
Total elasmobranchs		291.5	620.3	119.2	685.2	345.9	1,031.1
Scalefish							
Queen Snapper	<i>Nemadactylus valenciennesi</i>	18.7	32.2	0.2	41.7	9.4	51.1
Blue Groper	<i>Achoerodus gouldii</i>	24.5	22.3	0.7	30.9	16.6	47.5
Dhufish	<i>Glaucosoma hebraicum</i>	12.2	1.0	3.3	3.7	12.7	16.4
Pink snapper	<i>Pagrus auratus</i>	5.2	7.2	3.6	8.9	7.1	16.0
Boarfishes	F. Pentacerotidae	2.2	5.4	<0.1	6.1	1.6	7.7
Samsonfish	<i>Seriola hippos</i>	1.6	3.0	2.3	3.5	3.3	6.9
Redfishes	<i>Centroberyx</i> spp.	0.7	5.7	<0.1	6.2	0.2	6.4
Mulloway	<i>Argyrosomus hololepidotus</i>	2.9	2.0	0.9	2.0	3.7	5.8
Sweetlips	F. Haemulidae			2.5		2.5	2.5
Baldchin groper	<i>Choerodon rubescens</i>	<0.1		1.3	<0.1	1.3	1.3
Other scalefish		8.4	3.3	2.0	5.9	7.8	13.7

SOUTH COAST BIOREGION

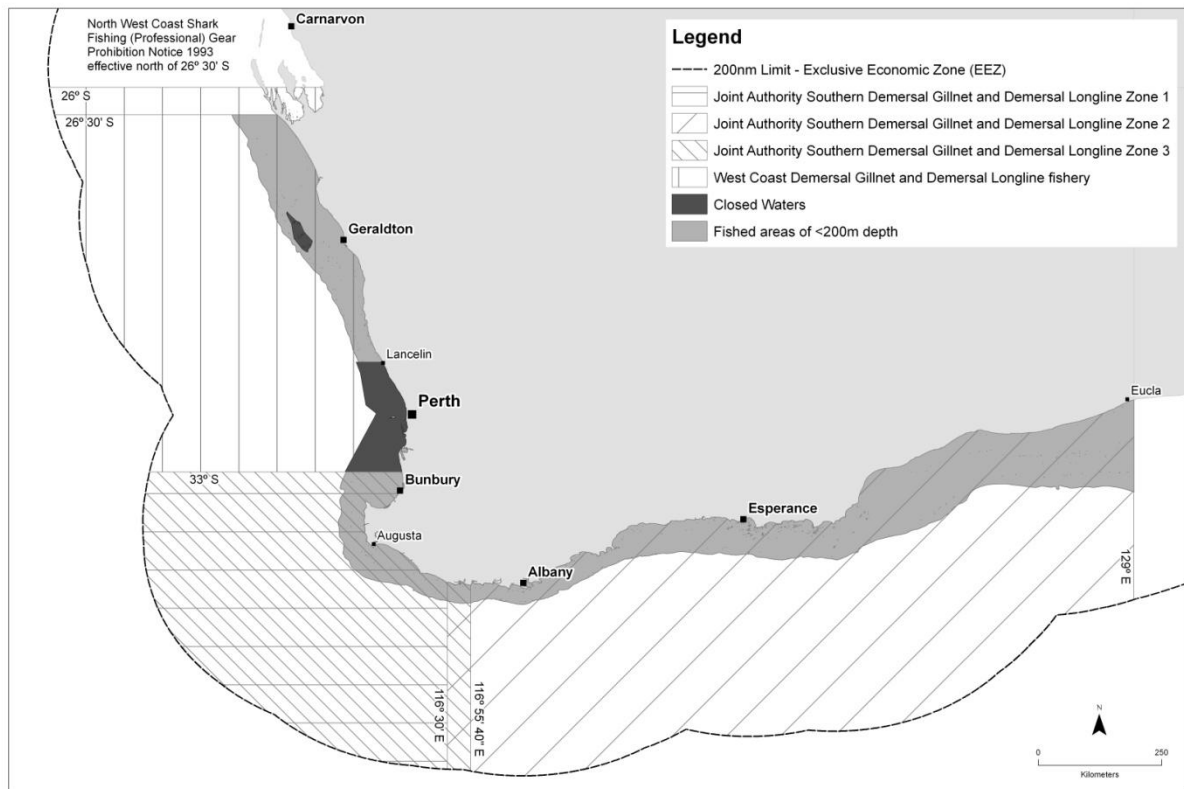
Name	Species or taxon	JASDGLF		WCDGDLF	Bioregion		Total
		Zone 1	Zone 2		South Coast	West Coast	
Total scalefish		76.3	82.1	16.8	109.0	66.3	175.2
<hr/>							
<i>'Demersal scalefish suite' component</i>		63.9	74.8	12.7	98.7	52.6	151.4
<hr/>							
Fishing effort (km gn d)		3,464 (99) ¹	6,126 (85) ¹	1,117 (39) ²			10,706 (79) ²
<hr/>							
Fishing effort (1000 km gn hr)		62.8 (75) ³	109.8 (76) ³	25.5 (38) ³			198.1 (67) ³

¹ Percentage of respective 2001/02 levels² Percentage of VFAS adjusted 2001/02 levels³ Values in parentheses are percentages of each management zone's maximum hourly effort capacity

DEMERSAL GILLNET AND LONGLINE TABLE 2

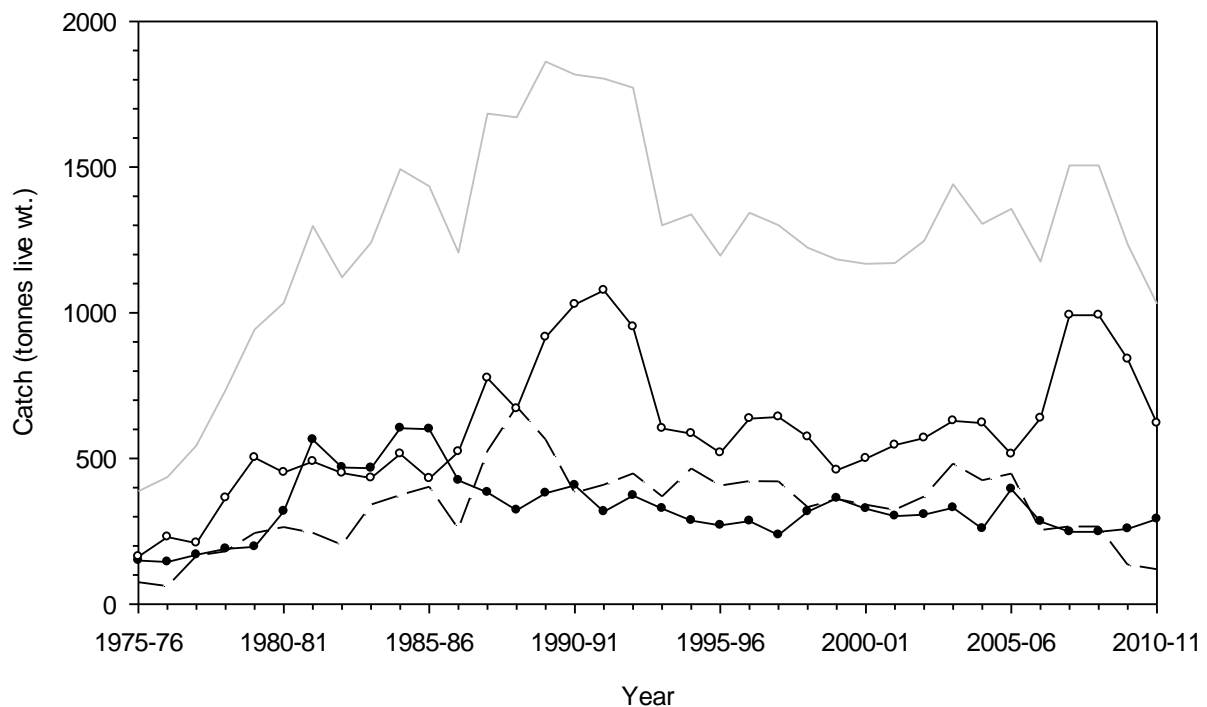
Recorded interactions with Threatened, Endangered, Protected (TEP) species.

TEP SPECIES	2006/07		2007/08		2008/09		2009/10		2010/11	
Alive(A)/Dead(D)	A	D	A	D	A	D	A	D	A	D
Dolphins		6	1		1	2		2		3
Manta Rays	2								2	
Muttonbird, General							7		4	
Sawfish, General			1						1	
Sea Birds	1	3		2	2	1				
Sea Lions						2				
Seal, NZ Fur	1	1		2	1	5		7		1
Shark, Grey Nurse	61	18	38	16	63	18	59	27	53	19
Shearwater, Fleshfooted								2		
Snake, Sea				2						
Turtle, General	4	3	5		2	2	2	1	1	
Whales					1					
White Pointer	10	3	10	3	14	2	2	1	3	5



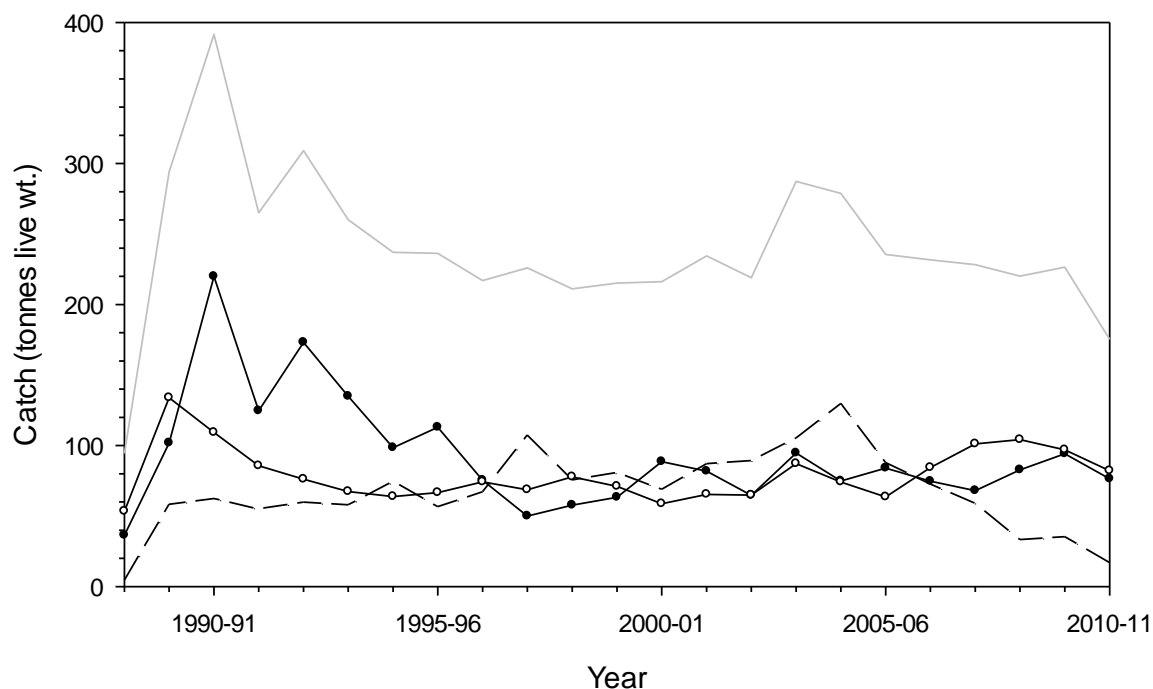
DEMERSAL GILLNET AND LONGLINE FIGURE 1

Management boundaries of the WA temperate Demersal Gillnet and Demersal Longline Fisheries. Black shading represents fished areas of less than 200m depth.



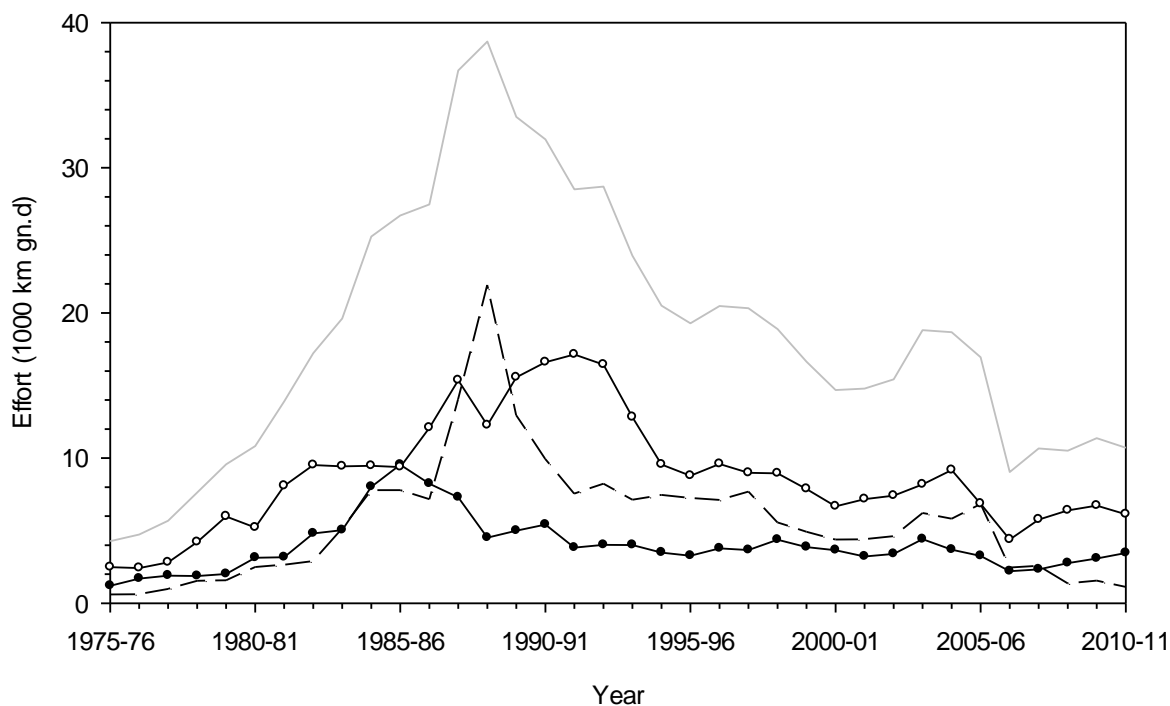
DEMERSAL GILLNET AND LONGLINE FIGURE 2

Total elasmobranch catches. Black circles = JASDGLF Zone 1; white circles = JASDGLF Zone 2; dashed black line = WCDGLF; plain grey line = total from the three management zones.



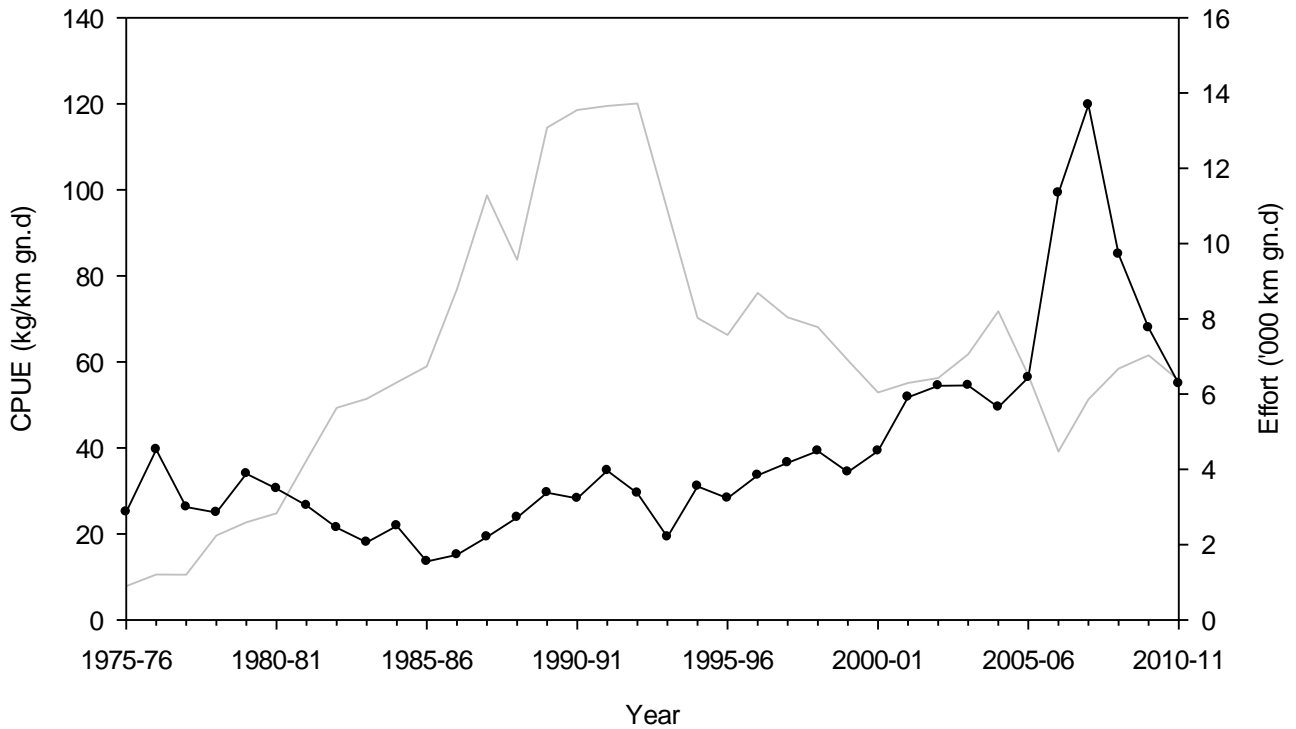
DEMERSAL GILLNET AND LONGLINE FIGURE 3

Total scalefish catch. Black circles = JASDGLDF Zone 1; white circles = JASDGLDF Zone 2; dashed black line = WCDGLDF; plain grey line = total from the three management zones. Catches prior to 1988/89 cannot be distinguished from other fisheries' gillnet and longline catches and are omitted.



DEMERSAL GILLNET AND LONGLINE FIGURE 4

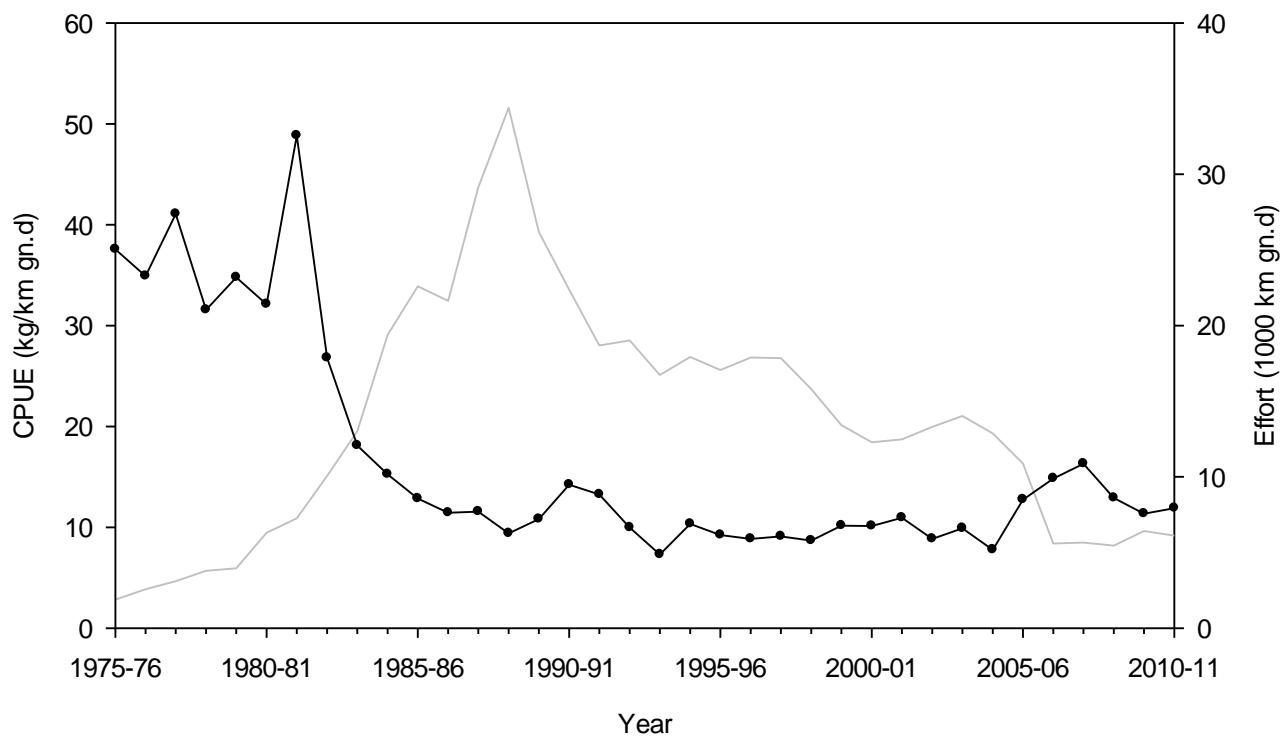
Standardised demersal gillnet and demersal longline effort. Black circles = JASDGLDF Zone 1; white circles = JASDGLDF Zone 2; dashed black line = WCDGLDF; plain grey line = total from the three management zones.

**DEMERSAL GILLNET AND LONGLINE FIGURE 5**

Gummy shark effective effort (grey line) and CPUE (black circles).

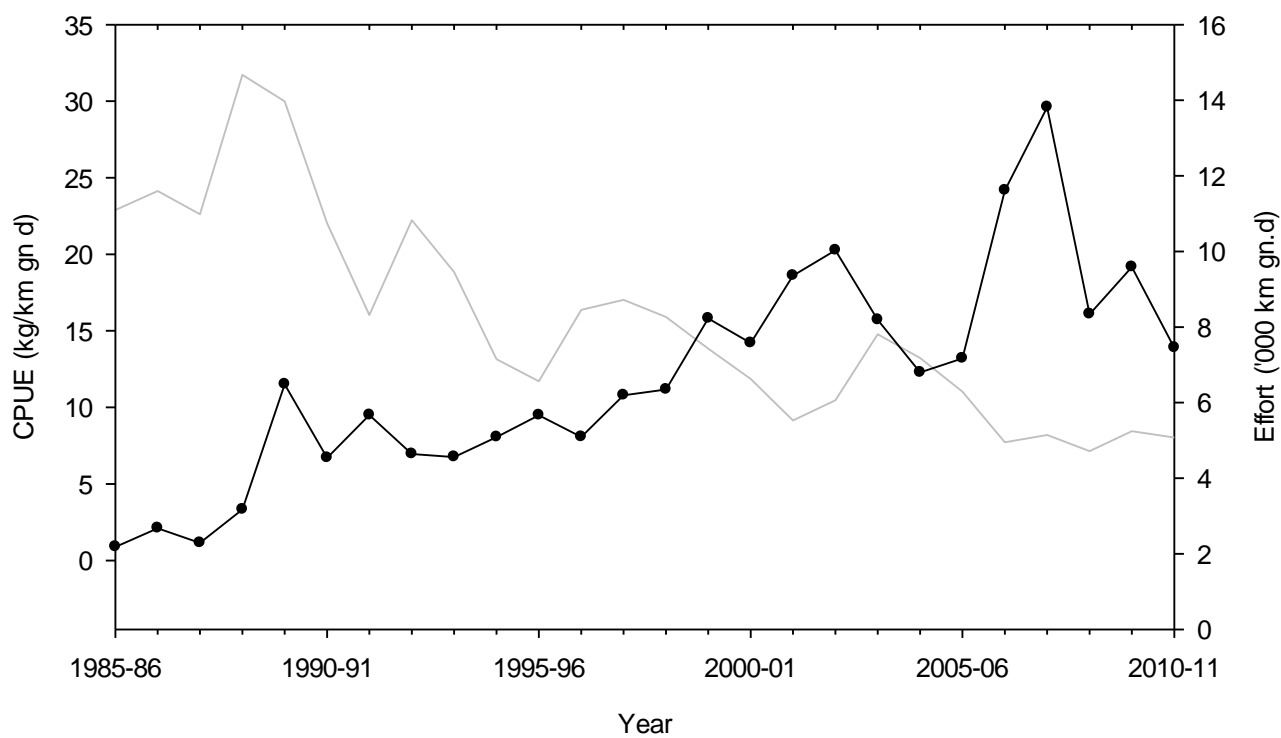
**DEMERSAL GILLNET AND LONGLINE FIGURE 6**

Dusky shark effective effort (grey line) and CPUE (black circles),



DEMERSAL GILLNET AND LONGLINE FIGURE 7

Whiskery shark effective effort (grey line) and CPUE (black circles),



DEMERSAL GILLNET AND LONGLINE FIGURE 8

Sandbar shark effective effort (grey line) and CPUE (black circles),

South Coast Demersal Scalefish Resource Report: Statistics Only

B. Molony, E. Lai and M. Holtz

Fishery Description

Commercial

Operators in this fishery target scalefish stocks in oceanic waters of the South Coast Bioregion, primarily using wetline methods such as droplines, handlines and trolling to take both offshore and inshore demersal scalefish species such as pink snapper, Bight redfish and queen snapper. Haul nets and set nets are also used to take nearshore scalefish species such as herring, whiting and mullet.

The take of scalefish by trap and trawl methods, salmon by line and beach netting and pilchards by purse seine in the South Coast Bioregion are separately managed fishery activities. The capture of demersal species by the Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery operating in the South Coast Bioregion is also managed separately (see Demersal Gillnet and Longline Fisheries Status Report).

Recreational

Recreational fishers, mostly using line based methods from boats target this suite of species.

Boundaries

The fishery operates in the South Coast Bioregion, from 115° 30' to the WA/SA border (South Coast Wetline Figure 1).

Management arrangements

Commercial

Fish Resources Management Act 1994, Fish Resources Management Regulations 1995 and other subsidiary legislation

The commercial 'wet line' fishery is currently 'open access' for the holder of a valid Fishing Boat Licence (for the boat) and a Commercial Fishing Licence (for the fisher).

Recreational

Fish Resources Management Act 1994, Fish Resources Management Regulations 1995 and other subsidiary legislation

Total Landings (Season 2011):

90.5 tonnes (demersal scalefish only)

Commercial

Estimates of catches are monitored through the mandatory CAES logbook system. Bight redfish, blue groper, blue morwong and pink snapper have been identified as indicator species of the inshore demersal suite of finfish for the South Coast Bioregion. These indicator species are used to monitor the status of the resource and fishery and make up a bulk of the catches from this suite by the commercial fishery. In addition, Hapuku, blue-eye trevalla and eightbar grouper have been identified as indicator species for the offshore

demersal suite of finfish in the South Coast Bioregion..

The catch of 90.5 t of demersal scalefish during 2011 is the second lowest since 2000, but remains within the range of catches since 2000 (80–140 t, South Coast Demersal Line Fishery Figure 2). The slightly lower catches reported since 2007 are mainly due to the ability to now better allocate catches east and west of 115° 30' to the South Coast Demersal and West Coast Demersal Scalefish fisheries respectively. The decline in demersal scalefish catch in 2011 (90.5 t) compared with 2010 (98.3 t) is mainly due to a lower catch of pink snapper in 2011.

In addition, 31 t of non-demersal scalefish were reported in 2011. The non-demersal catches were dominated by Samson fish (18.6 t, pelagic suite) and skippy (4.0 t, nearshore suite).

Recreational

Estimates of the recreational catch levels of this suite are not available. A State-wide recreational survey is currently underway and will result in estimates of recreational boat-based catches from this fishery being available in late 2012.

Fishery Governance

Target commercial catch range: Not available

A formal catch range has not been developed for this fishery. However, the 2011 catch levels of the inshore demersal suite falls within the 80 t -140 t range of catches reported since 2000 and is likely to be sustainable. Catch levels will be more closely monitored in future and additional monitoring of the resources and fishery is proposed; funding applications are pending a decision.

Current Fishing (or Effort) Level: Not available

This fishery is likely to undergo review in the near future. Development of an interim catch range will be considered during this review.

New management initiatives (2011/2012)

Following the introduction of the *West Coast Demersal Scalefish (Interim) Management Plan 2007* and reductions in effort applied to the West Coast Rock Lobster Managed Fishery, there have been concerns about a shift in effort to the South Coast and resultant increase in catches of scalefish off the south coast. This situation does not seem to have occurred at this stage.

In the absence of assessments of demersal scalefish stocks off the south coast such as pink snapper, queen snapper and Bight redfish, a potential increase in fishing mortality may increase the risks to unacceptable levels. Furthermore, recent data suggests that hapuku (an indicator species of the offshore demersal suite) of the south coast are possibly being

SOUTH COAST BIOREGION

overfished. A research project to undertake formal stock assessment of the key species is now planned to commence in late 2012.

The nearshore species targeted by open access inshore (oceanic) netters are also vulnerable and the recent increase in this activity has led to reports of resource sharing and user group conflict.

The Department will continue to monitor the fishery and may develop more formal management arrangements for wetline fishing off the south coast should a significant increase in effort and catch occur. These arrangements will aim to restrict effort and catches of demersal scalefish and may help to address social issues such as easing the conflict between users that share the inshore scalefish resource.

SOUTH COAST DEMERSAL SCALEFISH RESOURCE TABLE 1

Catches (t) of indicator species, demersal species and total scalefish catches by the commercial sector of the South Coast Demersal Line Fishery, 2007–2011.

Species	2007	2008	2009	2010	2011
Bight Redfish*	37.0	47.2	33.5	26.8	23.9
Blue groper	1.1	1.1	1.2	0.4	1.3
Blue Morwong	5.1	5.2	8.0	4.4	8.1
Pink Snapper	37.3	37.9	44.9	38.8	28.9
Hapuku	14.2	13.1	18.5	11.5	14.8
Blue-eye trevalla	4.9	5.5	2.4	3.2	3.4
Eightbar grouper	2.5	0.6	0.7	0.5	1.4
Other demersal scalefish	15.0	15.6	12.5	12.7	23.4
Total demersal scalefish	117.1	126.4	121.9	98.3	90.5
Total non-demersal scalefish**	20.6	27.6	26.5	21.3	31.0
Total Scalefish	137.7	153.9	148.4	119.6	121.5

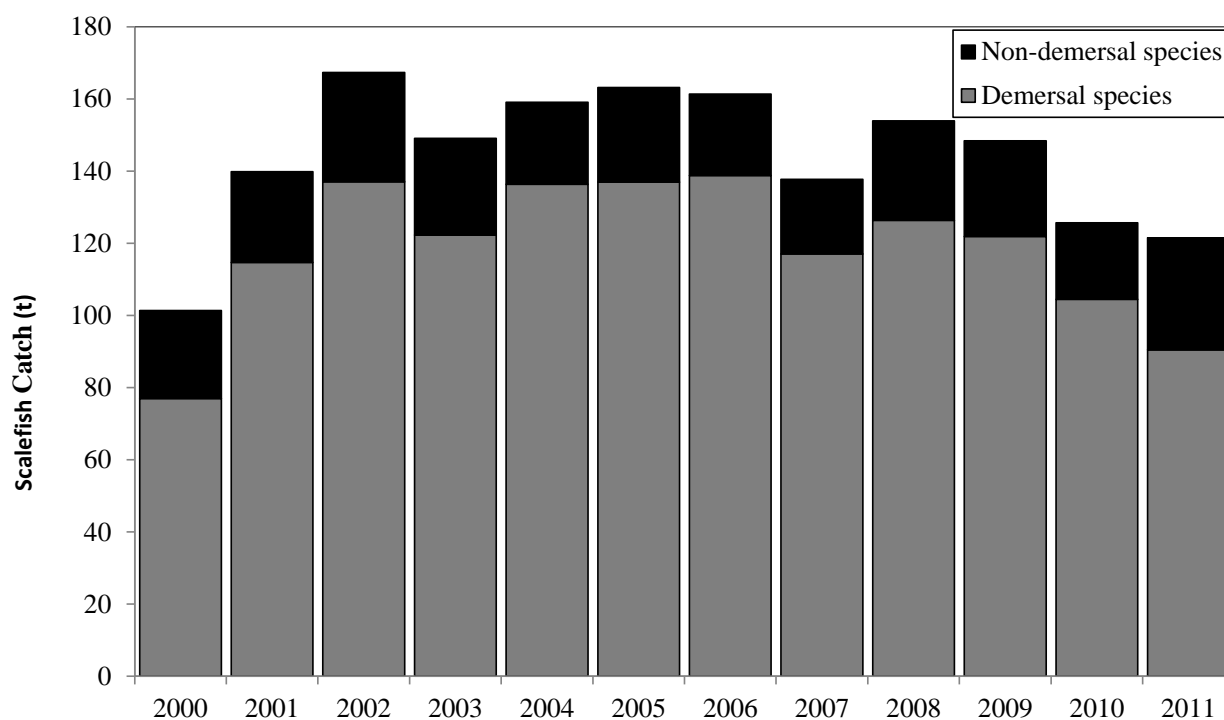
* Estimates of bight redfish catches represent catches by this fishery of fishes reported as 'Bight redfish', 'yelloweye redfish' and 'redfish'. Line catches of redfish from the south-west zones of the West Coast Demersal Scalefish Fishery are almost exclusively Bight redfish. In addition, the Commonwealth Great Australian Bight trawl fishery operating in the South Coast Bioregion only reports catches of Bight redfish. It is likely that catches of 'redfish' by the South Coast Demersal Line Fishery are likely to be of Bight redfish. This may be confirmed in the near future via catch or market sampling.

** Non demersal scalefish includes fishes from the pelagic suite (mainly Samson fish) and nearshore suite (mainly skippy).



SOUTH COAST DEMERSAL SCALEFISH RESOURCE FIGURE 1

Map of the extent of the South Coast Demersal Line Fishery.



SOUTH COAST DEMERSAL SCALEFISH RESOURCE FIGURE 2

Catches (t) of demersal and non demersal scalefish in the South Coast Demersal Line Fishery, 2000—2011.

AQUACULTURE

Regional Research and Development Overview

Greenlip abalone is considered a key species for aquaculture development on the south coast of WA.

An abalone farm and associated hatchery near Bremer Bay has been upgraded and modified to cater for planned growth in production and to accommodate biosecurity requirements. The land-based farm and hatchery are being operated according to a Biosecurity Plan, developed with input from the Department of Fisheries. Independent audits are undertaken to ensure compliance with the Biosecurity Plan.

An offshore abalone farm near Augusta is achieving encouraging early results for abalone grown out using purpose-built concrete structures located on the sea bed. The operator is testing two new sites under an Exemption issued by the Department of Fisheries.

The abalone aquaculture industry sector currently operates under the policy entitled *Abalone Aquaculture in Western Australia*. The Policy was developed in 2010, in consultation with the wild-capture and aquaculture industry sectors. An outbreak of abalone viral ganglioneuritis (AVG) in Victorian abalone farms in 2005, the spread of the disease to the wild-capture fishery in Victorian waters and the subsequent outbreak of AVG at an abalone processor in Tasmania caused significant mortalities and raised the matter of AVG preparedness in Western Australian waters. As a result, the 2010 Policy is being reviewed and expected to be completed in September 2012. The revised Abalone Aquaculture Policy will provide greater certainty to all sectors of the abalone industry, including aquaculture, stock enhancement, the wild fishery and the recreational sector.

COMPLIANCE AND COMMUNITY EDUCATION

Commercial and recreational fisheries compliance in the South Coast bioregion is undertaken by Fisheries and Marine Officers (FMOs) based at Albany, Esperance and Mobile 2 (occasional recreational patrols). Officers undertake a variety of compliance activities including land, at-sea, inspection of vessels, catches, fishing gear, marine safety equipment, covert investigations and verification of licenses for both the commercial and recreational fisheries.

There are two part-time South Coast Marine Education Officers who deliver the Education program for the South Coast.

Activities during 2010/2011

Compliance

Due to the variety of commercial and recreational fisheries, expanse of coastline and variable and seasonal weather conditions, Fisheries and Marine Officers employ a risk management driven approach to prioritise and plan compliance activities.

Overall, Fisheries and Marine Officers delivered a total of 3322 hours of “field” compliance activity during 2010/2011.

South Coast Compliance Table 1 represents an increase from the previous year (South Coast Compliance Figure 1).

Officers made contact with a total of 308 commercial fishers in the field, across the south coast. Generally only minor breaches were detected, mainly in terms of licensing issues, quota management and breaches of individual fisheries management arrangements. Illegal (unlicensed) commercial abalone operations continue to be a major concern in the South Coast bioregion threatening the sustainability of the commercial and recreational abalone fishery. Officers from the southern region conducted joint investigations with other compliance units into organized unlicensed illegal fishing operations.

The remainder of the commercial fishery compliance effort was directed to the wide range of minor commercial fisheries operating in the bioregion. There was an increase in Catch Inspections of the Estuarine fisheries and Commercial Licence Inspections. A review was made of the SOP for Joint Authority (Shark) Catch Inspections and improvements were made to the process of investigating VMS reports.

A dedicated effort was applied to the Abalone ‘black market’ trade with a substantial prosecution resulting in four people being prosecuted and convicted.

During the year, 6 infringement warnings, 11 infringement notices were issued and a further 2 cases resulted in prosecution action being instigated against commercial fishers. In addition to ‘black market’ abalone operations, illegal sale of other fish by unlicensed individuals or groups continues to be an issue of concern in the region.

Recreational compliance activities concentrated mainly on checking shore and boat based anglers, net fishers and shellfish collectors. Fisheries and Marine Officers (FMOs) made contact with a total of 5764 recreational fishers. During 2010/2011, 80 infringement warnings, 37 infringement notices were issued and 6 prosecutions were instigated against recreational fishers.

Compliance patrols in recreational fisheries principally involve checks to ensure that fishers are adhering to size and bag limits and complying with restrictions that apply in the recreational net fishery. The areas of highest risk of non-compliance with the management arrangements were considered to be abalone, marron, marine finfish and estuarine netting. There continues to be a growing awareness of the open season and availability of abalone on the south coast.

Education

Community and school education programs in the bioregion were conducted by the Marine Education Officer. Activities

included the delivery of school incursions and excursions to 1185 primary and secondary students across the region in 44 structured sessions. A further 258 people took part in structured community education activities such as school holiday programs, presentations and Teacher Professional Development sessions. Six regional events were also attended with around 1012 contacts made. These included agricultural shows, regional festivals, and fishing competitions. Where possible, education initiatives were delivered in collaboration with other environmental education providers. Partnerships included the Department of Environment and Conservation, South Coast Natural Resource Management, the Albany Museum and the Fishers with Disabilities Association.

Initiatives in 2011/2012

Compliance

Compliance and management personnel continue to refine compliance planning to deliver greater efficiencies and outcomes through the use of risk assessments and intelligence processes. This has resulted in greater capacity to target specific offence types, utilising risk analysis to deploy resources more efficiently.

Renewed focus on complaints and investigations with a view towards improving the keeping of records, gathering and managing evidence and delivering outcomes of those matters in a more timely fashion – with feedback (where appropriate) to the complainants.

Biosecurity is a strategic focus for the region with the complimentary efforts between compliance staff and the Biosecurity Unit.

Physical resourcing initiatives undertaken in the 2011/2012 year are expected to eventuate in the 2012/2013 year to enable better compliance initiatives.

Training and development of staff has been a focus which continues into the new financial year with four staff currently

attending the Frontline Managers Course, improvements to Warrant Execution refresher training, in the field mentoring, delegation of projects to junior staff to develop 'Operational Orders' and lead the operations.

FMO'S will structure recreational fishing compliance programs to address a growing concern of increased catches of demersal scalefish by recreational fishers due to the additional effort from fishers relocating from the West Coast as a result of the new West Coast rules and license fees. The program will include operations aimed at ensuring compliance with possession limits as well as investigations into suspected illegal fish sales.

The recent development of the Walpole – Nornalup Inlets Marine Park will see the personnel in the southern bioregion engaged in a range of tasks including delivery of marine park compliance services and education programs. Operational plans have been developed with the Department of Environment and Conservation with a focus on joint operations to maximize the management presence in the marine park.

The 2011/2012 year has delivered a total of 933 contacts made in this marine park and has included joint operations with the Department of Environment and Conservation (a partner of the marine park).

Education

The education program for the south coast will continue to focus on school-based incursions and excursions working on sustainability and education themes developed as part of the state-wide education plan. Education staff will continue to deliver community activities such as holiday programs, workshops and regional events, in partnership with other agencies where possible. Education for the Walpole-Nornalup Inlets Marine Park will continue to be delivered in collaboration with the Department of Environment and Conservation. The Marine Education Officer will also support community participation initiatives such as 'fish frame' collections.

SOUTH COAST BIOREGION

SOUTH COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and detected offences within the South Coast bioregion during the 2010/11 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	3,322 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	308
Infringement warnings	6
Infringement notices	11
Prosecutions	2
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	5,764
Infringement warnings	80
Infringement notices	37
Prosecutions	6
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field Contacts by Fisheries & Marine Officers	335
Fishwatch reports**	28
VMS (Vessel Days)****	2,114

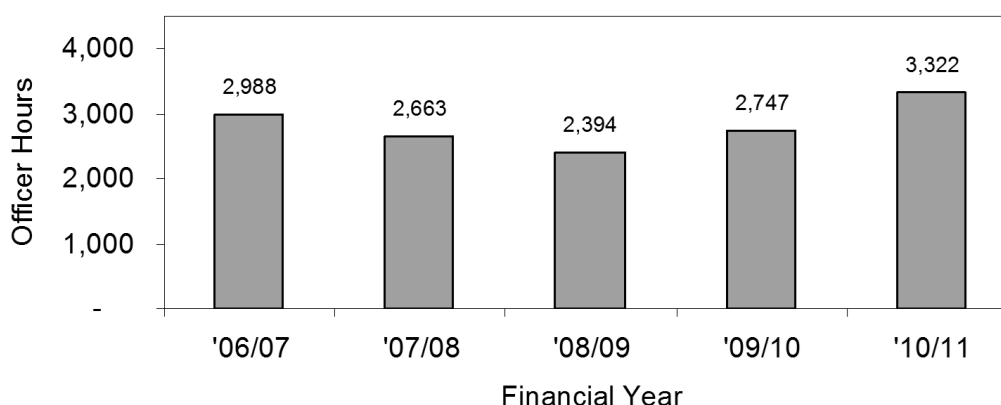
*Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational.

The "Other" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of these contacts are recreational in nature (e.g. personal contacts in Marine Protected Areas), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises etc. are also included in this category.

**This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors

**** VMS (Vessel Days) represents the number of vessel days recorded in this bioregion. That is, a count for each day that each vessel was polled within the bioregion.

South Coast Bioregion Compliance Patrol Hours



SOUTH COAST COMPLIANCE FIGURE 1

"On Patrol" Officer Hours showing the level of compliance patrol activity delivered to the South Coast bioregion over the previous 5 years. The 2010/11 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. (The totals exclude time spent on other compliance related tasks e.g. travel time between patrol areas, preparation and planning time etc.)

NORTHERN INLAND BIOREGION

ABOUT THE BIOREGION

The Northern Inland bioregion, encompassing 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 the Ord River. The continuous release of water from the dam has resulted in the Ord River maintaining its freshwater fish populations year-round, as does the lake, where some freshwater native fish populations have expanded.

Populations of reptiles, such as the protected freshwater crocodile, are also supported by the expanded food chain of native fish, and are thought to have increased significantly from their original billabong-based populations.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

The creation of Lake Argyle has produced a unique inland aquatic environment which is now home to various fishing and tourism-related activities. The lake supports the State's only commercial freshwater fishery – for the silver cobbler or catfish – together with a processing facility supplying predominantly Western Australian and interstate markets. The lake and its associated river system also support recreational fishing for the freshwater component of the barramundi stock and cherabin (freshwater prawns).

Aquaculture development operations in the region have previously included the production of barramundi from a cage operation in Lake Argyle, and a small but growing pond production of redclaw crayfish in the Ord River irrigation system around Kununurra.

The State Government has recently announced funding of a stock enhancement project at Lake Kununurra to create a recreational barramundi fishery in the region.

ECOSYSTEM MANAGEMENT

As one of the key ecosystem risks is the introduction of non-endemic species, the Department has an approval process in place for assessing proposals to translocate live non-endemic fish species into and within Western Australia, so as to minimise the environmental risks to freshwater ecosystems associated with this activity.

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets using the EBFM framework

The Department is now implementing an Ecosystem Based Fisheries Management (EBFM) framework (see How to Use section for more details). In terms of ecological assets, the Department has recognised the following for the Northern Inland Bioregion:

- Ecosystem structure and biodiversity;
- Captured fish species
- Protected species (direct impact – capture or interaction);

The full set of ecological assets identified for ongoing monitoring are presented in Northern Inland Ecosystem Management Figure 1.

Risk Assessment of Regional Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined Northern Inland Figure 1 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (Northern Inland Ecosystem Management Table 1) provides an overview and cumulative assessment of the current risks to the ecological assets of the Northern Inland Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department's Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

Summary of Monitoring and Assessment of Ecosystem Assets

The Department of Fisheries actively supports a number of studies into the native freshwater fish fauna and their habitats in northern river systems in conjunction with Murdoch University, the Department of Water and the Department of Environment and Conservation, and through involvement with local natural resource management councils. New aquaculture ventures are also subject to strict environmental evaluation under the Department's licensing and on-going arrangements, in conjunction with industry and TAFE.

NORTHERN INLAND ECOSYSTEM MANAGEMENT TABLE 1 RISK LEVELS FOR EACH ASSET.

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level components. Low and Medium values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, was not generated by fishing activities.

Ecosystem Structure and Biodiversity

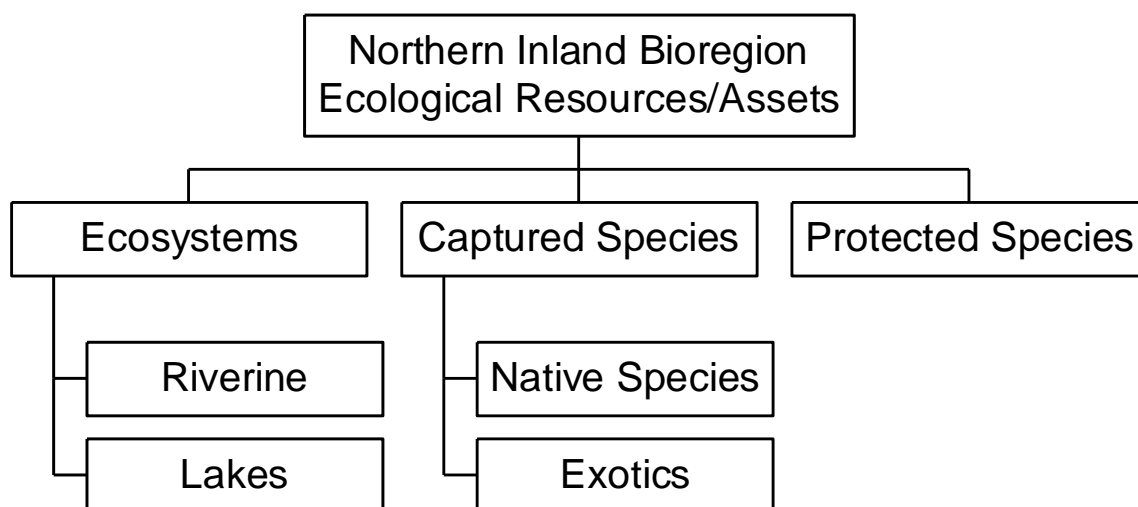
Ecosystem	Risk	Status and Current Activities
Ecosystems	LOW (non fishing)	Minimal threats and these would be due to non fishing activities

Captured fish species

Fish species	Risk	Status and Current Activities
Finfish Native	LOW	The stocks of freshwater fish are not under any material threat
Finfish Exotics	LOW	As above

Protected species

Protected fish species	Species	Risk	Status and Current Activities
Protected Species	Crocodiles	LOW	A small number of crocodiles have been reported captured in nets in Lake Argyle. The numbers are small and would not affect these stocks.



NORTHERN INLAND ECOSYSTEM MANAGEMENT FIGURE 1

Component tree showing the ecological assets identified and separately assessed for the Northern Inland Bioregion

FISHERIES

Lake Argyle Silver Cobbler Fishery Report: Statistics Only

S.J. Newman, C. Skepper, G. Mitsopoulos, R. Mason and P. Carter

Fishery Description

Commercial

The only commercial freshwater fishery in Western Australia is in Lake Argyle in the north-eastern Kimberley (Lake Argyle Silver Cobbler Figure 1). This gillnet fishery specifically targets the silver cobbler (*Arius midgleyi*).

Recreational

A small, but increasing recreational and charter boat fishery for this species exists in Lake Argyle with fishing activities peaking during the dry season (winter months).

Boundaries

Commercial

The waters of the Lake Argyle Silver Cobbler Fishery (LASCF) include all waters of Lake Argyle between the dam wall and 16° 37' south latitude.

Recreational

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

Management arrangements

The LASCF is a limited entry fishery, with six Fishing Boat Licences permitted to operate in the Fishery. A licence condition restricts the net type permitted, with fishers only permitted to use set nets that have a minimum mesh size of 159mm and maximum net drop of 30 meshes.

In June 2012 the *Lake Argyle Fishery Notice 1994* was revoked and replaced with a new notice (Prohibition on Commercial Fishing (Lake Argyle) Order 2012) containing the management arrangements for the Fishery. Under this Order the six Fishing Boat Licences listed are permitted to use no more than 1500 metres of net at any one time, and are prohibited from taking any fish whatsoever by means of nets during the period from 1 November to 31 December in any year. This seasonal closure is aimed at protecting silver cobbler during the spawning season. Furthermore, at this time of the year water temperatures in the lake are high resulting in spoilage of fish in the nets. Fishers in the LASCF operators are not permitted to take barramundi (*Lates calcarifer*) at any time and all nets used by LASCF operators must be suitably marked with licence identification.

In 2001, a voluntary industry Code of Practice was introduced to the LASCF, to implement sustainable fishing practices and to reduce conflict with other stakeholder groups in Lake Argyle. The Code specifies the accepted means of operation in the Fishery and outlines contingency procedures for lost or abandoned fishing gear.

A Bycatch Action Plan has also been developed for the LASCF which aims to minimise the incidental capture of protected species in Lake Argyle (including freshwater crocodiles, freshwater turtles, and birds) during commercial

gillnetting targeting the silver cobbler. The Lake Argyle Silver Cobbler Fishery Bycatch Action Plan and Code of Practice were revised in 2010.

Landings and Effort

Commercial (season 2011):

**Not reportable due to confidentiality limitations
(less than 3 fishers).**

The fishery first developed in 1979 with increasing catches reported until 1989 (143 t). Catches have fluctuated between approximately 70 t and 230 t per year since 1990 (Lake Argyle Silver Cobbler Figure 2). Catches in 2009 to 2010 were less than 70 t, while the 2011 catch was over 100 t and within the acceptable catch range.

Nominal effort in this gillnet fishery is calculated as the total number of fishing days by all boats multiplied by the average daily total net length fished per boat (divided by 100) to give '100 m net days'. Effort from 2003 to 2008 ranged from 5,070 to 6,787 units (100m net days; Lake Argyle Silver Cobbler Figure 2). Effort declined for 2009 and 2010 to approximately 4,000 units (100m net days) per year. However, the effort in 2011 was in excess of 7,000 units (100m net days).

The level of catch in the fishery at present is a reflection of the level of effort expended. Effort in the fishery is variable due to inconsistent fisher participation rates.

Recreational:

Charter <1 tonne

Limited data are currently available on recreational fishing in this region. The reported charter boat catch for Lake Argyle from 2002 to 2011 was less than 1 t of silver cobbler per annum. There are no data available on general angling catches. There is a bag limit of 8 fish that applies to any species in the Family Ariidae.

Fishery Governance

Commercial

Target commercial catch range: 95-155 tonnes

The current target catch range was developed by applying an autoregressive moving average control quality procedure to the annual catches from 1990 to 2002. Confidence intervals were obtained by estimating the variation of the observations compared with the variation of the predictions using the 13 years of catch data.

NORTHERN INLAND BIOREGION

Current Fishing (or Effort) Level

Acceptable

The level of catch in the fishery in 2011 is within the acceptable catch range. The lower levels of catch in the fishery in 2009 and 2010 should have allowed the breeding stock to rebuild.

New management initiatives

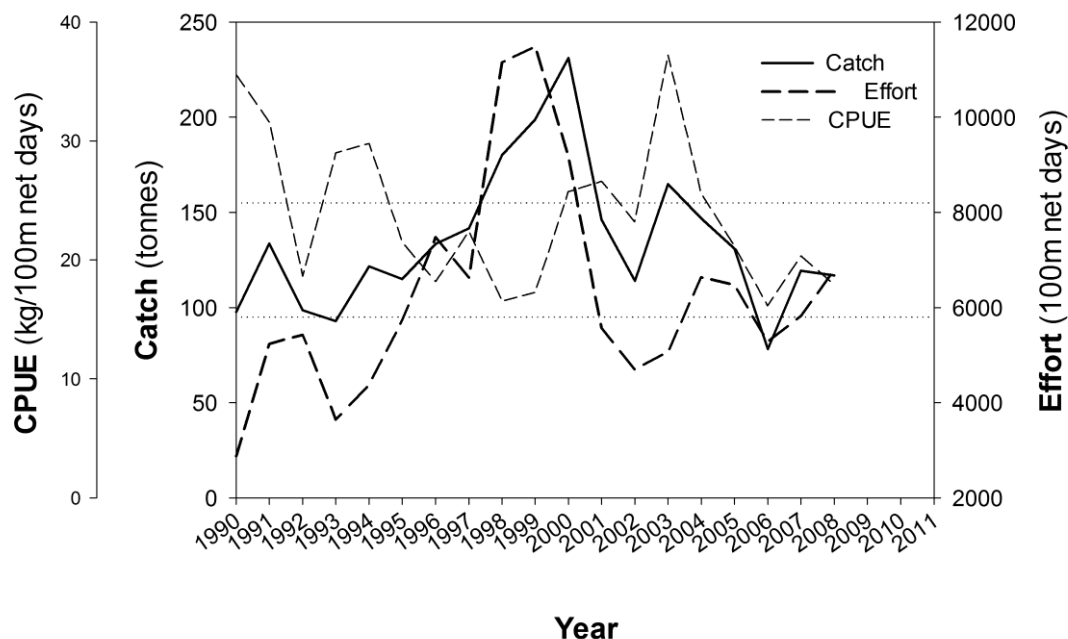
The new Order for this Fishery was gazetted in June 2012 which provided greater clarity around areas permitted to be fished. The next management review for the Fishery is scheduled for 2016/2017



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.

Lake Argyle Silver Cobbler Fishery



LAKE ARGYLE SILVER COBBLER FIGURE 2

The annual catch, effort and catch per unit effort (CPUE, kg/100 m net day) for silver cobbler in the Lake Argyle Silver Cobbler Fishery over the period from 1990 to 2008 (data since 2009 are not shown due to confidentiality requirements). The upper and lower bounds of the target commercial catch range are shown by the dotted lines.

AQUACULTURE

Regional Research and Development Overview

The outlook for significant aquaculture development in the northern inland region remains poor.

The process to identify a site to enable and support aquaculture around Lake Argyle as part of the implementation of the Ord Stage II final agreement continues to progress slowly. The issue of a lease has been delayed while the relevant group reviews its options.

A licence to produce barramundi has been issued, but is currently inactive; the licensee is also pursuing a land based

lease to support its proposed aquaculture activities. For proponents considering aquaculture in Lake Argyle, identifying a site suitable for land based support facilities has proved difficult.

A proposal to formulate a project to use aquaculture in Lake Argyle as a means to sequester carbon is being contemplated.

COMPLIANCE AND COMMUNITY EDUCATION

The Northern Inland bioregion includes the freshwater rivers, lakes, billabongs and wetlands primarily located in the Kimberley. Commercial fishing is permitted in Lake Argyle (man-made lake) and in the tidal area of the mouth of the lower Ord River.

Compliance and education for the freshwater systems in the North Inland bioregion focuses on:

- translocation inspections of non-endemic freshwater species;
- protected species interaction;
- monitoring of introduced fish species;
- aquaculture lease and licence compliance;
- localised depletion of barramundi as a target recreational species;
- cherabin catches; and
- commercial Silver Cobbler fishery in Lake Argyle.

Patrols continue to focus on the Fitzroy and Ord Rivers, due to the large number of campers and fishers accessing the inland Kimberley rivers during the peak tourism period of May to October and the area-specific barramundi size and possession limit legislation. Both the Fitzroy River and the Ord River are identified as major breeding areas for barramundi.

Officers pay particular attention to catch of any protected sawfish species, disused recreational fishing gear and localised impacts of fishers.

Activities during 2010/11

During 2010/11, Fisheries and Marine Officers (FMOs) recorded 1588 hours of active compliance patrol time in the Northern Inland bioregion – an increase compared to previous years due to the impact of the Recreational Mobile Patrol (Northern Inland Compliance Patrol Hours Figure 1).

Across the Northern Inland bioregion, personal contact was made with 4118 fishers and non-fishers across the commercial, recreational and other sectors (Northern Inland Compliance Table 1). FMOs focused on freshwater fishing compliance in areas of known high visitation or local complaints regarding illegal fishing activities.

Compliance and education was also undertaken in the Lake Argyle area, where FMOs inspected commercial silver cobbler fishers and aquaculture sites to ensure that compliance with management, protected species interaction

and environmental objectives were being met.

The Community Education Officer develops programs and coordinates delivery of education activities to school-aged children and awareness raising activities with the broader community. In-school and school holiday programs are the main method of reaching students in both the Pilbara and the Kimberley, while attendance at shows and local events target the broader community. An increased emphasis has been placed on developing materials that focus on local issues and their dissemination through regional brochure stockists and local publications.

Initiatives in 2011/12

Compliance service delivery will continue to target any areas of non-compliance and high levels of recreational fishing pressure. These locations are reviewed during annual risk-assessment processes.

The Department has established a District Office in Kununurra with one FMO who will conduct compliance Patrols with staff from other Government Agencies across the district. This presence will greatly increase the ability of the Department to effectively carry out its compliance and education program in the East Kimberley.

The Department has established a Northern Region Mobile Patrol, the patrol will be staffed by two FMO's and will focus on compliance and education of recreational fishers. A large portion of the mobile patrols time will be spent ensuring that fishers are aware of, and comply with, bag, size and possession limits relating to Barramundi, which is one of the States iconic fisheries that is primarily inland based.

Compliance activities relating to the only freshwater commercial fishery, which targets the Lake Argyle silver cobbler, will continue. The operators in this fishery are inspected to ensure that high levels of compliance and community confidence are maintained.

Improved levels of engagement with visitors, children in regional towns and remote Aboriginal communities are planned, through fishing clinics and school presentations promoting 'fish for the future' messages.

An Inland school tour will visit schools in Tom Price and surrounding towns.

The Department will deliver an extensive school holiday program in Kununurra with emphasis on disadvantaged youth as well as ongoing school initiatives in Kununurra, and a visit to the school and brochure stockists in Kalumburu.

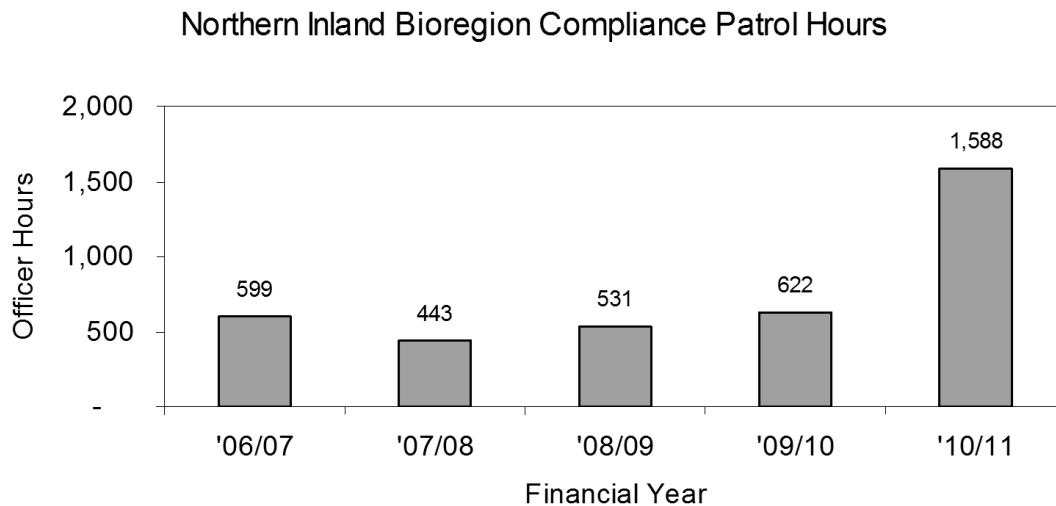
NORTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Northern Inland bioregion during the 2010/11 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	1,588 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	41
Infringement warnings	1
Infringement notices	0
Prosecutions	1
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	3,483
Infringement warnings	22
Infringement notices	28
Prosecutions	2
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	635
Fishwatch reports**	4

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

** This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors.

**NORTHERN INLAND COMPLIANCE FIGURE 1**

This figure gives the “On Patrol” officer hours showing the level of compliance patrol activity delivered to the Northern Inland bioregion over the previous five years. The 2010/11 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. The totals exclude time spent on other compliance-related tasks, e.g. travel time between patrol areas, preparation and planning time.

SOUTHERN INLAND BIOREGION

ABOUT THE BIOREGION

This region contains WA's only natural permanent freshwater rivers, which are fed by rainfall through winter and spring. These permanent rivers are restricted to the high-rainfall south-west corner of the State and flow through the significant native forest areas. Some of the rivers are more saline in their upper reaches owing to the effects of agricultural clearing of native vegetation in more inland areas.

Across the remainder of the Southern Inland bioregion, rivers flow primarily during the 3 months of winter rainfall, with very occasional summer flows from inland rain-bearing depressions resulting from decaying cyclones. Most large fresh water bodies are man-made irrigation, water supply or stock-feeding dams. There is a diverse variety of natural water bodies in this region ranging from numerous small springs and billabongs, up to Lake Jasper, the largest permanent freshwater Lake in the south west region, with 440 ha of open water up to 10 m deep. In combination these diverse natural and man-made permanent waterbodies provide valuable habitat for fish and freshwater crustaceans during the summer months. Some natural salt lakes also occur but generally dry out over summer each year.

The few natural freshwater rivers and man-made lakes support a small native fish fauna and create an environment, particularly in forest areas, which is highly valued by the community for a variety of recreational pursuits.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

While there are no commercial fisheries in the Southern Inland bioregion, this area provides significant recreational fishing opportunities. The major species fished recreationally are native marron, trout (both rainbow and brown trout) stocked by the Department of Fisheries into public dams and rivers, and feral redfin perch, an introduced, self-perpetuating stock. The native freshwater cobbler is also taken in small numbers, as are black bream artificially stocked into some inland impoundments.

Aquaculture development in the Southern Inland bioregion is dominated by the farm-dam production of yabbies, which can reach about 200 t annually depending on rainfall and market demand. Semi-intensive culture of marron in purpose-built pond systems provides around 60 t per year and has the potential to expand significantly.

Trout have historically been the mainstay of finfish aquaculture production in this region, originating from heat-tolerant stock maintained at the Department's Pemberton Freshwater Research Centre. Silver perch are also grown in purpose-built ponds to supply local markets.

ECOSYSTEM MANAGEMENT

The conservation of the 13 species of freshwater native fish in freshwater ecosystems in the south-west of WA is a growing issue for the Department of Fisheries. Many of these species are endemic to WA, and under pressure through increasing salinity, feral fish populations, infrastructure (bridges and dams) and adjacent land-use development.

The Department works with representatives from the Department of Water and the Department of Environment and Conservation, to facilitate information exchange and identify research projects and associated funding sources to mitigate environmental impacts and so better protect native fish species.

The Department also has an approval process in place for assessing proposals to translocate live non-endemic fish species into and within Western Australia, so as to minimise the environmental risks to freshwater ecosystems associated with this activity.

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets using the EBFM framework

The Department is now implementing an Ecosystem Based Fisheries Management (EBFM) framework (see How to Use section for more details). In terms of ecological assets, the Department has recognised the following ecological values for the Southern Inland Bioregion:

- Ecosystem structure and biodiversity;
- Captured fish species
- Protected species (direct impact – capture or interaction);
- External Drivers

The full set of ecological assets identified for ongoing monitoring are presented in Southern Inland Ecosystem Management Figure 1.

Risk Assessment of Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined Figure 1 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (Southern Inland Ecosystem Management Table 1) provides an overview and cumulative assessment of the current risks to the ecological assets of the Southern Inland Bioregion, at a

SOUTHERN INLAND BIOREGION

bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department's Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

Summary of Monitoring and Assessment of Ecosystem Assets

Researchers from the Biodiversity and Biosecurity Branch are involved in several research projects related to freshwater biodiversity and conservation. One of these projects has been monitoring and assisting the restoration of hairy marron (freshwater crayfish) populations in the Margaret River. The critically endangered hairy marron (freshwater crayfish) is endemic to the Margaret River. However, the common, wide-spread smooth marron was accidentally introduced to the lower reaches of the river in the early 1980s. Over time, smooth marron have replaced hairy marron, first from the lower reaches (in the 1980s), then the middle reaches (in the 1990s) and at present hairy marron are only found in significant number in the upper reaches, but together with smooth marron.

Hairy crossed with smooth marron hybrids are common in the upper reaches of the Margaret River and the hybrids are fertile and appear to have similar ecological fitness. The displacement of hairy marron by smooth marron is most likely driven by hybridization of what appear to have been two geographically distinct sub-species. Maintaining populations of hairy marron in the upper reaches of the Margaret River is vital for the conservation of the sub-species and will require ongoing removal of smooth marron in combination with re-stocking pure hairy marron from the captive breeding program.

In 2005 The Department of Fisheries was successful in obtaining a grant from the SWCC (South West Catchments Council) to collect "hairy" marron from the wild and establish a breeding program to save this rare species from extinction.

DNA fingerprinting was developed in collaboration with UWA to distinguish between pure "hairy" marron and hybrids. The DNA testing identified 230 pure "hairy" marron that were transferred to the Department of Fisheries Pemberton Freshwater Research Centre (PFRC) to establish a genetic repository of this critically endangered species. The breeding program has been very successful and has now progressed to the stage where sufficient "hairy" marron have been produced to permit restocking of the Margaret River with this critically endangered species. This will re-establish this species in its natural environment and prevent its extinction.

A further project funded by the Swan-Canning Research and Innovation Program (SCRIP) is aimed at determining the invasive potential of the feral cichlid (*Geophagus brasiliensis*) in Bennet Brook, a tributary of the Swan River. Recent salinity tolerance trials showed that this feral cichlid can easily cope with high salinities (>20 PPT). These results suggest that this feral cichlid could spread more widely throughout the Swan catchment in the future, posing a serious threat to native fish.

Most freshwater fish species are no longer present in large areas of their original range and some have been listed as critically endangered (e.g. Western trout minnow *Galaxias truttaceus hesperius*, and Margaret River marron *Cherax cainii*). While others have been listed as vulnerable to extinction (e.g. Balston's pygmy perch *Nannatherina balstoni*). This has resulted in a reduced abundance and distribution of many species in lakes, rivers and streams in the southwest bioregion. Research is ongoing into establishing production of threatened native fish species to facilitate stock enhancement in priority waterbodies in the region.

SOUTHERN INLAND ECOSYSTEM MANAGEMENT TABLE 1**RISK LEVELS FOR EACH ASSET.**

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level components. Low and Medium values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, was not generated by fishing activities.

Ecosystem Structure and Biodiversity

Ecosystem	Risk	Status and Current Activities
Riverine Ecosystems	HIGH (non fishing)	The community structure of most river and lake systems in this bioregion are substantially altered from historical levels. A survey of the main areas has been completed through a state NRM funded project with the report to be completed shortly.

Captured fish species

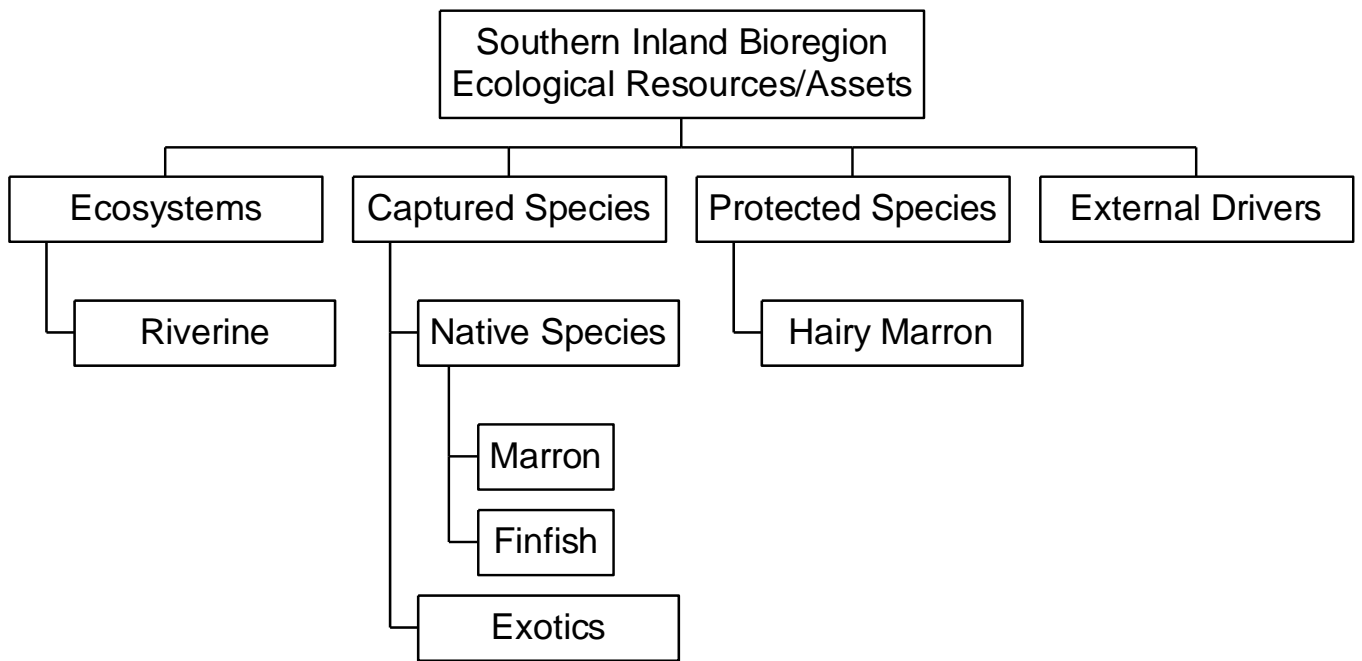
Fish species	Risk	Status and Current Activities
Finfish Native	HIGH (non-fishing)	The abundance and distribution of most native fish have been severely impacted due to reduced rainfall and land management practices. This has lead to widespread fragmentation of native fish populations (i.e. regional extinctions, which without restocking will be permanent as there is no migration between lakes or catchments) and some species are already listed in danger of extinction
Crustaceans Native	MODERATE (non fishing)	The abundance of smooth marron has been monitored at regular intervals for a number of decades. The fishery arrangements have been through a number of significant updates to ensure that the catch is sustainable. The biggest threat to these stocks is from non fishing causes.
Exotics (Stocked)	MODERATE	Trout have been stocked into a limited number of streams in WA for decades. The trout are produced from the Pemberton Hatchery and are heat tolerant.

Protected species

Protected fish species	Species	Risk	Status and Current Activities
Protected Species	Hairy Marron Western Minnow (non fishing)	SIGNIFICANT	There is a monitoring and restoration program for hairy marron and there is a captive breeding program for endangered finfish (see details below)

External Drivers (non fishing)

External Drivers	Risk	Status and Current Activities
Pests and Diseases	HIGH	A high number of exotic fish species have been released into the south west catchments. There is an assessment program underway to determine the extent of this and which of these events can be addressed by eradication.



SOUTHERN INLAND ECOSYSTEM MANAGEMENT FIGURE 1

Component tree showing the ecological assets identified and separately assessed for the Southern Inland Bioregion

FISHERIES

Licensed South-West Recreational Freshwater Angling Fishery Report: Statistics only

R. Duffy, N. Sumner and K. Walshe

Fishery Description

The south-west recreational freshwater fishery is primarily an angling fishery for rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) which are the subject of an annual controlled stocking program by the Department of Fisheries. In addition, anglers take the native freshwater cobbler (*Tandanus bostocki*) and an exotic species, redfin perch (*Perca fluviatilis*). Redfin perch were previously released in the south-west and now occur as self-breeding populations in most water bodies.

Boundaries

The south-west freshwater angling license authorizes anglers to fish for freshwater finfish species in all inland waters of Western Australia south of 29° latitude (Greenough) and above the tidal influence including all lakes, dams, rivers and their tributaries.

Management arrangements

Access to this fishery is controlled by licenses, seasonal closures, fishing gear restrictions, minimum sizes, and bag limits. People under 16 years of age are not required to hold a licence to go freshwater angling. Licensed anglers may only use a single rod, reel and line or single handline when targeting these species.

To protect newly released trout, a closed season applies from 1 May to 31 August in rivers and dams in the south-west of the State, with the exception of the Murray, Blackwood, Donnelly and Warren Rivers and sections of the Serpentine River. However, fishing for trout on the streams, brooks and tributaries flowing into these rivers is prohibited during the closed season. In addition fishing for all species is totally prohibited in Waroona Dam, Logue Brook Dam and their tributaries during the closed season.

A combined daily bag limit of 4 applies to rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), together with a minimum legal size limit of 300 mm. Waroona Dam is 'artificial lure only' (no bait areas) and a reduced bag limit (2 trout per day) also applies to this water. These measures are designed to improve the quality of the trout fishery over the spring period.

A daily bag limit of 30 applies to freshwater cobbler (*Tandanus bostocki*) when taken in the West Coast bioregion. No minimum legal size limit applies to this species. No bag limit or size limit applies to redfin perch (*Perca fluviatilis*) and anglers are encouraged not to return any redfin to the water as this feral species negatively affects the marron fishery and predated actively on trout fry.

The trout stocking program administered by the Department of Fisheries in consultation with Recfishwest, focuses on public waters where trout have been stocked or been present

since the 1930s. All trout stocked into public waters are produced at the Department of Fisheries, Pemberton Freshwater Research Centre (PFRC).

Landings and Effort

Commercial catch estimate (season 2010/11)

Not applicable

Recreational catch estimate (season 2010/11)

43,900 retained fish

An estimated total of 74,100 fish were landed in this fishery by recreational anglers in the 2010/11 season, including 43,900 retained fish and 30,200 captured and released fish. The estimated catch was composed of 10,000 rainbow trout, 1,300 brown trout, 44,600 redfin perch, 2,500 native freshwater cobbler and 15,700 black bream (Freshwater Angling Figure 1).

The overall catch for the 2010/11 season was approximately 33,000 fish lower compared to the 2009/2010 season. Landings of each species were also lower: redfin perch decreased by 40% from 74,700 fish; rainbow trout landings decreased 28% from 14,000; brown trout decreased 45% from 2,400; black bream increased 18% from 13,300 fish; and landings of native catfish decreased 26% from 3,400 fish (Freshwater Angling Figure 1).

Estimates of fishing effort are based on telephone surveys of license holders. Total effort was estimated to be 22,000 days, slightly lower than in the previous reported season (26,800 days).

A catch rate of 3.37 fish of all species per day was estimated for the 2010/11 season. This included 2.00 retained fish and 1.37 released fish per angler per day.

The stock levels of both rainbow and brown trout as indicated by catch rates and catches, have remained reasonably stable over the past ten years (Freshwater Angling Figure 1). Both species of trout display little or no breeding in local waters and the fishery is supported through the stocking of fry, yearling and ex-broodstock trout by the Department of Fisheries. Red-fin perch breed in all waters, and often dominate the biomass where introduced. The management arrangements (e.g. minimum legal size, bag limit) for native freshwater cobbler are currently under review based on historical and recent scientific data.

Fishery Governance

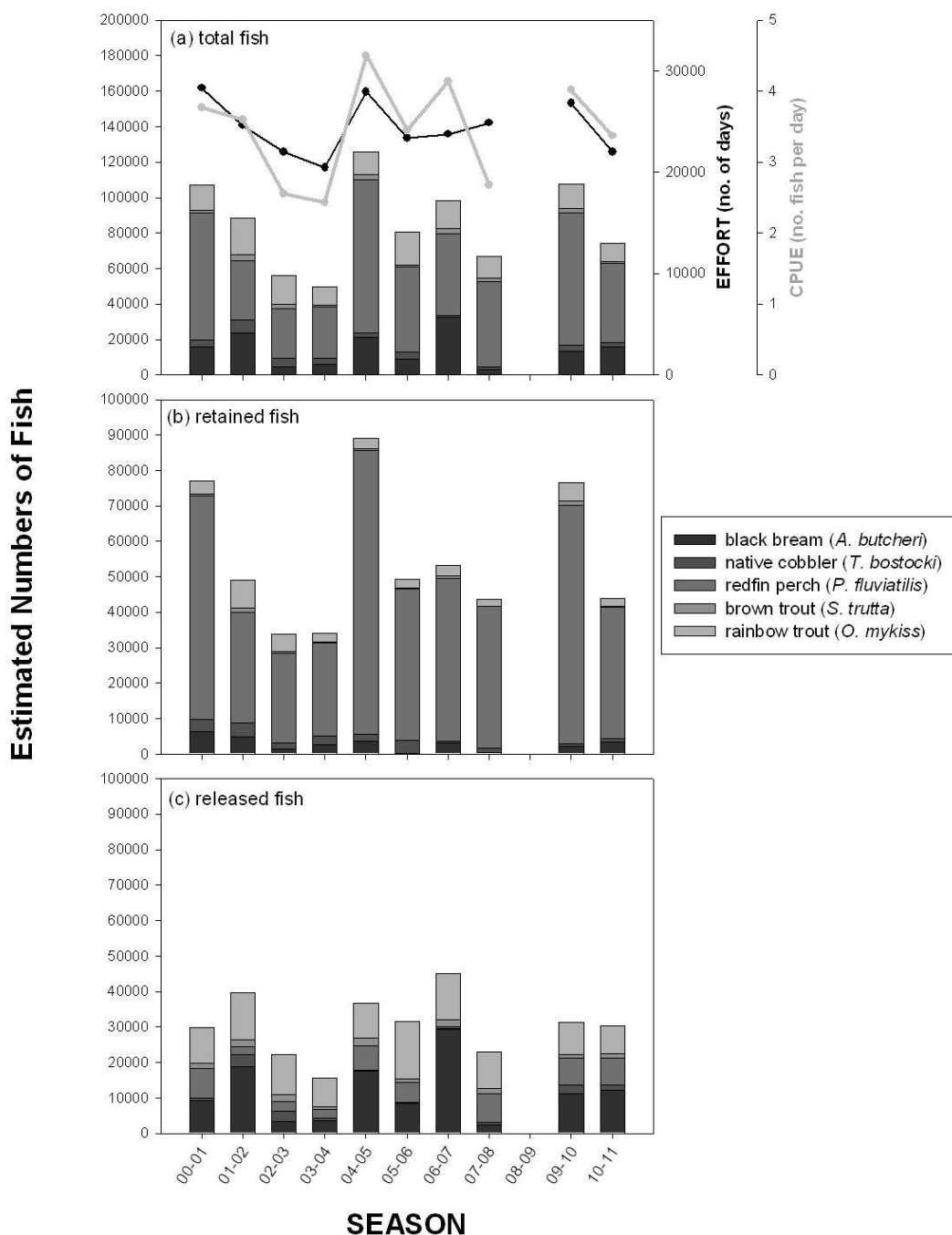
Target catch (or effort) range **Not applicable**

Current fishing (or effort) level **Not applicable**

New management initiatives (2010/11)

Baltson's Pygmy Perch (*Nannatherina balstoni*) and Western Trout Minnow (*Galaxias truttaceus hesperius*) are native freshwater fish species found in waters of the South West of WA that are both listed under the EPBC Act (1999) as

Critically Endangered. In response to the threatened status of these native fish species, the Department of Fisheries is currently developing a strategy to minimise the impacts of trout stocking on threatened native fish species.

**FRESH WATER ANGLING FIGURE 1**

Estimates of the development of total catch, effort and CPUE (a) and total numbers of fishes retained (a) and released (b) by species in the south-west freshwater angling fishery since the 2000-01 season.

Licensed Recreational Marron Fishery Report

R. Duffy, N. Sumner and K. Walshe

Main Features

Status		Current Landings	
Stock level	Adequate	Commercial	nil
Fishing level	Acceptable	Recreational catch estimate	74,400 marron

Fishery Description

Marron are endemic to Western Australia and are the third largest crayfish in the world. Recreational fishing occurs in freshwater dams and rivers throughout the southern part of the State extending from as far north as Geraldton, to Esperance in the east. Fishers may only use legal scoop nets, drop nets or snares to take marron.

Governing legislation/fishing authority

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation

Marron Recreational Fishing Licence

Consultation process

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

Boundaries

The recreational marron fishery extends from the Hutt River north of Geraldton to waters near Esperance. The fishery operates in freshwater dams and rivers, although drinking water supply dams servicing the Perth metropolitan area and southwest regional centres are closed to the public by the Water Corporation.

Management arrangements

This fishery is managed through input controls of licences, closed seasons and gear restrictions, and the output controls of size and bag limits (see <http://www.fish.wa.gov.au/>).

All marron fishers require a special marron recreational fishing licence. For the 2011 season, licensed fishers were permitted to fish for marron from 8th January to 5th February 2011. Three types of legal gear exist; scoop nets, drop nets and snares. In most waters there is a minimum size of 80 mm carapace length and a bag limit of 10 marron per day. However, Harvey Dam, Waroona Dam and Hutt River are managed as snare only 'Trophy Waters' with a minimum legal size of 90 mm carapace length and a daily bag and possession limit of 5 marron.

Research summary

Detailed research on the marron stocks in south-west rivers has been undertaken since the 1970s. Current research involves the annual scientific monitoring of stock levels before the summer fishing season, surveys of catches taken by recreational licence holders and volunteer logbook holders and biological characteristics (growth, size-at-maturity, fecundity etc) of key marron populations in different catchments. These data enable trends in stock levels to be monitored and recommendations to be made for adjustments to fishery management when necessary. The following status report is based on these research findings.

Retained Species

Commercial landings: Nil

Recreational catch estimate (season 2011)

74,400 marron

The total marron catch for the 2011 season was estimated at approximately $74,400 \pm 7,100$ standard error (SE) marron (See Fig. 1). This is a decrease of ~25% compared to the previous season (2010: $102,900 \pm 9,400$ marron). The decrease in catch in numbers is due to a decrease in effort and catch rate. The catch for 2011 is below the target catch range (see Fishery Governance below).

The overall CPUE (dams and rivers combined) recorded by fishers, based on phone surveys, was 3.6 marron per fisher per day. This is lower than the CPUE for the previous season of 4 marron per fisher per day, although it has been relatively stable since 2004.

Total effort for the 2011 season was estimated from phone surveys at around 21,500 days. Fishing effort was slightly lower than the previous season of 25,700 days. The number of participating fishers was stable from 2009 to 2010 (~8800). The average number of fishing days per fishermen increased to 3.6 days, higher than the 2009 (2.9 days) to 2010 (2.93 days) days.

In 2011, dams received an average proportion of total effort (25%), down from last year's high of 40%. Effort is widely spread among the rivers in the South-West. The Collie River (~26%) is the most popular site, followed by the Blackwood River (~23% effort) and the Warren River (~11%). The Murray, Preston and Donnelly rivers all received similar amount of effort of between 4 and 7%.

Stock Assessment

Assessment complete: Yes

Assessment Method and level:

Level 4 - Fishery Independent Direct Survey

Breeding stock levels: Adequate

Fishery-dependent catch and effort data (e.g. CPUE as determined by logbook or phone survey) can be poor indicators of true stock abundance especially in heavily managed fisheries (i.e. those with seasons, bag limits, size limits and gear restrictions) like the Recreational Marron Fishery. In 2006 a new stock assessment program using traps was initiated that provided fishery-independent data on relative abundance and average size (mm Orbital Carapace Length [OCL]) of marron in three dams (Waroona Dam, Wellington Dam, Harvey Dam) and eight rivers (Shannon, Warren, Donnelly, Blackwood, Preston, Collie, Murray and Moore River). These three dams and eight rivers account for more than 75% of the total fishing effort of the Recreational Marron Fishery (see Fig. 2).

The annual fishery-independent survey provides vital data for monitoring trends in stocks, evaluating the performance of changes in management on stocks and will allow for recommendations to be made for adjustments to the management of the fishery when necessary.

Relative abundance and size of marron varies greatly spatially among the surveyed rivers and dams (Fig. 3). Size of animals in most locations has stayed relatively stable. The abundance of marron is also relatively stable, however, abundance of animals in Wellington Dam is decreasing. The decrease is most likely due to reductions in available habitat resulting from decreased dam volume as a result of limited rain.

In addition to data on abundance and size, the annual fishery independent survey also provides information on size-at-maturity and fecundity for each of the rivers and dams. From the locations surveyed, the current breeding stock levels appear adequate (based on typical size-at-maturity). Size-at-maturity, i.e. size at which 50% of the females are mature, seems to be below the minimum legal size of 80 mm Rostrum Carapace Length (RCL) for the majority of marron stocks in the south-west (e.g. Warren River ± 56 mm RCL, Murray River ± 54 mm RCL, Collie River ± 42 mm RCL, Preston River ± 60 mm RCL, Waroona Dam ± 63 mm RCL, Drakesbrook Dam ± 31 mm RCL, Wellington Dam ± 54 mm RCL). Present size restrictions seem to adequately protect the majority of the female breeding stocks. The exception with regards to size-at-maturity are the stocks in Harvey Dam and Hutt River, where a larger female size-at-maturity of about 85 mm and 95 mm, respectively, occurs. A larger minimum legal size of 90 mm RCL has been introduced to protect the breeding stocks and these water bodies are managed as 'Trophy' waters.

A tagging program may be incorporated in the annual fishery-independent stock assessment, to obtain information on growth and mortality of marron in the different rivers and dams and to aid with abundance calculations.

Non-Retained Species

Bycatch species impact: Negligible

The marron fishery does capture small quantities of non-target species, principally gilgies (*Cherax quinquecarinatus*, *C. crassimanus*) and koonacs (*C. plebejus*, *C. glaber*). Although little is known about their biology, the impact of the marron fishery on these species is thought to be low as gilgies and koonacs are smaller than marron and are not targeted by marroners.

Protected species interaction: Negligible

A second type of marron has been identified ('Hairy' marron) which is threatened mainly by the extension in range of the more common 'Smooth' marron, which is the basis of the recreational marron fishery. In late 2002, recreational marron fishing upstream of Ten Mile Brook Junction (including all its tributaries) on the Margaret River was prohibited to remove the impacts of fishing on the remaining 'Hairy' marron stocks. However, illegal fishing is still reported in this reach of the Margaret River. A recovery plan, developed jointly between the Department of Fisheries, the Department of Environment and Conservation, and other stakeholders on the recovery team is underway for the 'Hairy' marron.

Ecosystem Effects

Food chain effects Low

The removal of legal-sized marron from freshwater rivers is unlikely to have a significant effect, noting that the bulk of the marron biomass is below legal size and that marron of all sizes have similar food and habitat requirements. Marron taken from man-made dams are already living in highly modified habitats, as such their removal does not significantly impact on natural freshwater ecosystem function.

Habitat effects Negligible

The impact of this fishery on the aquatic habitat is negligible. The major effects are litter in surrounding areas and the trampling of areas of riparian vegetation by marroners and subsequent bank erosion.

Social Effects

The marron fishery is an iconic fishery and a major recreational activity in regional areas of the south-west of the State. The effect of rainfall on the availability of marron habitat is expected to increase awareness of changes in climate patterns in the south-west.

Economic Effects

Recreational

While a dollar value is difficult to assign to recreational catches, the availability of quality fishing underpins the tourism industry and generates significant income for the regional economy.

Fishery Governance

Target catch (or effort) range

96,000-136,000 marron

In 2006, the Recreational Freshwater Fisheries Stakeholder Subcommittee (RFFSS) proposed that, based on the available research data and the knowledge of the marron fishery, the fishery be managed to a maximum target catch of between 96,000-136,000 marron. Effort has steadily increased since 2003 with a proportionate increase in catch. In 2007 the marron season was increased from 16 to 23 days. The season was increased to 29 days in 2009 with fixed dates whereas previously seasons varied each year to match with lunar cycles. Assuming relatively stable marron abundance, a limited growth in the fishery is allowed while maintaining catches at a sustainable level. Variations in marron abundance (fishery independent surveys) and marron catches (phone survey) will be monitored to determine the impact of the changes in season length and increase in legal minimum size.

In 2011 the Department reviewed the current Shannon river closure which is closed to provide a representative river system where researchers can assess the role of environmental factors on marron populations. It was decided that the closure should continue as it provides valuable data for marron fishery management.

Current fishing (or effort) level

Acceptable

Fishing effort has been low under current management arrangements. Since 2003 when the reduced 16 day season was introduced effort (fishing days) dropped considerably from ~40,000 fishing days (2000-2002) to ~11,000 fishing days (2003-2006). The season length was extended from 16 to 23 days in 2007 and a significant increase in effort from ~11,000 (2003-2006) to ~17,000 fishing days (2007-2008) was observed. The effort for 2011 was 21,500 fishing days with a 29 day season.

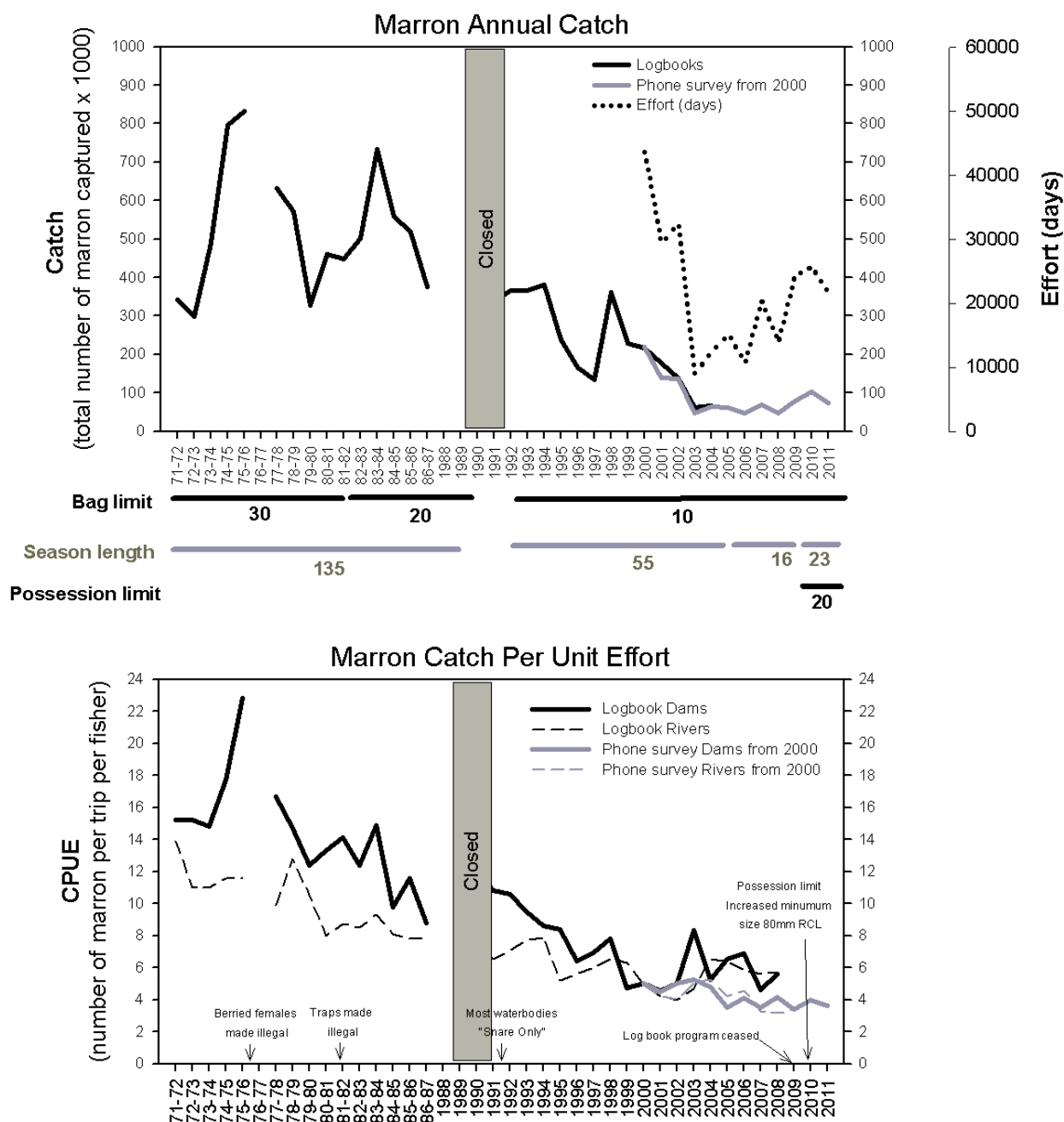
New management initiatives (2012/13)

For 2012 the marron season will start on 08 January and run for a 28 day period until 05 February. Fisheries managers and scientists will continue to monitor the impact of changing rainfall patterns in the south-west on marron populations. As a result of this monitoring and discussions with stakeholder groups, it was decided a precautionary approach would be taken and the 2012 daily bag limit would be reduced from 10 to 8 animals per licensed fisherman.

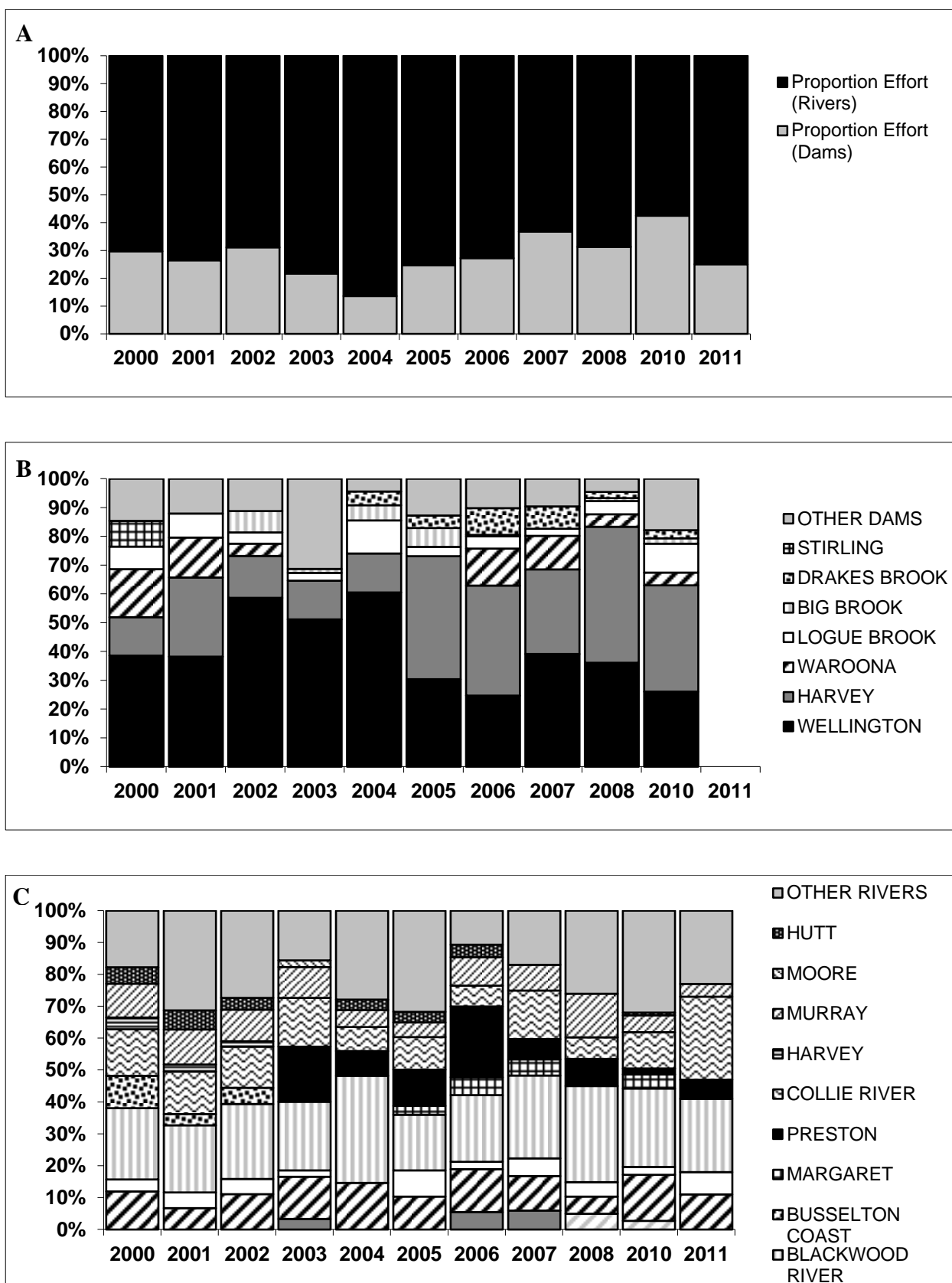
In 2012 the Department will add a water storage dam that is not open to recreational fishers to its annual survey. The aim of this is to provide a measure of natural fluctuations in marron populations independent of fishing pressure.

External Factors

Winter rainfall plays a major role in marron reproduction, growth and survival. Rainfall increases the quality of areas for marron by transporting leaf-litter into streams (providing food sources for marron growth and reproduction) and by maintaining water volume and quality. A second major issue in this fishery is access to irrigation dams. The Water Corporation closed access to Stirling Dam in 2001 and Logue Brook Dam in 2008 to divert the water to the metropolitan water supply, and there is a strong possibility of limitations to fishing in Wellington Dam in the near future. Drakesbrook Dam, due to maintenance work, is expected to be unavailable for recreational marron fishing in 2012 to possibly 2013. The Department of Fisheries has developed a memorandum of understanding (MOU) for working with the Water Corporation to ensure the refurbished and refilled dams will provide a high-quality marron fishery by installing refuges, adding marron and controlling introduced species.

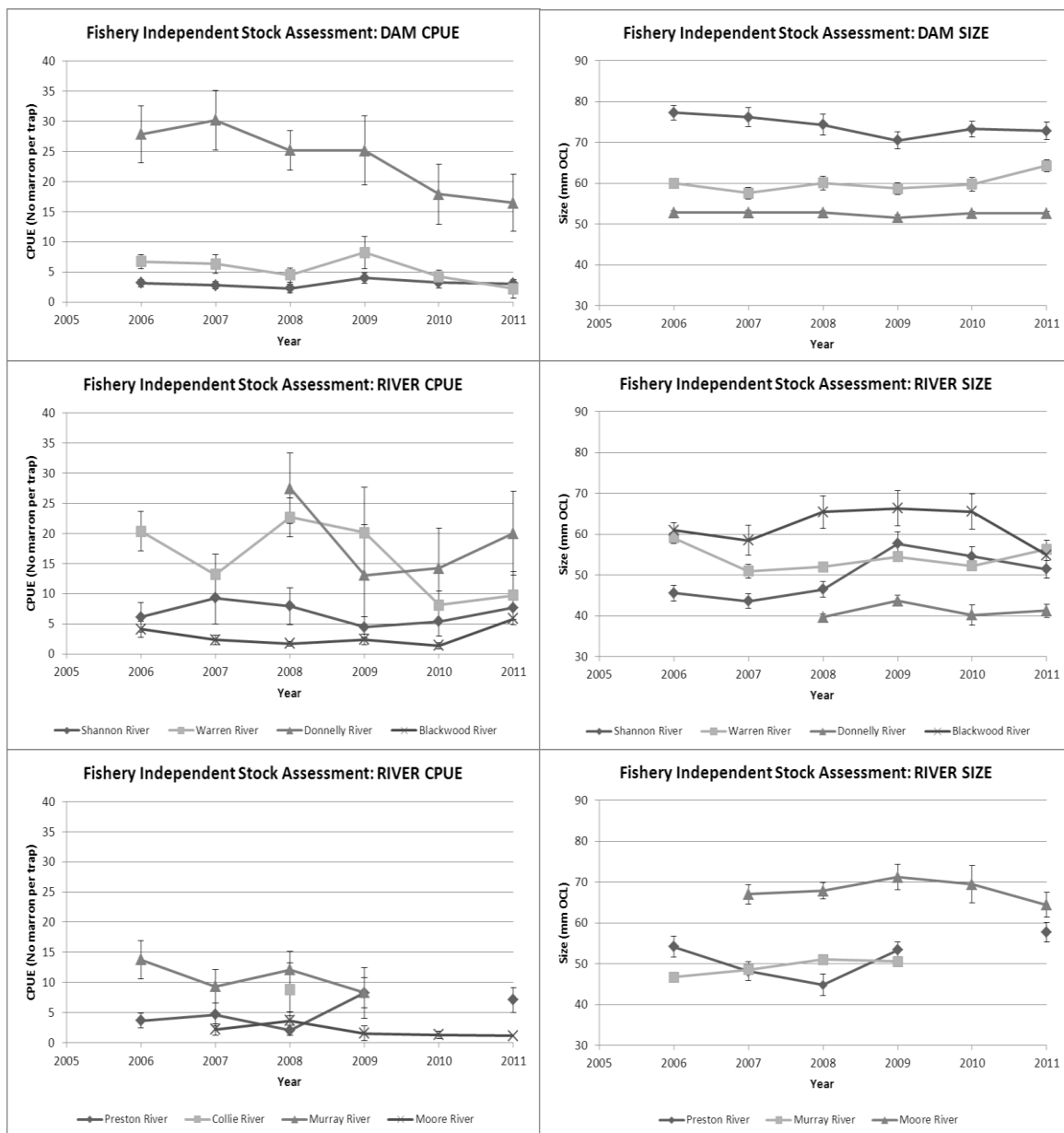
**RECREATIONAL MARRON FIGURE 1**

The estimated total catch (a) and catch per unit effort (b) of the recreational marron fishery between 1971 and 2011.



RECREATIONAL MARRON FIGURE 2

The distribution of effort over (a) rivers and dams, (b) among dams and (c) among rivers of the recreational marron fishery between 2000 and 2011. An exact breakdown of fishing effort for dams was not possible due to changes to licensing.



RECREATIONAL MARRON FIGURE 3

The relative abundance (CPUE) and size (mm OCL) of marron in three dams and eight rivers as determined by the fishery-independent stock assessment. Note: Values may be missing for a year if the site was not able to be sampled.

AQUACULTURE

Regional Research and Development Overview

Previous research undertaken at the Pemberton Freshwater Research Centre focused on marron husbandry and selective breeding research for yabbies and marron.

Industry sectors continue to apply the results of previous research, on the use of grains in aquaculture feeds, to commercial operations. Current research is focusing on

captive breeding programs for conserving endangered marron and native fish.

The Pemberton Freshwater Research Centre continues to be a major supplier of trout fingerlings to the aquaculture industry and for recreational fisheries restocking.

COMPLIANCE AND COMMUNITY EDUCATION

Fisheries and Marine Officers (FMOs) based in Geraldton, Dongara, Jurien, Lancelin, Hillarys, Fremantle, Rockingham, Mandurah, Bunbury, Busselton, Albany and Esperance conduct recreational fishing compliance and education activities in the Southern Inland bioregion.

The highest risk of non-compliance in the Southern Inland bioregion is within the recreational marron fishery. As the marron season lasts for just 28 days, (8 January to 5 February), the risk of illegal fishing during the closed season is high. This illegal fishing is particularly high during the period from September to December, after the winter rains and prior to the next season opening.

Increasingly, dams and catchment areas once open to marroning are being closed by the Water Corporation, which presents further challenges to ensure compliance in these areas. A number of Water Corporation Rangers have been authorized as honorary FMO's to assist with the compliance of illegal fishing on Water Corporation dams. Some DEC officers have also been authorized as honorary FMO's and play an important role in the marron compliance throughout the South West. During the open marron season, illegal activities (such as the use of scoop and drop nets in 'snare only' waters, take of undersize marron, and adherence to possession limits, particularly in trophy waters such as Harvey Weir) are a focus of compliance activities. FMOs continue to carry out joint initiatives with police to investigate the theft of marron from private properties and licensed aquaculture sites.

The other main fishery in the Southern Inland bioregion is the recreational trout fishery. Compliance and Education in this fishery focuses ensuring compliance with bag limits, fishers hold a current freshwater recreational fishing licence, and line fishing does not occur during the closed season.

Compliance patrols for the other recreational fisheries in these inland areas, as well as inspections of fish wholesale and retail premises also form part of the compliance activities conducted by FMOs in the Southern Inland bioregion.

Commercial fishing activity in rivers is also included in the Southern Inland bioregion and some compliance patrols target fishing activity in the West Coast and South Coast estuarine fisheries. The compliance effort in these fisheries focuses mainly on closed waters, setting times, net lengths

and licensing.

Activities during 2010/11

During 2010/2011, FMO'S delivered 2283 hours of compliance patrol hours to the Southern Inland bioregion (Southern Inland Compliance Table 1) – which is an increase from the 1650 compliance hours delivered in the previous year (Southern Inland Compliance Figure 1).

Officers conducted patrols throughout the bioregion in vehicles, dinghies and canoes, making 2744 field contacts with recreational fishers and 80 contacts with commercial operators. During the year, 60 infringement warnings and 30 infringement notices were issued with 96 prosecutions instigated for recreational offences.

The marron fishery continues to be the major focus for the compliance and education program in this bioregion. The 2010 marron season was the last year of the five year marron management strategy, public acceptance of the new rules is good and catches generally do not seem to have changed greatly in most areas. As was the case in 2010 the compliance activities for the 2011 marron season were developed from a risk assessment process, and targeted areas of high risk identified through that process.

Aquaculture compliance activities (classified as 'commercial' In Table 1) are also a major focus in the Southern Inland bioregion for FMOs. Activities mainly involve inspection of aquaculture facilities, oversight of broodstock collection to ensure compliance with exemption conditions, and inspection of proposed aquaculture sites to ensure that the harvesting does not affect the wild stocks in WA waters. FMO's also carry out joint patrols with police to investigate theft from farm dams.

Initiatives for 2011/12

Joint operations with regional Water Corporation Rangers and DEC officers will continue during 2011/2012. These joint patrols will increase the compliance presence in the marron fishery and the expert knowledge the Water Corporation rangers have of the dam areas and activities greatly assist in the compliance operations.

SOUTHERN INLAND BIOREGION

Poaching of wildstock marron during the closed season and theft of marron from dams on private property and aquaculture facilities will be a focus for compliance activities. District FMOs will also continue to work in partnership with local police to develop joint initiatives, facilitate the transfer of intelligence information and respond to compliance situations.

The Community Education team's activities will target recreational fishers prior to the start of the marron fishery and the delivery fisheries programs to school children and the public. The awareness of freshwater biodiversity posed and the threat posed by introduced species will also be promoted. The Community Education Team will maintain partnerships with natural resource management groups and the community to enable a holistic approach to catchment management and issues facing the sustainability of freshwater species.

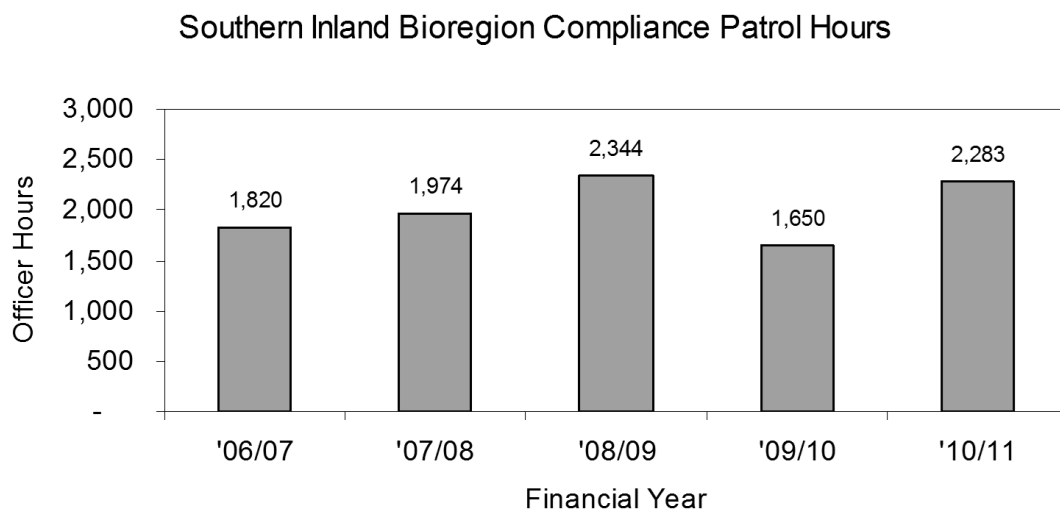
SOUTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Southern Inland bioregion during the 2010/11 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,283 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	80
Infringement warnings	6
Infringement notices	10
Prosecutions	58
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	2,744
Infringement warnings	60
Infringement notices	30
Prosecutions	96
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	398
Fishwatch reports**	55

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

** This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors.



SOUTHERN INLAND COMPLIANCE FIGURE 1

In this figure, “On Patrol” Officer Hours shows the level of compliance patrol activity delivered to the Southern Inland bioregion over the previous five years. The 2010/11 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. The totals exclude time spent on other compliance related tasks, e.g. travel time between patrol areas, preparation and planning time.

STATEWIDE

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Statewide Ecological Assets using the EBFM framework

While the bioregional scale of management has been adopted by the Department through the implementation of an Ecosystem Based Fisheries Management (EBFM) framework (see How to Use section for more details), due to their life histories or broader impacts, a small number of ecological assets cannot realistically be managed at a single bioregional level but need to be considered at either a statewide or at a multiple bioregional level.

Risk Assessment of Statewide Ecological Assets and External Drivers

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined Figure 5 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (Statewide Ecosystem Management Table 1) provides an overview and cumulative assessment of the current risks to those ecological assets that function at a statewide level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These level risks are now used by the Department as a key input into the Department's Risk Register which, combined with an assessment of the economic and social values and

risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions for Statewide Issues.

Summary of Monitoring and Assessment of Statewide Assets

The Department is working closely with the Commonwealth Government and other jurisdictions to develop and implement the National System for the Prevention and Management of Marine Pest Incursions that will minimise the biosecurity risks associated with increased shipping in all parts of the State. Within WA, this will be achieved through the Fish Resources Management Act 1994 and the Biosecurity and Agriculture Management Act 2007. Associated regulations and subsidiary legislation are currently being developed. Work has also been undertaken to develop monitoring designs for introduced marine species for most of the key Ports in WA. The design has been developed in conjunction with the Invasive Marine Pests Program within DAFF (Department of Agriculture, Fisheries and Forestry). This work is expected to contribute to introduced aquatic organism incursion and fish kill incident response programs already in place.

The Department of Fisheries' Research Division's Biodiversity and Biosecurity Branch recognises that the vast and remote coastline of the region dictates that remote sensing (satellite imagery and aerial photography) will be the primary tool for resource condition monitoring. The development of new Marine Parks across the State has brought an increased requirement for ecosystem resource condition monitoring in order to underpin effective management of these protected areas. Future directions of research will therefore concentrate on developing remote sensing as a monitoring tool, and developing a suite of resource condition indicators that accurately portray the health of the numerous marine and coastal environments.

STATEWIDE ECOSYSTEM MANAGEMENT TABLE 1 - RISK LEVELS FOR EACH ASSET.

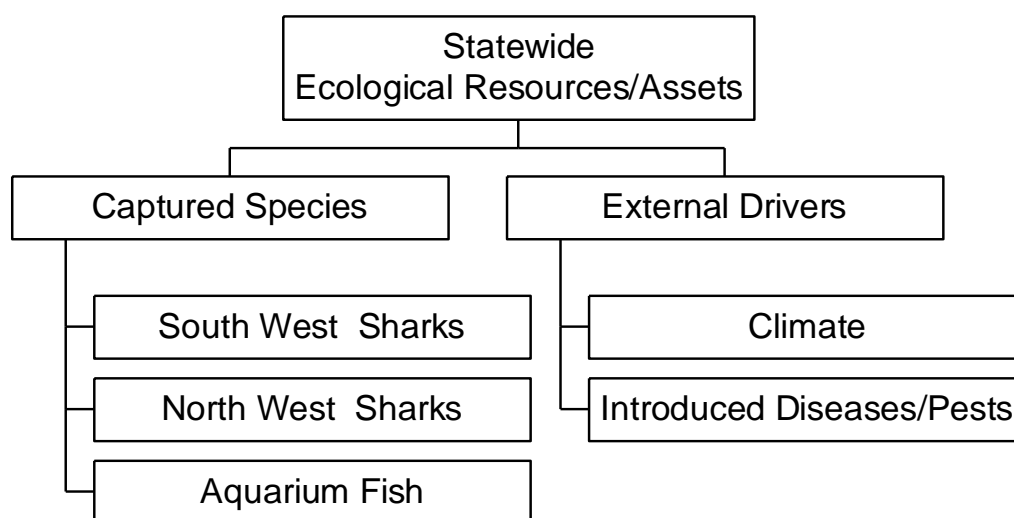
Low and Medium values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required.

Captured fish species

Fish species	Aquatic zone	Risk	Status and Current Activities
Sharks	South and lower west	MODERATE	The stock levels of most sharks in these regions are now either at acceptable levels or are deemed to be recovery at acceptable rates following management intervention.
	Mid West – North	HIGH	The stocks levels of some sharks in these regions are at unacceptable levels or have a high level of uncertainty. Some of these risks are being by fishing that is occurring outside of the direct jurisdiction of WA. The State based fisheries for these assets is currently being reviewed and no catches by these fisheries were recorded during the past season.
Aquarium Fish	Marine	LOW	The level of capture is low and the management restrictions are such that that these species are not at risk.

External Drivers (NON FISHING)

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	HIGH	There is a high risk that some exotic species will be introduced into the state through the increasing levels of international shipping that is occurring at ports around the country. Many of these pest species are capable of invading beyond a single bioregion.
Climate	MODERATE in short term HIGH in Medium term	The predictions for impacts of climate change affecting the Statewide ecosystems and process are moderate in the short term. The risk escalates to a higher level in the medium term.

**STATEWIDE ECOSYSTEM MANAGEMENT FIGURE 1**

Component tree showing the Statewide ecological assets and external drivers identified and separately assessed.

FISHERIES

Marine Aquarium Fish Managed Fishery Report: Statistics Only

S.J. Newman, C. Bruce, C. Syers and H. Zilles

Fishery Description

Commercial

The Marine Aquarium Fish Managed Fishery (MAF) has the capacity to target more than 250 species of finfish under the management plan. However, the number of species targeted and/or landed by the fishery varies from year to year (e.g. in the period from 2005 to 2011 the number of species landed ranged from 183 to 288). By way of a Section 43 Order and Ministerial Exemption, fishermen also take coral, live rock, algae, seagrass and invertebrates. It is primarily a dive-based fishery that uses hand-held nets to capture the desired target species that operates from boats up to 8 m in length. While the MAF operates throughout all Western Australian waters, catches are relatively low in volume due to the special handling requirements of live fish. Fishing operations are also heavily weather-dependent due to the small vessels used and the potentially hazardous conditions (e.g. waves, swell) encountered. In addition, human constraints (i.e. physiological effects of decompression) limit the amount of effort exerted in the fishery, the depth of water and the offshore extent where collections can occur.

Recreational

There is no documented recreational fishery. If members of the public wish to collect specimens for their own private aquariums they are permitted to do so, but are restricted to normal recreational bag limits and, for some species, size limits. There is a complete ban on the recreational take of coral, live rock and protected fish such as leafy and weedy seadragons.

Boundaries

The MAF operates in Western Australia's state waters spanning the coastline from the Northern Territory border in the north to the South Australian border in the south. The effort is spread over a total gazetted area of 20,781 km². During the past three years the fishery has been active in waters from Esperance to Broome with popular areas being around the Capes region, Perth, Geraldton, Exmouth and Dampier.

Management arrangements

This fishery is managed primarily through input controls in the form of limited entry to the fishery and permanent closed areas. There are 12 licences in the fishery following the cancellation of 1 licence in 2009 in response to the expansion of the Ningaloo marine reserve. In 2011, 10 licences operated in the fishery.

Licencees are not permitted to operate within any waters closed to fishing (e.g. Rowley Shoals, Reef Protected Areas, sanctuary zones). The fishery is permitted to operate in general-purpose zones of marine parks for the collection of fish and some invertebrates (usually excluding coral and live rock). Fishing is also prohibited on Cleaverville Reef in order to exclude the take of coral and associated organisms.

Fish caught in this fishery may not be used for food purposes, and operators are not permitted to take species covered by other specific commercial management arrangements or management plans.

The MAF is permitted to take most species from the Syngnathid family (seahorses and pipefish), which are listed under the *Environment Protection and Biodiversity Conservation Act 1999*. However, there is a total ban on the take of leafy seadragons (*Phycodurus eques*). If the current ESD trigger value of 2,000 individual syngnathids is reached, a review will be initiated, and the results used to determine whether further management action is required.

Landings and Effort

Data for assessing the status of the MAF are derived from the catch and effort returns provided by industry. These data are compiled annually and used as the basis for this assessment. In 2011, only 96% of the catch returns were available for the MAF (4% of returns were outstanding) and as such, this report is based only on these submitted returns.

A total of over 19,776 fish were landed in 2011. Collectors in this ornamental fishery can earn a high return from the capture of very small quantities of individuals. Therefore, the catches are small in comparison to the more common, food-fish fisheries. Fishers report the level of catch as either - kg, numbers or litres depending upon the species or species group involved (Marine Aquarium Fish Table 1). The reported landings of aquarium fish for 2011 were higher than those reported in 2009, but lower than those reported in 2010. The syngnathid catch was low and stable between 2009 and 2010 (i.e. 340 and 338 respectively). However, the syngnathid catches in 2011 have increased to catch levels similar to those reported in 2008 (i.e. 1,218 (2008) and 1,138 (2011)).

Effort in the fishery has decreased from 981 (2007) and 932 (2008) fishing days to 639 fishing days in 2009, 533 fishing days in 2010 and 502 fishing days in 2011, with 10 licences reporting some level of activity (Note: the 2011 effort data is complete). Effort in the fishery is concentrated in a number of discrete areas adjacent to the limited number of boat landing sites along the Western Australian coastline.

The level of effort in the MAF includes the effort of both MAF licensees and also those fishers that hold an exemption authorisation to collect land hermit crabs, *Coenobita variabilis*. In 2011, of the 5 land hermit crab exemption holders, 4 collectors reported some level of activity.

Given that the specimens are collected for a live market, licences are restricted in terms of the quantities that they can safely handle and transport (for example, by boat to shore, by vehicle to the holding facility and then on to the retailer) without impacting on the quality of the product. The size of the holding facility and access to regular freight and

infrastructure services (such as airports, particularly in the remote northern locations of WA) restricts the levels of effort that can be expended in the fishery at any given time.

The performance measures for the fishery relate to the catch of the syngnathids. The MAF is permitted to take species from the syngnathid family (seahorses and pipefish), which are listed under the Environment Protection and Biodiversity Conservation Act 1999, from state waters only (within 3nm). In 2011, the catch of syngnathids was 1138. The catch level of syngnathids has significantly increased from 2009 and 2010 levels (340 and 338, respectively). The catches of syngnathids have returned to catch levels similar to those reported in 2008 (1,218). (Note, that there is a prohibition on the take of leafy seadragons (Phycodurus eques) in the MAF.

Fishery Governance

Target commercial catch range:

2000 Syngnathids

Current Fishing (or Effort) Level: Acceptable

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

New management initiatives (2011/12)

In August 2011 an application for reassessment of the MAF as ecologically sustainable under the provisions of the EPBC Act 1999 was submitted to SEWPaC. This application was unsuccessful and the Wildlife Trade Operation (WTO) for the MAF expired on 24 October 2011, meaning any species taken in the fishery after this date is no longer able to be exported. The application for reassessment was unsuccessful due to the increased assessment and reporting requirements for the take of species listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The Department of Fisheries will be working with MAF licence holders and SEWPaC on requirements to gain a new WTO approval for the fishery in 2012-13.

MARINE AQUARIUM FISH TABLE 1

Summary of the reported catch landed from the Marine Aquarium Managed Fishery and associated endorsements in 2011.

Common Name	Quantity (numbers)	Weight (kg)	Litres (l)
Fish	19,776		
Syngnathidae (not included in Fish)	1,138		
Hermit crabs (land hermit crabs only - <i>Coenobita variabilis</i>) ¹	75,667		
Invertebrates	24,455		
Algae			147
Hard coral		4,082.55	
Soft coral ²		4,247.60	
Living rock		13,559	
Sponges	2,444		

¹ This total includes both MAF licensees and also those fishers that hold an exemption authorisation to collect land hermit crabs - *Coenobita variabilis*.

² The soft coral category includes 3,945kg of coral like anemone groups such as corallimorphs and zooanthids in the Class Anthozoa. These are harvested under an invertebrate Ministerial Exemption and are not part of the annual coral TAC.

Specimen Shell Managed Fishery Status Report

A. Hart, C. Bruce, C. Syers and H. Zilles

Main Features

Status		Current Landings	
Stock level	Adequate	Specimen Shell Catch Total	
Fishing level	Acceptable	Shell numbers	14,874 shells

Fishery Description

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

More than 200 different shellfish species are collected by using a variety of methods. The main methods are by hand by a small group of divers operating from small boats in shallow coastal waters or by wading along coastal beaches below the high water mark. A new Exemption method being employed by the fishery is using a remote controlled underwater vehicle at depths between 60 and 300 m. While the fishery covers the entire Western Australian coastline, there is some concentration of effort in areas adjacent to population centres such as Broome, Karratha, Exmouth, Carnarvon, metropolitan Perth, Mandurah, the Capes area and Albany.

Governing legislation/fishing authority

Specimen Shell Management Plan 1995

Specimen Shell Managed Fishery Licence

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

Consultation process

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

Boundaries

The fishing area includes all Western Australian waters between the high water mark and the 200 m isobath.

Management arrangements

This fishery is managed through input controls in the form of limited entry, gear restrictions and permanent closed areas. The primary controls in the fishery are operational limitations – depth, time and tide.

This is a limited entry fishery with 32 licences in the fishery, with 19 of the licences being active. Furthermore, a maximum of 2 divers are allowed in the water per license at any one time and specimens may only be collected by hand.

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

The SSF is not permitted to take any mollusc species for which separate management arrangements exist – such as abalone, mussels, scallops and pearl oysters.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of specimen shell species. Boxed text in this status report provides the annual assessment of performance for this issue.

Some minor-scale collection of dead shells is also undertaken above the high water mark by collectors operating under the authority of a commercial fishing licence, mainly for sale into the souvenir, pet supply and hobby craft markets. However, this activity does not form part of the Specimen Shell Managed Fishery.

Research summary

Current fishery-dependent data collection systems monitor the catch (species-specific), effort and catch rates for the fishery. Fishers within the SSF provide monthly returns under the statutory catch and effort system (CAES). These returns contain information on catch (species, numbers and spatial area), and days and hours fished by month and year.

In August 2004, fishers commenced reporting using 10 x 10 nautical mile (nm) grids rather than 60 x 60 nm grids, providing a finer spatial scale to the data collected. At the same time, they began collecting additional information on sightings of the 8 mollusc species identified as potentially 'vulnerable.' These data are used as the basis to provide research advice for fisheries management.

Retained Species

Commercial landings (season 2011):

14,874 shells

Recreational catch estimate (season 2011):**Unknown****Commercial Landings**

In 2011, the total number of specimen shells collected was 14,874 distributed over a wide range of species. This is based on 98% of submitted catch returns. In the past 5 years, more than 496 separate species of molluscs have been collected, with an average of more than 200 species per year – the majority in low numbers.

There is some focus of effort on mollusc families most popular with shell collectors, such as cowries, cones, murexes and volutes. For example, *Cypraea venusta*, *C. marginata* and *C. friendii* (including identified sub-species) make up approximately 18% of those collected in 2008, 31% of those collected in 2009, 16% of those collected in both 2010 and 2011. Cypraeidae or cowries are noted for their localised variations in both shape and colour, making them attractive to collectors.

Fishing effort/access level

Although there are 32 licences in the fishery, only about 11 of these are regularly active. Effort has been stable over the past 5 years, at an average of around 1,012 days fished. In 2011, 932 days were fished (Note: the 2011 effort data is incomplete).

Recreational component:**Not assessed**

Shell collecting is a popular recreational pastime, and members of the public are permitted to collect shells for their private collections. The recreational catch, while unknown, is considered to be declining, as evidenced by declining membership in shell collecting associations.

Stock Assessment**Assessment complete:****Yes****Breeding stock levels:****Adequate**

During the 2010 season the catch rate was approximately 16 shells per day.

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

‘Shell sighting’ is a new abundance category. It is a measure of the population of vulnerable shells that is observed but not taken, and provides evidence for the breeding stock being conserved each year. Of the 8 vulnerable species (including related sub-species), an overall average of approximately 77% in 2008, 61% in 2009, 60% in 2010 and 55% in 2011 of the shells sighted were not harvested. The measure of the number of shells sighted is reported correctly in about 71% of

the cases where one of the vulnerable species is reported. The figures for ‘sighted’ versus ‘taken’ of vulnerable shells is continually improving by licensees, which is demonstrated by the increase in the percentage of the number of vulnerable shells sighted from 22% in 2009 to 71% in 2011. It is anticipated that current sightings are an under estimate of the available populations.

The reporting of catch and effort on the finer spatial scale of 10 x 10 nm blocks from August 2004 is also providing more accurate information on the distribution of certain species. Again, the 2011 season has seen a wider adoption by licensees of the smaller spatial resolution grid blocks rather than reporting the 60 x 60 nm blocks.

All species collected in Western Australia, including the 8 prized species, occur over wide geographic ranges (hundreds or thousands of kilometres) and wide depth ranges (up to 200 m) where a substantial portion of the population cannot for logistical and safety reasons be collected. However, with the introduction of the remote controlled underwater vehicles these depth restrictions are starting to be overcome.

Even in shallow waters, many localities cannot be fished because of the lack of access to the beach and the small boats used, and collecting is prohibited in many of the more easily reached areas which are now in marine parks and reserves. Additional protection is afforded by the fact that collectors will ignore any specimens with slight visual imperfections, but their reproductive potential in the population remains undiminished. In summary, it is considered that the fishery has very little likelihood of having an unacceptable impact on breeding stocks.

The performance measures for the fishery relate to the maintenance of breeding stocks, as indicated by catch levels and catch rates. In 2011, the catch level of approximately 14,874 shells and catch rate of 16 shells/day are both within the ranges set, i.e. 10,000 – 25,000 shells and 10 – 40 shells/day.

Non-Retained Species**Bycatch species impact:****Negligible**

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

Protected species interaction:**Negligible**

The fishery reported no interactions with protected species during 2011. Reports of interactions with protected species are required to be recorded on monthly catch and effort returns.

Ecosystem Effects**Food chain effects:****Negligible****Habitat effects:****Negligible**

STATEWIDE

Social Effects

In 2011 there was 32 authorisation holders in this fishery with around 11 licences recording consistent activity, the number of people employed regularly in the fishery (licensees plus crew/ dive buddies) is likely to be around 23. There was also around 10 people (licensees plus crew/dive buddies) that operated occasionally in this fishery. With many of the licences there might be the additional employment of people to prepare the shells for collection, pack and distribute the shells and also, some licensees might have shop fronts, therefore, employing shop assistants. The number employed in this area is unknown.

Economic Effects

Estimated annual value (to fishers) for 2011:

Not assessed

Fishery Governance

Target catch range: 10,000 – 25,000 shells

A preliminary performance measure has been developed of a total annual catch range from 10,000 to 25,000 shells, which encompasses the range of catches taken from 2000 to 2003. This performance measure has been developed to ensure that

any major change in the patterns of fishing is noticed and investigated. If it is triggered, this may not necessarily indicate any problem with the stocks, but rather fluctuations in the natural environment or market dynamics.

New management initiatives (2011/12)

A recent amendment to the Specimen Shell Management Plan strengthened the clause pertaining to the taking and selling of specimen shells to improve the ability of the Department of Fisheries to successfully prosecute cases of black market sale, purchase and dealing of shell.

A Ministerial Exemption was granted on 26 March 2009, which permits the use of up to 2 fishing boats of any size (provided that the boats are not used simultaneously), the use of up to 2 nominated divers who are not nominated on the Managed Fishery Licence (provided no more than 2 people are in the water at any one time), collection of dead shells of non-commercial abalone species and specimen shells of the genus *Pecten*. This Exemption is in place while management plan amendments are progressed.

An Exemption has been granted for two licensees to trial the use of a remote operated underwater vehicle to collect shells in water depths of 60 to 300 metres.

APPENDICES

APPENDIX 1

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APPENDIX 2

Table of catches from fishers' statutory monthly returns for 2010/11

This table contains the landed¹ and estimated live weight² of species recorded in the compulsory catch and fishing effort returns provided by commercial fishers each month. These data include the catch taken as by-product as well as the targeted catch.

These catch data may differ slightly from some of the catch estimates presented for specific fisheries as the latter may include additional data from other sources, such as research log books and processors. The figures may also differ slightly from previously reported figures, as additional data may have been received by the Department of Fisheries. The table represents the latest year for which a complete set of data is available.

While scientific names have been included wherever possible, it should be noted that many fish recorded under a common name cannot be identified as belonging to a particular single species and therefore must be reported as being part of a commercial grouping of several species. For example, the common name 'cod' may be used for several species in the family of Serranidae.

Data for species with live weight catches of less than 500 kg have been combined into the general or 'other' category within each class. Data for the Indian Ocean Territories Fishery have not been included in this table.

Common Name	Scientific Name	Landed weight (tonnes)	Live weight (tonnes)
FISH			
Amberjack	<i>Seriola dumerili</i>	16	16
Australian sardine (Pilchard)	<i>Sardinops sagax ocellatus</i>	2,322	2,322
Barracuda (northern pike)	<i>Sphyræna</i> spp	5	5
Barramundi (giant perch)	<i>Lates calcarifer</i>	26	40
Bass grouper	<i>Polyprion americanus</i>	1	1
Bigeye (not tuna)	Priacanthidae	19	19
Boarfish	Pentacerotidae	7	8
Bream, black	<i>Acanthopagrus butcheri</i>	53	53
Bream, monocle	<i>Scolopsis</i> spp.	14	14
Bream, Mozambique	<i>Wattsia mossambica</i>	2	2
Bream, Robinson's	<i>Gymnocranius grandoculis</i>	37	37
Bream, silver (tarwhine)	<i>Rhabdosargus sarba</i>	5	5
Bream, western yellowfin	<i>Acanthopagrus latus</i>	12	12
Catfish, sea (golden cobbler)	Ariidae	14	14
Chinaman fish (not cod)	<i>Symphorus nematophorus</i>	9	9
Cobbler	<i>Cnidoglanis macrocephalus</i>	49	69
Cod	Serranidae	59	59
Cod, bar (grey-banded, eight-bar)	<i>Epinephelus octofasciatus</i>	23	23

APPENDICES

Common Name	Scientific Name	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Cod, breaksea	<i>Epinephelides armatus</i>	5	5
Cod, chinaman	<i>Epinephelus rivulatus</i>	1	1
Cod, Rankin	<i>Epinephelus multinotatus</i>	125	125
Cod, spotted	<i>Epinephelus microdon</i> , <i>E. areolatus</i> , <i>E. bilobatus</i>	34	34
Common Coral Trout	<i>Plectropomus leopardus</i>	1	1
Dhufish, West Australian (jewfish)	<i>Glaucosoma hebraicum</i>	73	75
Duskytail Grouper	<i>Epinephelus bleekeri</i>	2	2
Emperor, blue-lined (grass; black snapper)	<i>Lethrinus laticaudis</i>	3	3
Emperor, blue-spot	<i>Lethrinus hutchinsi</i>	296	296
Emperor, red	<i>Lutjanus sebae</i>	285	285
Emperor, red-spot (snapper)	<i>Lethrinus lentjan</i>	36	36
Emperor, spangled	<i>Lethrinus nebulosus</i>	71	71
Emperor, sweetlip	<i>Lethrinus miniatus</i>	67	67
Flagfish (Spanish flag)	<i>Lutjanus vitta</i> , <i>L. quinquelineatus</i> , <i>L. carponotatus</i> , <i>L. lutjanus</i>	107	107
Flathead	Platycephalidae	3	3
Flounder	Bothidae	2	2
Garfish, sea	<i>Hyporhamphus melanochir</i>	33	33
Groper (wrasses)	Labridae	1	1
Groper, baldchin	<i>Choerodon rubescens</i>	16	16
Groper, blue	<i>Achoerodus gouldii</i>	42	49
Halibut	<i>Psettodes erumei</i>	1	1
Hapuku	<i>Polyprion oxygeneios</i>	13	13
Herring, Australian	<i>Arripis georgianus</i>	148	148
Javelin fish	<i>Pomadasys</i> spp.	26	26
Jobfish (goldband snapper) –see Snapper, goldband			
Jobfish, rosy –see Snapper, rosy			
Jobfish (sharptooth snapper) –see Snapper, sharptooth			
Kingfish, black (cobia)	<i>Rachycentron canadum</i>	13	13
Kingfish, yellowtail	<i>Seriola lalandi</i>	1	1

Common Name	Scientific Name	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Knifefish	<i>Oplegnathus woodwardi</i>	1	1
Leather jacket	Monacanthidae	28	52
Mackerel, grey (broad-barred)	<i>Scomberomorus semifasciatus</i>	11	12
Mackerel, other	Scombridae	1	1
Mackerel, scaly	<i>Sardinella lemuru</i>	339	339
Mackerel, Spanish	<i>Scomberomorus commerson</i>	203	287
Mangrove jack	<i>Lutjanus argentimaculatus</i>	15	15
Mullet, red	Mullidae	33	33
Mullet, sea	<i>Mugil cephalus</i>	233	234
Mullet, yellow-eye	<i>Aldrichetta forsteri</i>	22	22
Mulloway	<i>Argyrosomus hololepidotus</i>	14	15
Mulloway, northern (black jew)	<i>Protonibea diacanthus</i>	3	3
Parrot fish	Scaridae	5	5
Perch, darktail sea (maroon sea) -see Snapper, marron			
Perch, Moses –see Snapper, Moses			
Perch, pearl	<i>Glaucosoma buergeri</i>	23	23
Perch, red, maroon sea perch	<i>Lutjanus</i> spp (large)	16	16
Perch, yellowtail	<i>Amniataba caudavittatus</i>	1	1
Perches, other	Lutjanidae	5	5
Pigfish	<i>Bodianus</i> spp.	1	1
Pike, sea	<i>Sphyræna novaehollandiae</i>	1	1
Pomfret, black	<i>Parastromateus niger</i>	1	1
Redfish	<i>Centroberyx</i> spp.	9	9
Redfish, bight	<i>Centroberyx gerrardi</i>	40	41
Redfish, yelloweye	<i>Centroberyx australis</i>	12	12
Rockcod, birdwire	<i>Epinephelus merra</i>	1	1
Rockcod, blackspotted	<i>Epinephelus malabaricus</i>	25	25
Rockcod, goldspotted	<i>Epinephelus coioides</i>	30	30
Salmon, Australian	<i>Arripis truttaceus</i>	102	102
Samson fish (sea kingfish)	<i>Seriola hippos</i>	33	34
Scad, yellowtail	<i>Trachurus novaezelandiae</i>	7	7
Scorpionfishes	Scorpaenidae	1	1

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Common Name	Scientific Name	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Shark, angel	<i>Squatina</i> spp.	2	4
Shark, blacktip	<i>Carcharhinus</i> spp.	1	1
Shark, bronze whaler (dusky whaler)	<i>Carcharhinus obscurus</i>	127	199
Shark, common saw	<i>Pristiphorus cirratus</i>	6	10
Shark, eastern school	<i>Galeorhinus galeus</i>	6	9
Shark, golden (copper whaler)	<i>Carcharhinus brachyurus</i>	37	56
Shark, gummy	<i>Mustelus antarcticus</i>	246	375
Shark, hammerhead	Sphyrnidae	43	68
Shark, mako (shortfin)	<i>Isurus oxyrinchus</i>	1	2
Shark, pencil	<i>Hypogaleus hyugaensis</i>	< 500kg	1
Shark, spinner (long-nose grey)	<i>Carcharhinus brevipinna</i>	40	60
Shark, thickskin (sandbar)	<i>Carcharhinus plumbeus</i>	45	71
Shark, tiger	<i>Galeocerdo cuvier</i>	2	3
Shark, whiskery	<i>Furgaleus macki</i>	85	127
Shark, wobbegong	Orectolobidae	19	30
Shark, other		3	4
Shovelnose (fiddler rays)	Rhinobatidae & Rhynchobatidae	1	3
Skates and rays, other		5	13
Smelt, hardy head	Atherinidae	5	5
Snapper, bullnose (variegated emperor)	<i>Lethrinus ravus</i>	5	5
Snapper, crimson (formerly red snapper)	<i>Lutjanus erythropterus</i>	212	212
Snapper, frypan	<i>Argyrops spinifer</i>	40	40
Snapper, goldband	<i>Pristipomoides multidens</i>	674	674
Snapper, long nose	<i>Lethrinus olivaceus</i>	15	15
Snapper, maroon (formerly maroon sea perch)	<i>Lutjanus lemniscatus</i>	12	12
Snapper, Moses (formerly Moses Perch)	<i>Lutjanus russelli</i>	38	38
Snapper, nor-west	Lethrinidae	2	2
Snapper, pink	<i>Pagrus auratus</i>	456	458
Snapper, queen	<i>Nemadactylus valenciennesi</i>	51	56
Snapper, red (swallowtail) –see Snapper, crimson			
Snapper, rosy (formerly Rosy jobfish)	<i>Pristipomoides filamentosus</i>	32	32
Snapper, ruby	<i>Etelis</i> spp.	86	86

Common Name	Scientific Name	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Snapper, saddletail sea (formerly scarlet sea perch)	<i>Lutjanus malabaricus</i>	180	180
Snapper, sharptooth	<i>Pristipomoides typus</i>	2	2
Sole	<i>Ammotretis rostratus</i>	1	1
Sprat, blue	<i>Spratelloides robustus</i>	1	1
Sweep	<i>Scorpius aequipinnis</i>	2	2
Sweetlip	Haemulidae	48	48
Tailor	<i>Pomatomus saltatrix</i>	24	24
Threadfin	Polynemidae	10	14
Threadfin bream (butterfish)	Nemipteridae	147	147
Threadfin, giant (king salmon)	<i>Eleutheronema tetradactylum</i>	65	67
Trevalla, deepsea	<i>Hyperoglyphe antarctica</i>	3	3
Trevally, golden	<i>Gnathanodon speciosus</i>	3	3
Trevally, other (skippy)	Carangidae	121	121
Trevally, skipjack	<i>Pseudocaranx dentex</i>	10	10
Tripletail	<i>Lobotes surinamensis</i>	2	3
Trout, coral	<i>Plectropomus maculatus</i>	22	22
Trumpeters	Terapontidae	3	3
Tuna, Longtail	<i>Thunnus tonggol</i>	1	1
Tuna, other	Scombridae	1	1
Tuna, yellowfin	<i>Thunnus albacares</i>	1	1
Tuskfish, bluebone	<i>Choerodon</i> spp.	7	7
Whitebait	<i>Hyperlophus vittatus</i>	38	38
Whiting, golden-lined	<i>Sillago analis</i>	10	10
Whiting, King George	<i>Sillaginodes punctata</i>	15	15
Whiting, other	Sillaginidae	22	22
Whiting, western sand	<i>Sillago schomburgkii</i>	119	119
Other fish		140	168
TOTAL FISH		8,588	9,151
CRABS			
Crab, blue swimmer (blue manna, sand)	<i>Portunus pelagicus</i>	1,063	1,063
Crab, champagne (spiny)	<i>Hypothalassia acerba</i>	12	12
Crab, coral	<i>Charybdis feriata</i>	1	1
Crab, crystal (snow)	<i>Chaceon bicolor</i>	146	146

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Common Name	Scientific Name	Landed weight (tonnes)	Live weight (tonnes)
CRABS (continued)			
Crab, giant (king)	<i>Pseudocarcinus gigas</i>	8	8
Crab, mud	<i>Scylla</i> spp.	< 500kg	< 500kg
TOTAL CRABS		1,231	1,231
PRAWNS			
Prawn, banana	<i>Penaeus merguensis</i>	304	304
Prawn, brown tiger	<i>Penaeus esculentus</i>	1,122	1,122
Prawn, coral	<i>Metapenaeopsis</i> spp.	132	132
Prawn, endeavour	<i>Metapenaeus</i> spp.	160	160
Prawn, western king	<i>Penaeus latisulcatus</i>	1,503	1,503
Prawns, other	Penaeidae	< 500 kg	< 500 kg
TOTAL PRAWNS		3,223	3,223
LOBSTERS			
Bugs	Scyllaridae	14	14
Rock lobster, southern	<i>Jasus edwardsii</i>	52	52
Rock lobster, western	<i>Panulirus cygnus</i>	5,194	5,194
TOTAL LOBSTERS		5,261	5,261
MOLLUSCS			
Abalone, brownlip	<i>Haliotis conicopora</i>	15	38
Abalone, greenlip	<i>Haliotis laevigata</i>	61	162
Abalone, Roe's	<i>Haliotis roei</i>	99	99
Cuttlefish	Sepiidae	50	50
Octopus	<i>Octopus</i> spp. (mainly <i>O. tetricus</i>)	219	270
Scallop, saucer	<i>Amusium balloti</i>	612	3,058
Squid	<i>Sepioteuthis</i> spp., <i>Loligo</i> spp.	56	56
Trochus	<i>Trochus niloticus</i>	4	4
TOTAL MOLLUSCS		1,115	3,737
OTHER CLASSES			
Beche de Mer	Holothuridae	36	107
TOTAL OTHER CLASSES		36	107
GRAND TOTAL		19,453	22,710

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'.

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. This is because it would usually have to be made on board a fishing vessel where the practical difficulties associated with the working conditions render it impossible. Live weight has to be derived and this is usually done by applying a conversion factor to the landed weight.
2. Weight figures are round off to the nearest tonnage.

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>

APPENDIX 3

Research Division - Other Activities

Activities of the Pemberton Freshwater Research Centre 2011/12

Craig Lawrence & Tony Church

The Department of Fisheries Pemberton Freshwater Research Centre (PFRC) is the largest freshwater hatchery and research facility in Western Australia. Located on the Lefroy Brook in Pemberton it consists of two neighbouring sites, the original PFRC hatchery and the Dr Noel Morrissy Research Ponds located on Thomson's Flat. The original PFRC hatchery site contains 10 earthen ponds, 22 concrete ponds, 36 research tanks, fish hatching and larval rearing troughs. The nearby Dr Noel Morrissy Research Ponds on Thomsons Flat feature 25 earthen ponds, ranging in size from 150m² breeding ponds to 1000m² commercial growout -scale ponds, 28 tanks and a post-harvest handling facility. This site also includes an area that is leased to Forest Fresh Marron for processing and marketing the product from over 60 local marron growers.

PFRC staff are responsible for the maintenance and production of native fish, crayfish and trout at the facility. They are also responsible for stocking trout into public waters and packing trout and marron for sale to commercial farmers. Efficient management and operation of a large production and research facility for fish and crayfish such as PFRC requires a high level of expertise. As a result PFRC staff provide a key regional extension service to aquaculture, recreational fishing and biodiversity client groups. As part of the NRM funded hatchery infrastructure modifications a front office has been allocated for public enquiries, community education material on the department's activities and the recommencement of tours of the facility by the public. The community education material is being developed as resources permit. Once complete it will enable the PFRC hatchery to recommence public education tours.

PFRC provides facilities, expertise and stock to support research and industry development in the four key areas of i) conserving and recovering biodiversity, ii) recreational fishing, iii) aquaculture and iv) freshwater fisheries.

Key PFRC projects in 2011/12 are briefly discussed below:

Trout production for recreational fishing, aquaculture and research

Trout production at PFRC provides fingerlings and yearlings for recreational fishing, aquaculture and research. Two species of trout are produced at PFRC Brown trout (*Salmo trutta*) for recreational fishing and Rainbow trout (*Oncorhynchus mykiss*) for both aquaculture and recreational fishing.

In 2011/12 the PFRC produced 753,000 fry. These consisted of 740,000 Rainbow trout fry and 13,000 Brown trout fry, representing an increase in production of 12% and a decrease of 56% respectively, compared with 2010/11. The majority of production (66%) consisting of 490,000 Rainbow trout fry and 10,000 Brown trout fry were stocked into public waterways to support recreational fishing. A further 200,000

Rainbow trout (27%) were sold to individuals and clubs for stocking private farm dams; recreational fishing and tourism operations; and licensed aquaculture producers. The 250% increase in sales from PFRC in 2011/12 was due to increased demand from recreational fishout operators and commercial aquaculture producers for both yearlings and fry.

No sterile triploid rainbow trout were produced at PFRC in 2010/11. Consequently triploid sales to private waters for recreational fishing (0) were significantly less than in 2010/11 (36,000).

The remaining 35,000 trout produced (5%) were retained for future brood stock for PFRC, yearling stocking, and research.

In 2011/12 during the Winter-Spring months 8,700 Rainbow yearlings as well as 2,620 Rainbow and 470 Brown trout ex brood stock, were released to public waters for recreational fishing and control of stunted redfin perch populations.

The 36% reduction in yearlings stocked in 2011/12 (8,700) compared with 2010/11 (24,500) is due to compliance with the Department of Fisheries revised translocation policy. Consequently, no yearlings have been stocked since December 2011. It is anticipated that translocation approval to stock the remaining 16,000 yearlings currently being held at PFRC will be received in late June 2012. Upon which stocking will recommence and proceed as in previous years albeit delayed.

Trout research for recreational fishing and aquaculture

In late 2006 the Department commenced a review of trout production at PFRC to consider two key factors: Brown trout embryo survival and Rainbow trout brood stock selection strategies. In 2007 the Department commenced research to evaluate hatchery production techniques for producing sterile triploid trout and develop improved protocols using a hydrostatic pressure chamber and tetraploids.

Brown trout embryo survival

In 2005 Brown trout embryo survival was sub-optimal, however after consulting with stakeholders, prior to PFRC disposing of this valuable line, that is highly regarded by recreational fishers, Research Division staff commenced a study to confirm the extent of this problem and determine the contributing factors. This research can only be undertaken during the brief spawning period each year. Factors being investigated include poor sperm motility, water quality or climate change.

Investigations by the department into brown trout sperm motility showed that some trout were not producing motile sperm. This resulted in modifications to hatchery protocols to include assessment of sperm quality prior to egg fertilisation. In 2009/10 sperm motility assessment using basic visual

evaluation of sperm quality resulted in a 500% improvement in brown trout egg fertilisation rates. However, visual assessment of sperm motility is labour intensive. Consequently sperm motility assessment was postponed until the purchase of computing equipment and software. Computer Assisted Sperm Analysis software (CASA) was purchased by the department in late 2010. This software will enable research staff to efficiently analyse and quantify trout sperm fitness during the 2012 spawning season.

Rainbow trout brood stock selection

The current breeding strategy for both Rainbow and Brown trout at PFRC focuses upon random selection of brood stock. However, trout production at PFRC has two key client groups with different objectives, recreational fishing and aquaculture. Therefore, it is likely that breeding objectives for these two groups may be different. Accordingly Research division staff commenced discussions with both major client groups to establish and prioritise breeding objectives. This will ensure that in coming years, brood stock selection strategies at PFRC can be implemented to produce trout with traits that specifically meet the needs of key client groups.

The genetic line of rainbow trout at PFRC is unique. In 2008/09 staff completed a series of temperature tolerance experiments that demonstrated that the PFRC rainbow trout genetic line can withstand water temperatures of up to 28°C without any mortalities. This temperature tolerance is superior to most domesticated lines elsewhere and is significant in regards to adapting to global warming. Due to resource limitations between 2009-2012 the commencement of a trout selective breeding program to further increase temperature tolerance has been delayed until after the 2012 spawning season.

Sterile triploid trout production

Triploids are valuable for both stocking and the environment as they cannot reproduce and continue to grow after reaching sexual maturity. The PFRC hatchery has produced triploids for many years using temperature shock to retain the first polar body of fertilised eggs. However, temperature shocking is known to have considerable variability in triploidy rates. To address this in 2006 PFRC obtained a hydrostatic pressure chamber for manipulating chromosome numbers to produce triploids and tetraploids.

Protocols for the production of triploids and tetraploids using hydrostatic pressure were developed and trialled at PFRC in 2006. Juveniles were produced, however resource limitations prevented the percentage of triploids and tetraploids being analysed in either 2008/09 or 2009/10 or 2010/11. These samples have been frozen and will be analysed when finances permit. In 2010/11 and 2011/12 Department of Fisheries researchers have worked with colleagues from The University of Western Australia to develop and validate a more efficient technique of quantifying the percentage of triploids, diploids and tetraploids from embryo samples. This will enable research in this area to recommence in 2012.

Native and endangered fish conservation and biodiversity research

In response to a declining prevalence of native fish in the southwest Department of Fisheries researchers established brood stock populations of two endemic species Pygmy Perch (*Edelia vittata*) and Western Minnows (*Galaxias*

occidentalis) at PFRC. The aim of this research is to develop large-scale pond production techniques for these species to 1) enable stocking of public and private water bodies in the southwest, 2) develop and validate the most efficient production strategies for each species 3) transfer this technology to achieve captive breeding of two listed species (*G. truttaceus* - Critically endangered and *N. balstoni* - Vulnerable to extinction).

Western Minnow (*Galaxias occidentalis*)

In 2011/12 PFRC successfully achieved large scale spawning of the Western Minnow (*Galaxias occidentalis*) in hatchery ponds. Over 6,000 juveniles were produced from this pilot research project this year. The technology developed will now be applied to further increase mass production of Western Minnow for restocking and transferred to breeding the critically endangered Trout minnow (*Galaxias truttaceus*).

One of the challenges of captive breeding for release programs is to ensure that genetic drift within the hatchery environment does not result in progeny that are less fit for survival in the wild. At PFRC an innovative strategy developed by Department of Fisheries researchers to address this challenge received NRM funding in 2010. This strategy is based upon the upstream spawning migration of native fish. This means that juveniles produced in the PFRC hatchery and tagged, if released into the adjacent Lefroy Brook, when they reach sexual maturity will return to the hatchery to spawn. From several thousand fish released only those genetically fit enough to survive in the wild will return to PFRC to spawn. The NRM funding enabled a Fish Ladder supplied with water from PFRC to be constructed between the hatchery and the Lefroy Brook. In future years, by releasing juveniles produced at PFRC at the mouth of the Fish Ladder, after spending two years in the wild they will now be able to swim back up the fish ladder and into the hatchery to provide the next generation of PFRC broodstock.

During the planning stage of the PFRC Fish Ladder, consultation between Department of Fisheries researchers and Department of Water engineers identified critical knowledge gaps in the design specification's required for native fish to successfully migrate up a fish ladder. While there are proposals by university researchers to commence testing some design specifications (i.e. swimming ability) using laboratory scale swim chambers, the lack of a full scale fish ladder for research has limited the variables that can be examined. Consequently, the PFRC Fish Ladder has been designed so that it can not only be used to validate results from laboratory experiments, but can also be modified to test the effects of variables such as board height, pool length, pool depth, barrier type, flow rate etc. in a full scale working model. The information obtained from these experiments will lead to improved and scientifically validated designs for Fish Ladders in WA.

Pygmy Perch (*Edelia vittata*)

In 2011/12 Pygmy perch were spawned in tanks at PFRC following the protocols developed and refined at the Shenton Park Aquaculture and Native Fish Breeding Laboratory. This technology will now be scaled up to mass production in ponds on Thomson Flat to produce fish for restocking; and transferred to the related Balston's Perch (*N. balstoni*), which is listed as vulnerable to extinction.

It is thought that the decline in prevalence of native fish is related to the increased spread of introduced *Gambusia*

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(*Gambusia holbrooki*), but research at PFRC and a NRM funded survey by Department of Fisheries researchers in 2010 indicates that other factors may also be responsible. Although *Gambusia* were originally introduced to control mosquito populations, it appears that the native Pygmy perch consume more mosquito larvae. Therefore, while production and stocking of Pygmy perch has direct conservation and biodiversity benefits, it is also likely to result in human health benefits through a reduction in mosquito borne diseases such as Ross River virus.

Listed Native Fish Species

Broodstock populations of two endangered native fish species the Trout Minnow (*G. truttaceus*) listed as critically endangered, and Balston's Pygmy Perch (*N. Balstoni*) listed as vulnerable to extinction, are being established at PFRC and Shenton Park Aquaculture and Native Fish Breeding Laboratory. In addition to establishing a living gene bank before these species become extinct, the focus of this project is to close their lifecycles, develop large scale production techniques and restock waterbodies within their original distribution.

Native Fish Research Priorities 2012/13

In 2012/13 Department of Fisheries will address the following native fish research priorities:

Techniques to increase production of Pygmy Perch & Western Minnows

A recent collaborative project with UWA showed that native fish are more abundant in waterbodies with complex habitat. One hypothesis, that has also improved marron breeding, is that this occurs due to the shelter provided to juveniles. This hypothesis will be examined by comparing native fish production among spawning ponds that either contain hides or without hides in 2012/13

The achievement of the first ever large scale pond production of Western Minnows (*G. occidentalis*) in earthen ponds at PFRC highlighted a production technology gap. The harvesting of several thousand small native fish from a pond is labour intensive, time consuming and exposes the fish to both stress and the risk of physical injury. Techniques to more efficiently remove native fish from ponds will be evaluated in 2012/13

Establishing key genetic lines for conservation and restocking

The Department of Fisheries NRM survey showed that genotypes of Pygmy perch and Western Minnow among water bodies north of Collie are similar. However, those south of Collie are different from the northern populations and show increased variation among catchments. Consequently, in 2012/13 the breeding program for these two species will be split into two major populations, a northern genetic line at Shenton Park Aquaculture & Native Fish Breeding Laboratory for restocking the Swan Coastal Plain; and a southern genetic line at PFRC. This will require collection and quarantine of northern genetic lines at the Shenton Park facility in 2012/13

Endangered Fish Species

Broodstock populations of two endangered native fish species the Trout Minnow (*G. truttaceus*) listed as critically

endangered, and Balston's Pygmy Perch (*N. Balstoni*) will be collected and established in 2012/13. They will be managed using the same suite of husbandry techniques that Department of Fisheries scientists have developed, and shown to be effective, for the production of the related Western Minnows (*G. occidentalis*) and Pygmy Perch (*Edelia vittata*).

Mosquito predation

While it is widely accepted that native fish consume more mosquito larvae than the introduced mosquito fish (*Gambusia*) this has yet to be scientifically verified. In a series of experiments Department of Fisheries researchers will quantify the mosquito larvae consumption of key native fish and *Gambusia*. These results will also determine which species is the most suitable for stocking artificial water bodies in which mosquito control, rather than biodiversity, is the primary objective.

Native and endangered crayfish conservation and biodiversity research

In 2005/06 a captive breeding program to conserve marron biodiversity was established at PFRC. The key focus of this program was to establish a living gene bank and breeding population of the critically endangered "hairy" Margaret River marron, before it became extinct in the wild. The South West Catchments Council (SWCC) provided funding for Department of Fisheries researchers working in collaboration with The University of Western Australia to develop a molecular genetic test (RAPID's) to identify "pure" marron from hybrids. This resulted in the establishment of the only "pure" brood stock population of the rare Margaret River marron at PFRC. These broodstock at PFRC produced over 1200 juveniles in their first breeding season. These juveniles were reared to sexual maturity at PFRC. In July 2009 these marron bred in the ponds at PFRC and 2500 progeny were tagged and restocked in the Margaret River. In 2010 during field sampling to monitor the wild population in the Margaret River a tagged marron, which had been released as juvenile in 2009, was recaptured.

In addition, a living gene bank representing marron populations from three other river systems are bred and reared in the captive breeding program at PFRC. These broodstock represent the genetic biodiversity of the ancestral Pemberton strain upon which the WA aquaculture industry has been developed, and the rare blue marron. Their progeny are used for 1) marron farmers wishing to increase the genetic diversity of their stocks, 2) wild fisheries research involving the release and recapture of tagged juveniles in the recreational marron fishery, and 3) Where appropriate, restocking both catchments and farm dams in the region.

Marron aquaculture research and development

In 2006 the FRDC project 2000/215 "Improved performance of marron using genetic and pond management strategies" was completed. Working with industry on commercial marron farms Research Division staff validated and established current best practice farming techniques. This showed that correctly constructed and professionally managed marron farms achieved production levels twice that of those which do not follow best practice.

The project also showed that poor brood stock selection, where farmers sell their largest marron and breed from the remaining slower growing animals had reduced the growth rate of marron on commercial farms. To address this, the Research Division staff initiated a selective breeding program that resulted in a 100% improvement in growth rate. In 2007 PFRC produced around 25,000 juveniles for sale to industry. A repository population of the best performing mass and pedigree selected genetic lines was retained at PFRC for future selective breeding and sale of progeny to industry. Increased demand for these juveniles, combined with limited supply from industry, is likely to necessitate re-establishing the selective breeding program at PFRC in the near future.

Summary

In 2011/12 increased requirements to provide scientific support to i) policy development (translocation, biodiversity, biosecurity) and ii) Water Corporation projects, as well as an 18-month rebuilding project at the Perth based facility, required a reallocation of resources from research activities to policy support. Despite this key core activities for recreational and aquaculture stakeholders, including trout production and monitoring of recreational marron fishery were delivered. It is anticipated that freshwater research activities will return to normal in 2012.

Activities of the Fish Health Unit during 2011/12

The Fish Health Unit of the Department of Fisheries was formed in 1988 following an outbreak of disease in the state trout hatchery. The unit is based at South Perth within the Animal Health Laboratories of the Department of Agriculture and Food, bringing economies of scale through sharing of equipment. The unit is permanently staffed by 1 full-time and 1 part-time fish pathologist, one research scientist, one laboratory manager, a research officer and one technical officer.

The unit is accredited to ISO 17025 and provides a diagnostic service to the seafood industries in Western Australia, undertakes disease surveillance for key fisheries, investigates 'fish kills', contributes to policy advice developed by the Department, carries out research on diseases of aquatic organisms and has a minor extension role. In addition, protocols for high health hatchery status have been developed and adopted by key industries. Key activities and achievements of the unit during 2011/12 were as follows:

- The fish health laboratory received a total of 180 diagnostic cases during the 2011/12 – about the same case load as last year.
- The provision of export health certificates for yabbies and marron has continued its downward trend since 2002, when 55 certificates were issued, to none for the last two years. This decline in export activity is due to the continuing drought and to changes in product destinations within the industry.
- The provision of pearling translocation certificates remained steady at 14 in this reporting period.
- Staff spent time assisting sea-cage culture farms in WA coastal waters. This is a growing area of activity in Western Australia.
- There were 4 cases of notifiable diseases reported in 2011/12, the diseases were all records of iridovirus in ornamental fish in quarantined imported fish.
- Investigation of disease in pearl oysters (*Pinctada maxima*) through two Fisheries Research and

Development Corporation (FRDC) funded projects; FRDC 2008/30 to develop methods to detect stress in oysters and FRDC 2008/31 to investigate novel Chlamydia-like bodies in pearl oysters has concluded. The cause of the mortalities since 2006 has not yet been determined, however, a novel Chlamydia-like organism has been found to be associated with the pearl oyster mortalities. This requires further work. It is also anticipated that the stress work will develop as a new project in 2012/13 with the assistance of the pearling industry and Macquarie University.

- A new 3 year FRDC project 2011/005 to examine WA prawn samples for virus was started in early 2012.
- In collaboration with staff from the Department of Water and the Water and Rivers Commission, 23 reports of 'fish kills' throughout the State were investigated. Most 'fish kills' were due either to poor water quality or toxic algal blooms. During the 2010/11 year, the fish kill program was successfully introduced into the Indian Ocean Territories and kits were left at the islands, under agreement with the federal government. This initiative resulted in successfully obtaining samples from a fish kill, due to an algal bloom, in January 2012.
- A range of national committees including: the national Subcommittee for Aquatic Animal Health; the Fisheries Research Development Corporation Subprogram on Aquatic Animal Health; the Aquatic Animal Health Project under the Australian Biosecurity Intelligence Network; and Biosecurity Australia frequently seek the expertise of the Fish Health Unit. This reflects the greater emphasis on national coordination and consultation on aquatic animal health issues.
- The laboratory continued in its role as one of 7 regional resource centres for aquatic animal health within the Network of Aquaculture Centres (NACA) in the Asia-Pacific. As part of that activity, the Vietnamese government funded a quarantine officer to train in the Fish Health laboratories during 2012.

Activities of the Biosecurity Group during 2011/12

Marine Unit

The Marine Biosecurity Research group currently monitors high risk ports around the state and has developed research programs to increase our knowledge of the marine pest threat to our State waters.

Introduced Marine Pests

Introduced marine species are organisms that have moved, or been moved from their natural environment to another area. Many of these organisms remain inconspicuous and innocuous causing no known adverse effects. However, they can potentially threaten human health, economic values or the environment, in which case they are then referred to as marine pests. Introduced marine species are a global problem, and second only to habitat change and loss in reducing global biodiversity (Millennium Ecosystem Assessment, 2005).

The introduction of marine species into a new region can be deliberate or accidental. Deliberate introductions may result from aquaculture practices or releases from aquariums. Accidental introductions are primarily due to shipping and recreational craft moving from country to country, with the pests being transported in ballast water, on ship hulls, or within a vessel's internal seawater pipes. Introduced marine species also arrive naturally via marine debris and ocean currents.

The impacts of introduced marine pests are wide and varied. They can predate on native and farmed species, out-compete natives for space and food, alter nutrient cycles and lead to a loss of diversity in local species. In addition to environmental consequences, introduced marine pests have the potential to harm human health (e.g. cholera, paralytic shellfish poisoning), negatively affect commercial fish and seafood species, negatively affect amenity and recreational activities and reduce the fuel efficiency for all vessel types (hull fouling organisms). With increasing human population and associated travel, transport and trade, the risk of introducing new species is likely to grow (Convention on Biological Diversity, 2005).

Early detection of an introduced marine pest is vital if we are to have any chance of eradicating it before it becomes established. There has only been one introduced marine species that has been successfully eradicated to date in Australia, the black striped mussel which was found in Darwin Harbour in 1999. This program or eradication cost more than \$2M, but the mussel threatened the \$225M (value of production in 1998) pearling industry. If eradication is not an option then other management controls can be put in place, such as community education regarding boating habits and routines, quarantining areas and managing vessel movements between locations.

As an ocean bound nation Australia relies heavily on maritime transport, with over 95% of our imports and exports carried by sea. The large ocean going vessels that transport these goods represent one of the largest vectors of introduced species. For these reasons our ports and marinas become high risk areas for the introduction of a marine pest. The Commonwealth Government, together with the states and

territory have developed a national system of policies and procedures to try and reduce the risk of marine pests arriving in Australian waters. Part of this system includes the monitoring of high risk ports, which are those ports that receive large numbers of vessels, high risk vessels (such as dredges) or are geographically close to areas of known invasive marine species.

The monitoring and research activities of the group are aimed at preventing or minimising further introductions of marine pests, and advocating control measures where they do exist.

Monitoring and Surveillance

The Marine Biosecurity Research group is actively involved in developing and implementing monitoring programs for marine pests along our WA coast using a suite of tools. These programs adhere to the Australian Marine Pest Monitoring Guidelines and have been endorsed by the Commonwealth. These programs occur every two years and were previously completed in Fremantle, Port Hedland, Dampier and Christmas Island ports in late 2010/early 2011. The Marine Biosecurity Research group has also developed targeted supplementary monitoring programs, to complement the above, which occur in the off years. The supplementary monitoring has been completed for Fremantle Port (February 2012) and is planned to occur for Dampier and Port Hedland Ports in the middle of 2012 and Christmas Island the end of 2012. The Marine Biosecurity Research group has also developed monitoring program designs for the Geraldton Port Authority and HMAS Stirling (Garden Island, Defence Services Group).

Early warning system

The Early Warning System uses settlement arrays to examine recruitment of marine organisms, thus potentially providing a mechanism for the early detection of marine pests. Settlement arrays are an established methodology currently being used by the Marine Biosecurity Research group as a complementary method for marine pest monitoring in Dampier, Port Hedland and Fremantle Ports and at HMAS Stirling. These arrays are simple structures designed to act as extra surfaces for organisms to settle on, using 10cm x 10cm plates and mops as collectors. In addition to the deployment of the settlement arrays, twice a year shoreline searches are carried out and crab traps are deployed.

Surveillance in response to detection

Charybdis japonica

In 2010 a single male specimen of the invasive Asian Paddle crab *Charybdis japonica* was handed in to the Mandurah District Office of the Department of Fisheries. This triggered extensive trap-based surveillance of the Mandurah waters. The original surveillance did not detect any further specimens of *C. japonica*. Repeat surveillance was conducted in late 2011, whilst a third and final survey is planned for late 2012. To date no further specimens of *C. japonica* have been detected.

Didemnum perlucidum

In 2011 the Biosecurity management group were alerted to

the presence *D. perlucidum* in our waters. This species is considered non-native to Western Australia and based on current knowledge has only ever been recorded once previously in Australia (on a vessel in NSW).

The initial detection of this species triggered further investigation by the Department's Marine Biosecurity Research group who have since found the species to be present in the Ports of Fremantle (including Henderson and Garden Island); the Swan River; Hillarys Boat Harbour and the Port of Dampier. It has also been confirmed that this species is fouling mussel lines on a commercial mussel farm in Cockburn Sound and has been recorded on the hulls of several vessels traversing the coastline.

The widespread distribution and extensive growth of this species raises biosecurity concerns for the Department. *Didemnum perlucidum* is a heavy fouling species that may cover and smother other benthic assemblages. Based on information from the Northern Hemisphere, *D. perlucidum* displays typical invasive characteristics of a high growth rate, early maturity and extremely high fecundity. Further this species may spread asexually, both through lateral expansion at the edges of the colony as well as through pieces breaking off. Reports from the Cockburn Sound mussel farm are that this species caused approximately 80% mortality of their 2012 end-sellable harvest.

Based on detections of *D. perlucidum* by the Marine Biosecurity Research group this species has wide temperature and salinity tolerances (evident by its current known distribution). As such this species has the potential to become a significant pest in WA.

Didemnum perlucidum is a very difficult species to identify and differentiate from other native species which are known to exist in Australian waters. The Marine Biosecurity Research group has developed identification capabilities for this species based on characterisation of its DNA. Analysis of populations detected in Western Australia indicate that this species is genetically identical to specimens originating in Brazil. Initial examination of *D. perlucidum* populations sampled along our coast suggest very low genetic variation which is consistent with a recent appearance of this species in Western Australian waters.

Research programs

Likelihood analysis

The Marine Biosecurity Research group are gathering shipping information from ports around WA from Esperance to Wyndham. This research will be looking at the types and number of commercial vessels that visit our ports from domestic and international last port of calls, duration of the vessels stay, duration of the voyage, the bioregions the vessel traverses on its way to WA and environmental matching

between the last port of call and the WA port(s) visited. This research will provide an up-to-date analysis of the likelihood of a potential marine pest introduction to individual ports based on the above data that will inform management and policy.

Recreational vessel study

WA has a very high ownership of recreational vessels (90,000 registered vessels: Department of Transport, 2012). However, very little is known about the risk associated with recreational vessels for the introduction and translocation of marine pests along our coast line. The Marine Biosecurity Research group will quantify that risk by studying a range of recreational vessels from marinas all over the State. This will be achieved by firstly observing these vessels for the presence of known IMPs, or species displaying invasive characteristics, secondly by assessing the degree and type of fouling from different areas on a vessel's hull and finally by gathering information from boat owners with respect to antifouling practices and vessel travel history.

Vessel wrapping

Preventative measures such as maintenance of a clean vessel hull is widely acknowledged as more effective in curtailing invasions of marine pests than are eradication or control measures. Recreational vessels, are often left in-water for ease of use, their use is sporadic, vessels may travel widely but remain in areas for long periods of time and they have slow travel speeds. All these factors contribute toward providing the "right" conditions for the settlement of marine organisms, making this group of vessels a good candidate for developing innovative methods to eradicate biofouling that are user-friendly. The Marine Biosecurity Research group is running a trial in collaboration with South Australian researchers to ascertain how effective wrapping a recreational vessel's hull is in eliminating/killing biofouling on the wet areas of the hull. Vessels of less than 15m are being used in this trial with the aims of determining the efficacy, ease and practical limitations of the method.

Crab condos

Baited crab traps have been used in many decapod sampling regimes around the world and are specifically target larger predatory/scavenger crustaceans. Crabs are lured inside the traps by an attractant, typically fish-bait and stay inside until the trap is recovered. This technology is effective at capturing larger and aggressive crab species, however, juvenile, small or non-carnivorous species are generally excluded from such devices. A device nick-named the 'crab condo' was developed by New Zealand researchers to try and target these 'excluded' species. The Marine Biosecurity Research group are conducting research into the efficacy of these crab condos to sample these species and evaluate their efficacy in different habitats.

Indian Ocean Territories 2011/12

The Biodiversity and Biosecurity branch have implemented a series of biosecurity related projects during 2011 – 2012.

Marine pest surveillance

The introduction and spread of marine pests poses a serious threat to native biodiversity and can have widespread effects on both our economy and health. To this end the Marine Biosecurity Research group are actively involved in developing and implementing targeted marine pest monitoring and research programs at Christmas Island Port in the Indian Ocean Territory. The aim is to detect the presence of introduced marine pests (IMPs) using a suite of tools. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. The Marine Biosecurity Research group previously completed a large-scale marine pest monitoring program in Christmas Island port in late 2010. This biennial program adhered to the Australian Marine Pest Monitoring Guidelines and has been endorsed by the Commonwealth. The repeat survey is scheduled for late 2012. No marine pests were detected

during the 2010 survey.

Marine pest research

The Marine Biosecurity Research group currently have two research projects planned for the region.

- Assessment of the likelihood of a marine pest being introduced into Christmas Island port and the Cocos Islands (Please refer the Appendix section “Activities of the Marine Biosecurity Research Unit during 2011/12” for further details on this program).
- Determination of the risk posed by unofficial vessel entries as vectors of IMP. This would involve an examination of suspected illegal entry vessel (SIEV) hulls and characterisation of fouling and its invasive potential.

Indian Ocean Territories Fishery Status Report

S.J. Newman, L. Bellchambers, C. Skepper, M. Pember, S. Evans, B. Rome and R. Green

Main Features

Status		Current Landings	
Stock level	Some species at risk	Total	Not assessed
Fishing Level	Not Assessed	Main Commercial Fishery	Not reportable

Fishery Description

Commercial

In November 2002, the territorial seas of the Cocos (Keeling) Islands and Christmas Island were declared as ‘excepted waters’ from the Commonwealth’s *Fisheries Management Act 1991*. Management responsibilities for these waters were transferred from the Australian Fisheries Management Authority (AFMA) to the Department of Transport and Regional Services. The Government of Western Australia’s Department of Fisheries (the Department) has taken on management responsibilities for the marine Territorial waters of the Indian Ocean Territories, under a Service Delivery Arrangement with the Commonwealth. The location of the Indian Ocean Territories and their proximity to the Western Australian coast are illustrated in Indian Ocean Territories Figure 1.

Under the Service Delivery Arrangement with the Commonwealth, the Department now manages commercial, recreational, charter and aquaculture activities at the Cocos (Keeling) Islands and Christmas Island, in addition to providing fish health diagnostic services, biosecurity

services, fish habitat protection advice, fish pathology and licensing services. The Commonwealth Minister for Regional Australia, Regional Development and Local government currently holds responsibility for these excepted waters under the *Fish Resources Management Act 1994 (WA) (CI/CKI)* (the ‘Applied Act’).

The commercial Christmas Island Line Fishery (CILF) primarily targets pelagic species, mainly wahoo (*Acanthocybium solandri*) and yellowfin tuna (*Thunnus albacares*). In addition, limited demersal fishing activities are also undertaken targeting deepwater snappers.

The Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) primarily targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge jocularis*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*).

Recreational

Large amounts of recreational fishing are undertaken around the Cocos (Keeling) Islands and Christmas Island targeting both finfish and invertebrate species. The Cocos (Keeling)

Islands consist of a diverse range of fishable habitats that include a sheltered lagoon, fringing reefs and offshore 'blue water' environments that support a range of demersal and pelagic fish species, as well as various crustaceans (e.g. crabs) and molluscs (e.g. gong gong), which are highly sought after by fishers for both individual and community purposes. Christmas Island, on the other hand, has a limited amount of habitat available for fishing with no lagoon present, fringing reef surrounding the island and offshore 'blue water' environments that support a limited range of demersal and pelagic fish species, as well as some invertebrates.

Governing legislation/fishing authority

Commercial

Fish Resources Management Act 1994 (WA) (CI/CKI) (the 'Applied Act')

Fish Resources Management Regulations 1995(WA) (CKI/CI) and subsidiary legislation

Fishing Boat Licenses with conditions

Cocos (Keeling) Islands Marine Aquarium Fish Fishery – Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption).

Recreational

Fish Resources Management Act 1994 (WA) (CI/CKI) (the 'Applied Act')

Fish Resources Management Regulations 1995 (WA) (CKI/CI) and subsidiary legislation.

Consultation processes

Commercial

Department–industry/community consultation – Christmas Island and Cocos (Keeling) Islands.

Recreational

Community Consultation - Cocos (Keeling) Islands and Christmas Island.

Boundaries

Commercial

The territorial seas around the Cocos (Keeling) Islands and Christmas Island (Indian Ocean Territories Figure 2 and 3).

Recreational

The territorial seas around the Cocos (Keeling) Islands and Christmas Island (Indian Ocean Territories Figure 2 and 3).

Management arrangements

Commercial

The Christmas Island Line Fishery (CILF) is managed primarily through input controls in the form of limited entry to the fishery and gear restrictions. There are 2 licenses in the fishery. In 2011, 2 licences operated in the fishery. The CILF also has output controls in the form of quota limits on both demersal and pelagic species to be harvested. Data for this fishery cannot be reported due to confidentiality limitations (i.e. less than 3 vessels).

The commercial Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) is managed through input controls in the form of a limited entry fishery (there is only 1 licence in the fishery) and gear restrictions. The fishery also has a number of output controls in the form of limits on the species permitted to be harvested, limits on the total number of individuals of all species combined that can be harvested in a year and limits of the number of individuals within a Family that can be harvested within a year. Data for this fishery cannot be reported due to confidentiality limitations (i.e. there is only one licence in the fishery).

Recreational

Island-specific recreational fisheries management arrangements for the Indian Ocean Territories are currently being progressed to legislation.

Research summary

A risk assessment workshop was undertaken in 2011 to refine fisheries management and research priorities at the Indian Ocean Territories. Following this and previous workshops, finfish fisheries research has focused on collecting biological material to assess wahoo stocks and on collecting tissue samples from a suite of species at the Cocos (Keeling) Islands and Christmas Island to examine their connectivity with other sites along the Western Australian coast and locations to the north. Invertebrate fisheries research has focused on surveys to assess the abundance and biology of gong gong (*Lambis lambis*) and also to understand the abundance and distribution of bêche-de-mer (Holothurians) and clams (*Tridacna* spp.). Biodiversity research has also established a reef-monitoring program to detect changes in reef health due to natural and anthropogenic impacts.

Retained Species

Commercial landings (season 2011)

Not reportable

Wahoo (*Acanthocybium solandri*) is the main target species of the CILF. Other pelagic species are also targeted during the trolling operations and include yellowfin tuna (*Thunnus albacares*) and to a lesser extent mahi mahi (*Coryphaena* spp.). Some commercial fishing activities are also undertaken for demersal fish species, mainly deep slope species such as ruby snapper (*Etelis* spp.). The commercial catch for Christmas Island consists of catch data from only 2 vessels and the exact catch data is not reportable due to confidentiality provisions. The total reported catch for this fishery has been less than 10 tonnes per annum over the last 5 years.

There is no commercial line fishery at the Cocos (Keeling) Islands.

The CKIMAFF targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge jocularis*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*). As there is only one license in the CKIMAFF the catch data is not reportable due to confidentiality provisions.

Recreational catch estimate (season 2011)

Not assessed

APPENDICES

Recreational fishing vessels operate around the Cocos (Keeling) Islands and Christmas Island. The amount and magnitude of the recreational fishing catch and effort at these islands has not been assessed. Island-specific recreational bag limits, area closures, and gear restrictions are currently being progressed.

Fishing effort/access level

Commercial

Effort in the CILF has been relatively stable over the past three years. Effort in the fishery is weather dependent and is limited by access to the water through the principal boat ramp at Flying Fish Cove, and to a lesser extent the Ethel Beach boat ramp.

Effort in the CKIMAFF has been similar over the last few years providing a similar level of catch.

Recreational

Effort by recreational anglers at both the Cocos (Keeling) Islands and Christmas Island is weather dependent. At the Cocos (Keeling) Islands the prevailing weather conditions determine what part of the Island complex is subject to fishing activities. Access to the water at Christmas Island is limited to the principal boat ramp at Flying Fish Cove, and to a lesser extent the Ethel Beach boat ramp.

Stock Assessment

Assessment complete: Yes

Assessment method: Risk Assessment

Breeding stock level: Some species at risk

Holothurians: In 2006 a large-scale assessment of the holothurian communities inhabiting the lagoon and outer reef at the Cocos (Keeling) Islands was undertaken to determine the status of key holothurian species and enable recommendations to be made regarding the feasibility of a commercial holothurian fishery being developed in the region. Analysis of abundance and distribution data found that the holothurian community is strongly influenced by habitat and although some species are wide-ranging and found in relatively high densities, they tend to be of low economic value. In contrast, species of moderate to high value were recorded at densities too low to support commercial fisheries and typically had very restricted distributions. The holothurian community found at the Cocos (Keeling) Islands is near to pristine, due to a lack of historical fishing pressure. Holothurian stocks are very sensitive to fishing pressure and have been heavily overexploited in other areas of the Indian and Pacific Oceans.

Gong Gong: The common spider conch or gong gong (*Lambis lambis*) is a heavily recreationally-targeted gastropod inhabiting shallow waters of the lagoon. This species is vulnerable to over-fishing as it is highly accessible and presumably shares biological traits with other exploited conch species, including slow growth and late maturity. Monitoring data collected between 2007 and 2011 indicate that the current abundance of gong gong is lower than that recorded historically. While heavy fishing pressure has presumably contributed to the reduction in gong gong numbers, further monitoring is required to determine the role of recruitment variability in maintaining gong gong

populations at the Cocos (Keeling) Islands and changes in the lagoon system.

Giant Clams: The sustainability of giant clam (*Tridacna* spp.) and coral species were identified as potential concerns during recent risk assessments undertaken for the marine resources of the Cocos (Keeling) Islands by the Department of Fisheries. To address these concerns, research has been expanded to assess the status of *Tridacna* clams at the islands. In addition, an on-going reef monitoring program has been established. The implementation of these initiatives will enable the Department of Fisheries to assess the health of the coral reef ecosystems at the Cocos (Keeling) Islands and effectively detect change, both spatially and temporally, resulting in better management of the natural resources of the Atoll.

Finfish: Data on the abundance of finfish species is being collected and collated to determine changes over time. A number of recent surveys have been undertaken at both localities (Hobbs, Choat pers. comm.). Some species appear to have exhibited marked declines in abundance. For example, Lincoln Smith et al. (1995)¹ reported that the squaretail coral trout (*Plectropomus areolatus*) was abundant on shallow reefs (<10m) and was one of the species most commonly recorded on deep reefs (15-20m). Cocos Malay community members have advised that recreational fishers in the waters of the lagoon targeted these species using lines. This species is now extremely low in abundance at the Cocos (Keeling) Islands (Choat pers. comm.), suggesting local depletion and/or overexploitation of the stock (little is known about the stock structure of many fish species in the Indian Ocean Territories, in particular gene flow and linkages with other populations elsewhere in the Indian Ocean).

The pelagic species that are targeted by the CILF (e.g. wahoo, yellowfin tuna) are likely to be part of a wider Indian Ocean stock. However, the demersal species are likely to be localised stocks that are reliant upon self-recruitment.

There is anecdotal evidence of localised depletion of some deep slope species like rosy snapper (*Pristipomoides filamentosus*) and ruby snapper (*Etelis carbunculus*) around Christmas Island. An increasing number of recreational fishers are using electric-powered lines to target deep-slope demersal finfish species at the Indian Ocean Territories, thereby increasing the effective fishing effort for these species.

Aquarium Fish: The CKIMAFF targets *Centropyge jocular* and to a lesser extent *Centropyge flavissima*. *Centropyge jocular* is endemic to the Cocos and Christmas Islands and inhabits fringing reefs from 15 to 70 m.

¹ Lincoln-Smith, M.P., Skilleter, G.A., Underwood, A.J., Stark, J., Smith, A.K., Hawes, P.M.H., Howitt, L., White, G.A. and Chapman, M.G. 1995. Cocos (Keeling) Islands: Quantitative baseline surveys for core marine reserves and biosphere reserve in the South Keeling lagoon (prepared for Australian Nature Conservation Agency Project 153). The Institute of Marine Ecology, University of Sydney and The Ecology Lab Pty. Ltd., Sydney, Australia

Little is known about the biology of *C. joculator* although Allen et al. (2007)¹ describe this species as being abundant on Christmas Island.

Non-Retained Species

Bycatch species impact: Negligible

Fishing in the CILF for pelagic species such as wahoo uses specialised trolling gear to target the fish and involves limited discarding. Species occasionally caught and sometimes retained but generally discarded include billfish, barracuda, shark, mackerel tuna and trevally. A high proportion of the above species are expected to survive capture and release by the fishery. Consequently, it is considered likely that the pelagic fishery has a negligible impact on stocks of discarded species. Fishing for demersal species in the CILF particularly those in the deep slope waters involves limited discarding as most species are retained for processing.

The fishing techniques used to capture fish in the CKIMAFF involve using hand or scoop nets, or a small seine net of specific dimensions (the seine net cannot exceed 16 metres in length, must have a mesh of less than or equal to 28mm and a drop of not more than 3 metres) and may use SCUBA equipment. Thus, the CKIMAFF has negligible bycatch due to the highly selective nature of fishing activities.

Protected species interaction: Negligible

The line fishing methods used in CILF are not known to catch any protected species. However, there is some potential for lines to inadvertently catch seabirds at Christmas Island.

No protected species interactions have been reported for the CKIMAFF.

Ecosystem Effects

Food chain effects: Not assessed

Habitat effects: Negligible

The line fishing methods used in the CILF and the hand collection method used in the CKIMAFF are likely to have minimal impact on the habitat.

Social Effects

Commercial

At least 2 people were employed in the CILF around Christmas Island during 2011. This estimate is based on the number of vessels reporting catches and the average number of crew on each boat.

At least 2 people were employed in the CKIMAFF around Cocos (Keeling) Islands during 2011.

Recreational

Due to their sport fishing and eating qualities, wahoo and

other pelagic species are popular target species for recreational anglers and fishing charter operators at the Indian Ocean Territories, particularly at Christmas Island. They are usually captured from small boats, although shore-based fishing is also undertaken.

A large variety of demersal and lagoon finfish and invertebrate species are caught by recreational fishers at Cocos (Keeling) Islands involving the use of a large number of small vessels. Similarly, recreational fishers at Christmas Island undertake fishing activities from a number of small vessels and also fishing from the shore and catch a large variety of demersal finfish species including a large number of deep slope species.

Economic Effects

Estimated annual value (to fishers) for 2011:

Not assessed

The value of the CILF is not known. The value of the CKIMAFF is also unknown, although *C. joculator* commands a high price on the international market (reported in excess of AUS \$700.00 each).

Fishery Governance

Commercial

Target commercial catch range Not available

Current Fishing (or Effort) Level Not assessed

The potential fishing effort for both pelagic and demersal fish species at both the Cocos (Keeling) Islands and at Christmas Island is high with a capacity to operate over the entire extent of the fishable area at each island group. Given the restricted amount of habitat and fishing area available it is expected that fishing pressure on some species at Cocos (Keeling) Islands or Christmas Island is above sustainable levels.

The catch of the CKIMAFF has been small since its inception in 1993. There is little incentive for the single licensee to increase catch or effort since market viability and high prices are maintained by only having small numbers of fish available for sale.

New management initiatives (2012)

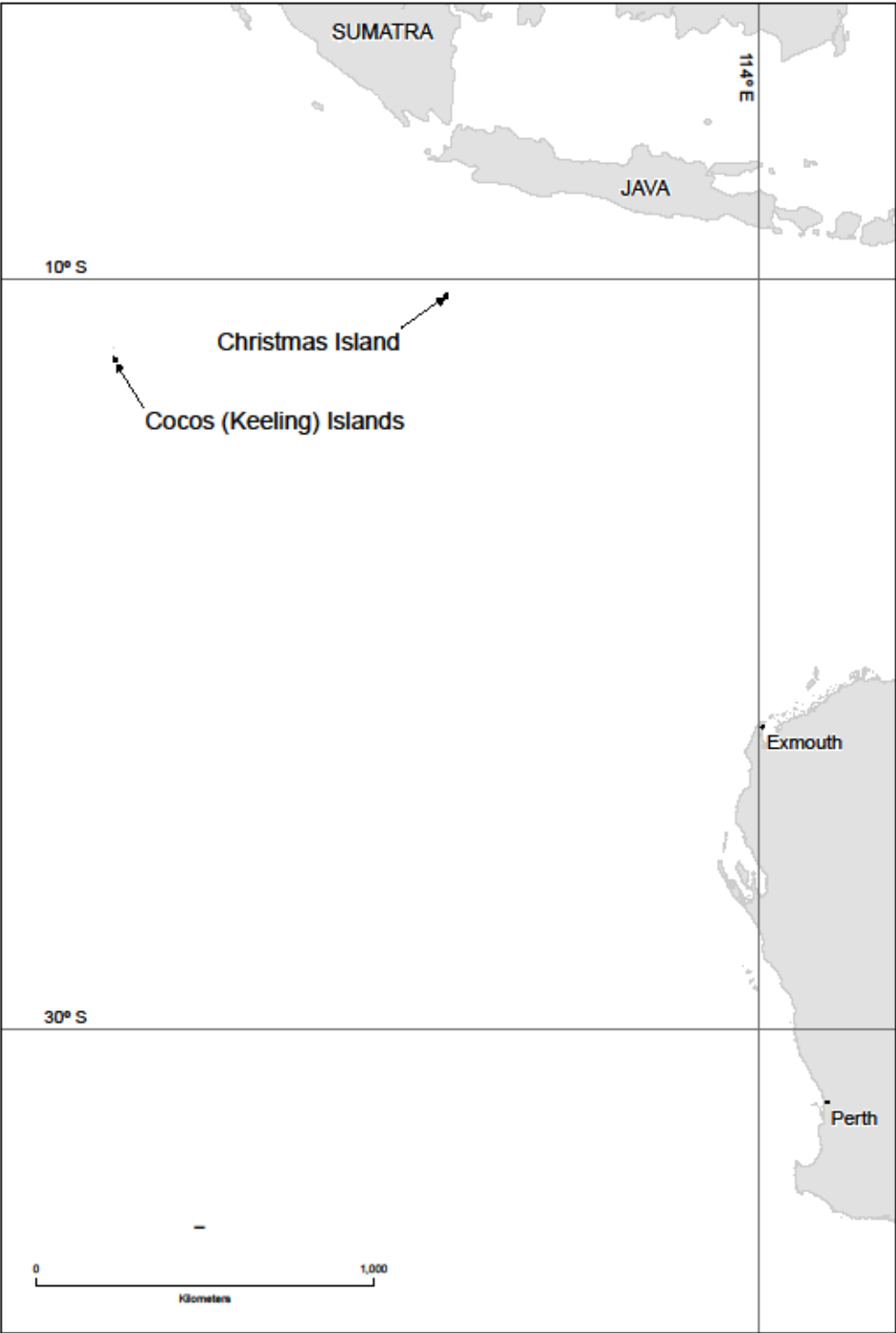
New island-specific fisheries management arrangements for the Indian Ocean Territories are currently being progressed to legislation.

The effective implementation of any future fisheries management legislation at the Indian Ocean Territories, will require ongoing community education and compliance enforcement programs.

External Factors

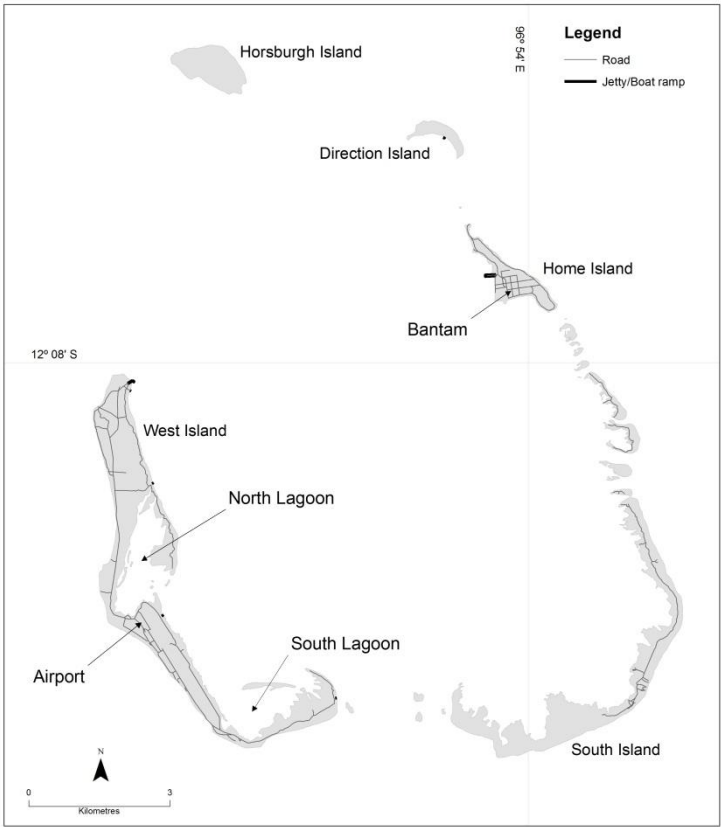
The demersal fish and invertebrate populations of Cocos (Keeling) Islands and Christmas Island are likely to consist of small, isolated populations that are expected to experience highly variable recruitment due to environmental fluctuations.

¹ Allen, G.R., Steene, R.C. and Orchard, M. 2007. Fishes of Christmas Island (Second Edition). Christmas Island Natural History Association, Christmas Island, Indian Ocean, Australia. 284p

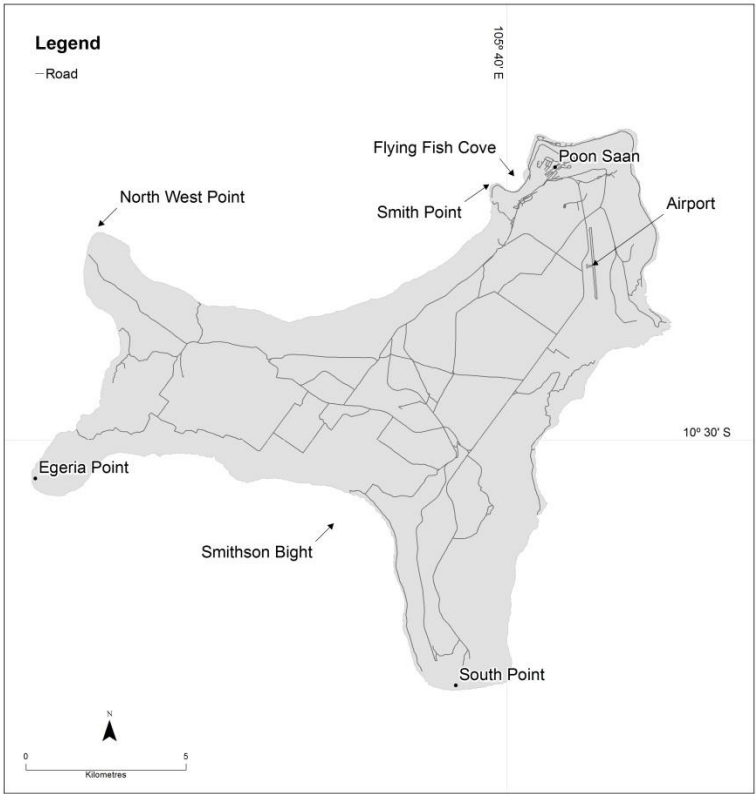


INDIAN OCEAN TERRITORIES FIGURE 1

Location of the Cocos (Keeling) Islands and Christmas Island comprising the Indian Ocean Territories within the Indian Ocean and illustrating their proximity to the Western Australian coast.



INDIAN OCEAN TERRITORIES FIGURE 2
Location of the major Islands and landmarks within the Cocos (Keeling) Islands in the Indian Ocean.



INDIAN OCEAN TERRITORIES FIGURE 3
Location of the key landmarks around Christmas Island in the Indian Ocean.

Finfish Ageing Laboratory

Jeffrey Norriss

The Finfish Ageing Laboratory (FAL) at the WA Fisheries and Marine Laboratory continues to produce high quality otolith sections revealing the age structure of the catch of important Western Australian finfish species. Knowing the demographics of our fish stocks allows us to estimate of the rate of fishing mortality and therefore risks to their biological sustainability. Also revealed are recruitment patterns, growth rates, age at onset of sexual maturity and/or sex change, and longevity - all critical information for fisheries management.

Estimating a fish's age is a routine procedure accomplished by removing the otoliths (ear stones) and interpreting the alternating opaque and translucent zones deposited throughout the lifetime of the fish, similar to growth rings in a tree. Usually the otolith requires sectioning and mounting on a microscope slide before age can be estimated.

The priority species for the FAL are set by the Resource Assessment Framework (RAF) for Finfish Resources (Department of Fisheries WA, 2011¹). It identifies the most important indicator species for a range of ecological niches across four marine Bioregions, ranked in terms of their risk to sustainability. The RAF is subject to periodic review.

The result: in 2011 the FAL aged over 16,000 fish (see Table 1).

Priority species processed in 2011 included those from the Inshore Demersal suite in the West Coast Bioregion: dhufish, pink snapper and baldchin grouper. From the Pilbara area of the North Coast Bioregion many red emperor, brownstripe snapper and bluespot emperor were aged to support upcoming stock assessments for what is West Australia's most valuable commercial finfish fishery. Other species aged in significant numbers during 2011 included cobbler from Wilson Inlet (South Coast Bioregion), and King George whiting (from South Coast and West Coast Bioregions) in a collaborative arrangement with Murdoch University masters student, Elena Sulin.

The FAL continues to be involved in current developments in fish ageing protocols, in association with experts from others fisheries agencies around Australia. Together we are developing national standards for establishing long-term otolith reference collections, used for testing and re-testing otolith readers and thus ensuring long term comparability of age data. This national project is being led by Department of Fisheries WA Scientist Dr Ross Marriott. Also on the agenda are protocols for repeat readings to measure precision, and possibly the incorporation of precision estimates into stock assessment confidence levels. Finally, documentation for processing and ageing indicator species are being developed.

FINFISH AGEING LABORATORY TABLE 1.

The number of fish processed and aged by the Finfish Ageing Laboratory in 2011, by Bioregion, species, ecological suite and whether it is and indicator species for that suite.

Christmas Island Bioregion	Number processed	Ecological suite	Indicator species
Red Tip Grouper <i>E. retouti</i>	39	NA	NA
Total	39		
North Coast Bioregion	Number processed	Ecological suite	Indicator species
Red Emperor <i>L. sebae</i>	1,000	Inshore demersal	Yes
Brownstripe Snapper <i>L. vitta</i>	1,147	Inshore demersal	Yes
Blue Spot Emperor <i>L. punctulatus</i>	1,433	Inshore demersal	Yes
Eightbar Grouper <i>H. octofasciatus</i>	22	Offshore demersal	Yes
North Coast Bioregion (continued)	Number processed	Ecological suite	Indicator species

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

Ruby Snapper <i>E. carbunculus</i>	456	Offshore demersal	Yes
Total	4,058		
Gascoyne Bioregion	Number processed	Ecological suite	Indicator species
Blue Lined Emperor <i>L. laticaudis</i>	8	Nearshore	No
Mulloway <i>A. japonicus</i>	7	Nearshore	No
Pink Snapper <i>P. auratus</i>	504	Inshore demersal	Yes
Goldband Jobfish <i>P. multidentis</i>	278	Inshore demersal	Yes
Spangled Emperor <i>L. nebulosus</i>	725	Inshore demersal	Yes
Eightbar Grouper <i>H. octofasciatus</i>	23	Offshore demersal	Yes
Total	1,545		
West Coast Bioregion	Number processed	Ecological suite	Indicator species
Tailor <i>P. saltatrix</i>	467	Nearshore	Yes
Australian Herring <i>A. georgianus</i>	1,288	Nearshore	Yes
King George Whiting <i>S. punctata</i>	1,066	Nearshore	No
Dhufish <i>G. hebraicum</i>	1,930	Inshore demersal	Yes
Pink Snapper <i>P. auratus</i>	2,303	Inshore demersal	Yes
Baldchin Grouper <i>C. rubescens</i>	1,126	Inshore demersal	Yes
Breaksea Cod <i>E. armatus</i>	279	Inshore demersal	Yes
Bight Redfish <i>C. gerrardi</i>	237	Inshore demersal	Yes
Eightbar Grouper <i>H. octofasciatus</i>	45	Offshore demersal	Yes
Bass Groper <i>P. americanus</i>	28	Offshore demersal	Yes
Hapuku <i>P. oxygeneios</i>	17	Offshore demersal	Yes
Blue Eye Trevalla <i>H. antarctica</i>	137	Offshore demersal	Yes
Total	8,923		
South Coast Bioregion	Number processed	Ecological suite	Indicator species

APPENDICES

Cobbler <i>C. macrocephalus</i>	1,213	Estuarine	Yes
Australian herring <i>A. georgianus</i>	302	Nearshore	Yes
King George Whiting <i>S. punctata</i>	171	Nearshore	Yes
Hapuku <i>P. oxygeneios</i>	18	Offshore demersal	Yes
Blue Eye Trevalla <i>H. antarctica</i>	137	Offshore demersal	Yes
Total	1841		
Southern Inland Bioregion	Number processed	Ecological suite	Indicator species
Spangled Perch	3	NA	NA
Total	3		
GRAND TOTAL	16,409		

APPENDIX 4

Annual performance for commercial fisheries subject to export approval under the Commonwealth Government's Environment Protection and Biodiversity Conservation Act 1999

The following table provides a summary of the issues, performance measures and any conditions for fisheries subject to the above Act and their annual performance. The period assessed in each case is the most recent season for which complete data are available. As a result of the duration required for data collection and analysis, the years being assessed in this volume are the 2010/11 season or the calendar year 2011 for fisheries data but up to June 2012 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 2010/11 or 2011	Comment
<i>Fishery:</i> Abalone <i>Date of certification:</i> March 2008 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> September 2014	Greenlip/brownlip abalone Areas 2/3 (spawning stock)	Effort range 907–1,339 diver days; minimum meat weight 140 g greenlip, 160 g brownlip	Acceptable	
	Roe's abalone Area 1 (spawning stock)	Effort range 14–43 diver days; total catch 9.9 t	Acceptable	Exploratory quota. No fishing in 2011.
	Roe's abalone Area 2 (spawning stock)	Effort range 80–106 diver days; total catch 19.8 t	Acceptable	
	Roe's abalone Area 5 (spawning stock)	Effort range 100–140 diver days; total catch 20 t	Acceptable	75% of quota taken in Area 5 due to adverse weather.
	Roe's abalone Area 6 (spawning stock)	Effort range 80–127 diver days; total catch 12 t	Acceptable	
	Roe's abalone Area 7 (spawning stock)	Effort range 175–215 diver days; total catch 36 t	Acceptable	Area 8 fishery closed to fishing due to environmentally induced mass mortality
	Roe's abalone Area 8 (spawning stock)	Effort range 140–200 diver days; total catch 12t	Acceptable	
<i>Fishery:</i> Abrolhos Islands and Mid West Trawl <i>Date of certification:</i> 17 March 2005 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> March 2013	Scallops (spawning stock)	The residual stock index determines a predicted catch that sets the length of the next season and the fishing season ceases at a catch rate threshold level,	Acceptable	
<i>Fishery:</i> Beche-de-mer <i>Date of certification:</i> December 2004 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> December 2010	Beche-de-mer species (spawning stock)	Sandfish acceptable catch range: 20-100 t. Catch rate above 25 kg/hr. Redfish acceptable catch range: 40-100 t. Catch rate above 60 kg/hr.	Acceptable	Only sandfish assessed. No fishing for Redfish occurred in 2011.

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Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
<i>Fishery:</i> Broome Prawn <i>Date of certification:</i> August 2004, extended April 2010 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> August 2015	Western king prawn (spawning stock)	Annual exploitation rate of king prawns to not exceed 60% in any one year	Acceptable	Very low level of effort this year.
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–90 t (7-year catch range)	Acceptable	As above
	Tiger prawn (spawning stock)	Catch rate above 25 kg/hr (6 fathom quad gear) revised from original 8–10 kg/hr (7.5 fathom twin gear)	Acceptable	
	King prawn (spawning stock)	Total catch within acceptable range of 350–500 t	Acceptable	Below range due to conservative harvesting strategies
<i>Fishery:</i> Exmouth Gulf Prawn <i>Date of certification:</i> March 2003 <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> February 2013	Endeavour prawn (spawning stock)	Total catch within acceptable range of 120–300 t	Acceptable	
	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	.
	Non –Retained species	The major species of bycatch are found in significant numbers outside of the trawled areas	Acceptable	
	Impact to mud/shell (habitat)	< 40% of mud/shell habitat in Exmouth Gulf trawled	Acceptable	
<i>Fishery:</i> Gascoyne Demersal Scalefish Managed Fishery <i>Date of certification:</i> September 2009 <i>Approval type:</i> Export exemption <i>Expiry date:</i> September 2014	Pink snapper (spawning stock)	Catch rate not to fall below 500 kg/standard June–July boat day	Acceptable	The performance measure needs to be reviewed following significant reductions in quota and the move (in 2008) to higher resolution catch & effort reporting (daily/trip logbooks).

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
<i>Fishery:</i> Kimberley Prawn <i>Date of certification:</i> November 2004, extended April 2010 <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> August 2015	Banana prawn (spawning stock)	Total catch within acceptable range of 200–450 t	Acceptable	
	Brown tiger prawn (spawning stock)	Total catch within acceptable range of 15–60 t	Acceptable	Low landings due to low effort and targeting on high catch rates of banana prawns.
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 7–80 t	Acceptable	As above
	Coral prawns (spawning stock)	Total catch within acceptable range of 0–6 tonnes (10-year catch range)	Acceptable	As above
	Black tiger prawn (spawning stock)	Total catch within acceptable range of 0–1 t	Acceptable	
	Squid (spawning stock)	Total catch within acceptable range of 1–50 t	Acceptable	
<i>Fishery:</i> Mackerel <i>Date of certification:</i> November 2009 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> November 2014	Spanish mackerel (spawning stock)	Total catch within acceptable range of 246–410 t: acceptable regional catch ranges: Kimberley 110–205 t: Pilbara 80–126 t: Gascoyne/West Coast 56–79 t	Acceptable	
<i>Fishery:</i> Marine Aquarium Managed Fishery <i>Date of certification:</i> October 2008 <i>Approval type:</i> Approved Wildlife Trade Operation Exemptions <i>Expiry date:</i> October 2011	Seahorses of hippocampus species	Total catch < 2000. Number taken - 338	Acceptable	
<i>Fishery:</i> Northern Demersal Scalefish <i>Date of certification:</i> June 2010 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> June 2015	Red emperor and goldband snapper (spawning stock)	Spawning biomass > 40% of virgin spawning biomass with lower limit of 30%; total annual catches should not increase > 20% above average catches of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years	Acceptable	Total catch was slightly above the upper limit due to a high level of catch in Zone A.
	Cods/groupers (spawning stock)	Total annual catch should not increase >20% above average catch of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years.	Acceptable	

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Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
<i>Fishery:</i> Onslow and Nickol Bay Prawn <i>Date of certification:</i> November 2004, extended April 2010 <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> August 2015	Banana prawns (spawning stock)	Nickol Bay: total catch in high rainfall years within acceptable range of 40–220 t; in low rainfall years within acceptable range of 0–40 t.	Acceptable	
		Onslow: total catch within acceptable range of 2–90 t	Acceptable	Below target due to very low effort.
	Brown tiger prawn (spawning stock)*	Acceptable catch ranges of Nickol Bay 2–40 t and Onslow 10–120 t	Acceptable	Below target in Nickol Bay due to low effort and targeting on high catch rates of banana prawns and fleet transfer to other trawl fisheries.
	Western king prawn (spawning stock)	Acceptable catch ranges of Nickol Bay 20–70 t and Onslow 10–55 t	Acceptable	Below target due to low effort.
	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	
<i>Fishery:</i> Pearl Oyster <i>Date of certification:</i> September 2003, extended October 2008 <i>Approval type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> October 2013	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 in Zones 2 and 3 above performance levels due to good stock levels.
<i>Fishery:</i> Pilbara Trawl <i>Date of certification:</i> November 2004 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> June 2013	Long-lived target species (spawning stock) – includes Rankin cod, red emperor, scarlet perch, goldband snapper, red snapper, spangled emperor	Spawning biomass of Rankin cod and red emperor should remain above minimum limit of 40% of virgin spawning biomass; annual trawl catch should not increase > 20% above average catch of previous 4 years; no decrease in annual trawl catch rates in > 2 consecutive years	Acceptable	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
	Short-lived target species (spawning stock)	Median spawning biomass of blue-spot emperor should be > 40% of the 1993 spawning biomass in Area 1; annual catch of each short-lived target species should not increase > 20% above the average annual catch of the previous 4 years; annual catch rate of each short-lived target species should not decrease in two consecutive years	Acceptable	
	Bycatch of protected species - dolphins	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Less than 20 captures per year recorded. Trials of new fishing gear to further minimise capture of dolphins are to be completed during 2012
	Bycatch of protected species – turtles	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Number of turtles caught should be reduced by 50% of 2002 level following implementation of mitigation devices; number of turtles released alive should be greater than or equal to 72% of total captures per year
	Bycatch of protected species – syngnathids	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Number of pipefish caught and released alive should be < 500/yr; number of seahorses caught and released alive should be < 60/yr;
	Bycatch of protected species – sawfish	; all skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Number of sawfish caught should be < 120/yr; number of sawfish released alive should be increased to 50% of captures by 2008

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Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
	General ecosystem – large epibenthos	The total area of the Pilbara demersal fish fishery (encompassing both trawl and trap fisheries) that is closed to trawling is 80%; the total area of the Pilbara demersal fish fishery between depths of 30 m and 120 m should remain at or below the current level of 60%	Acceptable	
<p><i>Fishery:</i> Salmon</p> <p><i>Date of certification:</i> November 2004, extended November 2009</p> <p><i>Approval type:</i> Accredited Export Exempt Fishery</p> <p><i>Expiry date:</i> November 2014</p>	Western Australian salmon (spawning stock)	Expected catch range under the current management regime is 1,200–2,800 t	Acceptable	2011 catch below target range due to the combined effects of lack of targeting due to weak market demand, low catchability due to environmental factors (relatively high water temperatures) and low availability of fish due to recruitment variation. Stock level considered adequate.
<p><i>Fishery:</i> Shark Bay Crab Interim Managed Fishery</p> <p><i>Date of certification:</i> November 2004</p> <p><i>Approval type:</i> Approved Wildlife Trade Operation Exemption</p> <p><i>Expiry date:</i> July 2011</p>	Blue swimmer crab (breeding stock)	CPUE to remain above 1 kg/trap lift	Acceptable	The catch comes from a dedicated trap fishery and prawn trawlers. A heat wave and floods over the 2010/11 summer have impacted on the crab stock available for the 2012 season.
<p><i>Fishery:</i> Shark Bay Prawn</p> <p><i>Date of certification:</i> February 2003</p> <p><i>Approval type:</i> Accredited Export Exempt Fishery</p> <p><i>Expiry date:</i> February 2013</p>	Tiger prawn (spawning stock)	Level of spawning stock present based on fishery independent surveys during the spawning season to be between 25-30 kg/hr (5.5 fathom quad gear	Acceptable	
	King prawn (spawning stock)	Total catch within historical acceptable range of 1,100–1,600 t, given no change in effort	Acceptable	
	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	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
	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 2011 season, 15 turtles were recorded as caught in nets and all were recorded as being returned to the sea alive.
	Discarded fish (abundance)		Acceptable	Majority of bycatch species are found in relatively significant numbers outside of trawled areas
	Impact to sand/shell (habitat)	< 40% of sand/shell habitat in Shark Bay trawled	Acceptable	
	Impact to coral/sponge (habitat)	<20% of the remaining coral/sponge habitat in Shark Bay to be contained within the legally trawled area	Acceptable	
	Discarding fish (provisioning)		Acceptable	Reduction in amount of discards and ratio of discards to target catch from pre-catch reduction device levels and in water hopper system increasing survival of some bycatch species.
<i>Fishery:</i> Shark Bay Scallop <i>Date of certification:</i> February 2003 <i>Approval type:</i> Export exemption <i>Expiry date:</i> February 2013	Scallop (spawning stock)	Monitoring of recruits/ residual stock to ensure the start date of the season is set so that there is adequate level of breeding stock present when spawning commences	Acceptable	
	Loggerhead turtles (captures)	90% of turtles captured from non-BRD nets returned alive	Acceptable	BRDs are mandatory in all net so this performance measure is no longer valid. For the 2011 season, no turtles were recorded as caught in nets.

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Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
<i>Fishery:</i> South Coast Crustacean <i>Date of certification:</i> September 2004 <i>Approval type:</i> Wildlife Trade Order <i>Expiry date:</i> September 2011	Southern rock lobster (spawning stock)	Catch to remain below 40 t for Esperance fishery	Acceptable	New management arrangements for south coast crustacean fisheries should be finalised in 2010
<i>Fishery:</i> Specimen Shell <i>Date of certification:</i> 25 May 2005 <i>Approval type:</i> Export exemption <i>Expiry date:</i> May 2015	Specimen shell species (spawning stock)	Preliminary acceptable catch range is from 10,000–25,000 shells; acceptable catch rate 10–40 shells per day	Not assessed	Incomplete data from fisher catch and effort returns
<i>Fishery:</i> Temperate Demersal Gillnet and Demersal Longline (Shark) Fisheries <i>Date of certification:</i> April 2009 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> March 2012	Dusky and sandbar sharks	Review and report outcomes of actions taken to rebuild stocks,	Underway	Recovery of dusky sharks is now clearly evident.
	Australian sea lion interaction rates with demersal gillnets	(a) undertake a study to estimate risk of interactions between fishers and Australian sea lions by 30 March 2011 and (b) implement an appropriate observer program based on results of (a)	(a) Completed (b) pending (a)	A recent FRDC-funded project examined the relative spatial risks of Australian sea lion interactions and a further FRDC-funded study estimated quantitative rates of sea lion encounters with demersal gillnets
<i>Fishery:</i> Western Rock Lobster <i>Date of certification:</i> August 2002 <i>Approval Type:</i> Accredited Export Exempt Fishery <i>Expiry date:</i> September 2012	Western rock lobster (spawning stock)	Spawning biomass at Abrolhos Islands and coastal regions to remain above respective levels during the early 1980s with 75% certainty	Acceptable	
	Octopus (spawning stock)	Catch rate not to drop outside of historic range by > 10%	Acceptable	
	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

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
	Whales and dolphins (entanglements)	No increase in rate of interactions	Acceptable	Four whale entanglements were recorded (within historical range). Indicator requires revision as whale populations are increasing hence level of interactions will also increase.
<i>Fishery:</i> West Coast Deep Sea Crab <i>Date of certification:</i> May 2010 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> May 2013	Champagne crab (spawning stock)	Unitisation of the fishery has permitted a maximum of 14t of Champagne crab (combined with Giant crab) to be taken in a season	Acceptable	
	Crystal Crab (spawning stock)	The fishery is quota based with catches limited to 140t of crystal crab per season	Acceptable	As the fishery has moved to catch quota, the performance measure needs to be updated.
<i>Fishery:</i> West Coast and South Coast Purse Seine <i>Date of certification:</i> February 2009 <i>Approval type:</i> Approved Wildlife Trade Operation Exemption <i>Expiry date:</i> February 2012	Bycatch and environment	Identify byproduct, bycatch (including protected species) and impacts on the marine environment. Develop strategy for mitigating interactions with flesh-footed shearwaters and dolphins; and Identify long-term trends in composition and quantity of other bycatch.		Low levels of effort in West Coast Purse Seine fishery.
	Target species	Quota and catch to remain less than 10% of spawning biomass.		

APPENDIX 5

Fisheries Research Division staff adjunct positions and supervision of students

Staff Member	Position
Lynda Bellchambers	Adjunct Researcher, Faculty of Natural and Agricultural Sciences, University of Western Australia
	PhD co-supervision, University of Western Australia, supervises Luke Thomas - 'Coral recruitment on a high latitude remote reef system.'
Matias Braccini	PhD co-supervision, Universidad de Mar del Plata, Argentina, supervises Marcelo Perez – 'Patrones de desplazamiento del gatuzo (<i>Mustelus schmitti</i>) en el Ecosistema Costero Bonaerense a partir de la técnica de marcación con marcas convencionales. Implicancias para el manejo y explotación del recurso' (in Spanish).
Simon de Lestang	PhD co-supervision, University of Western Australia, supervises Jean-Philippe Dumas - 'Examining sperm limitation as a contributing factor in recent low western rock lobster puerulus settlements.'
David Fairclough	Adjunct Senior Lecturer (Mar 2011 – Feb 2014), Centre for Fish and Fisheries Research, Murdoch University.
Danielle Johnston	Adjunct Senior Lecturer, School of Animal Biology, University of Western Australia
Brian Jones	Adjunct Professor, Murdoch University, School of Veterinary and Biomedical Sciences
	PhD co-supervision, Murdoch University, supervises Susan Keoh - "Diseases of Asian seabass or barramundi"
	MSc Co-Supervisor, University of Tasmania, supervises Graeme Knowles "Immunity and stress response in oysters"
Sagiv Kolkovski	EU COST Action LarveNet member
	MSc co-supervision, Edith Cowan University, supervises Justin King - 'Artemia production'
Craig Lawrence	Adjunct Associate Professor, The University of Western Australia
	PhD supervision, University of Western Australia, supervises Miriam Sullivan- Aquarium fish welfare
Rod Lenanton	Adjunct Associate Professor, Faculty of Sustainability, Environmental and Life Sciences, School of Biological Sciences and Biotechnology, Murdoch University.
Brett Molony	Member of Marine and Freshwater Course Consultative Committee, Edith Cowan University.
	Member of the Technical Advisory Panel (TAP) for the Swan River Trust
Stephen Newman	Adjunct Professor, Marine Ecology Group, School of Plant Biology, University of Western Australia.
	Adjunct Associate Professor, Faculty of Sustainability, Environmental and Life Sciences, School of Biological Sciences and Technology, Murdoch University

Staff Member	Position
Corey Wakefield	Masters co-supervision, University of Western Australia, supervises Claire Wellington – “Description and comparison of demersal fish assemblages of the continental slope of Western Australia”.
	Masters co-supervision, Victoria University of Wellington, supervises Natalie Stewart – “Population structure of Polyprionidae”.
	Adjunct Researcher, University of Western Australia.
	Honorary Research Fellow, Victoria University of Wellington, New Zealand.
Brent Wise	Adjunct Associate Professor, School of Mathematics and Engineering, Edith Cowan University.

GLOSSARY OF ACRONYMS

AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AIMWTMF	Abrolhos Islands and Mid West Trawl Managed Fishery
BPMF	Broome Prawn Managed Fishery
BRD	Bycatch Reduction Device
BRUVS	Baited Remote Underwater Video System
CAES	Catch and Effort Statistics
CDR	Catch and disposal record
CI/CKI	Christmas Island and Cocos (Keeling) Island
CILF	Christmas Island Line Fishery
CKIMAFF	Cocos (Keeling) Islands Marine Aquarium Fish Fishery
CPUE	Catch Per Unit Effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSLPF	Cockburn Sound (Line and Pot) Managed Fishery
CW	Carapace Width
DEC	Department of Environment and Conservation (formerly Department of Conservation and Land Management)
DFAC	Developing Fisheries Assessment Committee
EBFM	Ecosystem Based Fisheries Management
ECU	Edith Cowan University
EPBC	(Commonwealth Government) Environment Protection and Biodiversity Conservation (Act 1999)

ERLF	Esperance Rock Lobster Managed Fishery
ESD	Ecologically Sustainable Development
FED	Fish escapement device
FHPA	Fish Habitat Protection Area
FMO	Fisheries and Marine Officer
FRDC	Fisheries Research and Development Corporation
FRMA	Fish Resources Management Act
FRR	Fisheries Research Report
GAB	Great Australian Bight
GDSF	Gascoyne Demersal Scalefish Managed Fishery
HMAS	Her Majesty's Australian Ship
IBSS	Independent Breeding Stock Survey
IFM	Integrated Fisheries Management
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IMP	Introduced Marine Pests
IMS	Introduced Marine Species
ISO	International Organisation for Standardisation
ITQ	Individual Transferable Quota
IUCN	International Union for the Conservation of Nature
JANSF	Joint Authority Northern Shark Fishery
JASDGLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery

KGBF	Kimberley Gillnet and Barramundi Managed Fishery
KPMF	Kimberley Prawn Managed Fishery
LASCF	Lake Argyle Silver Cobbler Fishery
MAF	Marine Aquarium Fish Managed Fishery
MBP	Marine Bioregional Plan
MFL	Managed Fishery Licence
MOP	Mother-of-Pearl
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NBPMF	Nickol Bay Prawn Managed Fishery
NDSF	Northern Demersal Scalefish Managed Fishery
NPF	Northern Prawn Fishery
NRM	Natural Resource Management
NTAC	Notional Target Total Allowable Catch
OCL	Orbital Carapace Length
OPMF	Onslow Prawn Managed Fishery
PFRF	Pemberton Freshwater Research Centre
RAP	Research Angler Program
RCL	Rostrum Carapace Length
RFBL	Recreational Fishing from Boat Licence
RFFSS	Recreational Freshwater Fisheries Stakeholder Subcommittee

RRAMF	Ranked Risk Assessment of Multiple Fisheries
SBBSMNF	Shark Bay Beach Seine and Mesh Net Managed Fishery
SBCIMF	Shark Bay Crab Interim Managed Fishery
SBSF	Shark Bay Snapper Managed Fishery
SCRIP	Strategic Criteria for Rural Investments in Productivity
SCTF	South Coast Trawl Fishery
SEWPac	(Commonwealth Government) Department of Sustainability, Environment, Water, Population and Communities (formerly Department of Environment, Water, Heritage and the Arts)
SFD	Standard Fishing Day
SIEV	Suspected Illegal Entry Vessel
SLED	Sea Lion Exclusion Device
SMFG	Size Management Fish Ground
SSF	Specimen Shell Managed Fishery
SWCC	South West Catchment Council
SWTMF	South West Trawl Managed Fishery
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TAE	Total Allowable Effort
TARC	Total Allowable Recreational Catch
TDGDLF	Western Australian Temperate Demersal Gillnet and Demersal Longline Fisheries
TEP	Threatened, Endangered and Protected
UWA	University of Western Australia

APPENDICES

TPSA	Tiger Prawn Spawning Area
VFAS	Voluntary Fisheries Adjustment Schemes
VMS	Vessel Monitoring System
WAFIC	Western Australian Fishing Industry Council
WAFMRL	Western Australian Fisheries and Marine Research Laboratories
WAMSI	Western Australian Marine Science Institute
WANCSF	Western Australian North Coast Shark Fishery
WCB	West Coast Bioregion

WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery
WCDSF	West Coast Demersal Scalefish Fishery
WCDSIMF	West Coast Demersal Scalefish (Interim) Managed Fishery
WCEF	West Coast Estuarine Managed Fishery
WCRLF	West Coast Rock Lobster Managed Fishery
WDWTF	Western Deepwater Trawl Fishery
WTO	Wildlife Trade Operation