

Research, Monitoring, Assessment and Development Plan 2010 – 2011

Department of Fisheries, Western Australia



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

Fisheries Research Division

Western Australian Fisheries and Marine Research Laboratories
PO Box 20 NORTH BEACH, Western Australia 6920

Fish for the future

Department of Fisheries
3rd floor SGIO Atrium
168-170 St George's Terrace
PERTH WA 6000
Telephone: (08) 9482 7333
Facsimile: (08) 9482 7389
Website: www.fish.wa.gov.au
ABN: 55 689 794 771

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Table of Contents

INTRODUCTION	4
Background	4
Potential uses of the plan	6
Description of the report structure	7
INDICATIVE PRIORITIES FOR NEW RESEARCH AND DEVELOPMENT PROJECTS 2010-2012	8
COLLABORATIVE PROJECTS 2010/11	10
RECREATIONAL FISHING RELATED PROJECTS 2010/11	13
STATE-WIDE	15
State-wide – Strategic Research and Development Activities	15
State-wide – Ecosystem Based Fisheries Management	18
State-wide – Biosecurity (Diseases and Aquatic Health)	22
State-wide – Biosecurity (Pest Incursions)	24
State-wide – Specimen Shell Managed Fishery	26
State-wide – Marine Aquarium Fish	27
WEST COAST BIOREGION	29
West Coast – Biodiversity & Ecosystem Issues	29
West Coast – Abrolhos Islands FHP Region	33
West Coast – West Coast Demersal Scalefish Fishery	37
West Coast – Western Rock Lobster	41
West Coast – Nearshore and Estuarine Finfish Resources	46
West Coast – Purse Seine Fishery	50
West Coast – Abrolhos Islands and Midwest Trawl, South West Trawl and South Coast Trawl Fisheries	52
West Coast – Blue Swimmer Crab Fishery	55
West Coast – Abalone Managed Fishery	59
West Coast – Deep Sea Crab Fishery	62
West Coast – Octopus Fishery and Aquaculture	65
West Coast – Artemia Aquaculture	67
GASCOYNE COAST BIOREGION	69
Gascoyne – Biodiversity Issues	69
Gascoyne – Gascoyne Demersal Scalefish Fishery	71
Gascoyne – Blue Swimmer Crab Fishery	75
Gascoyne – Exmouth Gulf Prawn Fishery	78
Gascoyne – Inner Shark Bay Scalefish Fishery	82
Gascoyne – Shark Bay Prawn Fishery	85
Gascoyne – Shark Bay Scallop Fishery	89

NORTH COAST BIOREGION	94
North Coast – Biodiversity Issues	94
North Coast – Mackerel Fishery	96
North Coast – Beche-de-mer Managed Fishery	98
North Coast – Nearshore Fisheries	100
North Coast – Pearl Oyster Managed Fishery and Pearl Production	102
North Coast – Demersal Fisheries	106
North Coast – Shark Fisheries	110
North Coast – Northern Prawn Managed Fisheries	114
SOUTH COAST BIOREGION	119
South Coast – Biodiversity Issues	119
South Coast – Greenlip and Brownlip Abalone Fishery	120
South Coast – Crustacean Fisheries	123
South Coast – Nearshore and Estuarine Finfish Resources	126
South Coast – Purse Seine Fishery	129
South Coast – Trawl Fishery	131
South Coast – Temperate Demersal Gillnet and Longline Fisheries	133
South Coast – South Coast Demersal Fishery	136
NORTHERN INLAND BIOREGION	139
Northern Inland – Biodiversity Issues	139
Northern Inland – Lake Argyle Silver Cobbler Fishery	140
SOUTHERN INLAND BIOREGION	141
Southern Inland – Biodiversity Issues	141
Southern Inland – Freshwater Aquaculture	144
Southern Inland – Recreational Marron Fishery	147
Southern Inland – Recreational Freshwater Angling	149

Introduction

Background

The 2010/11 Research, Monitoring, Assessment and Development Plan (RMAD Plan) for the Department of Fisheries outlines the current and proposed activities to support the collection and analysis of data to assist the Department meet the objectives of the *Fish Resources Management Act* (1994) over the coming five year period. The change in name for this edition reflects that a large proportion of the activities undertaken for management are assessment and monitoring rather than new ‘research’, the name of this year’s edition has been revised. This distinction in terminology is also consistent with the directions of the PIMC approved National RD&E framework (CoA, 2010)¹.

The RMAD Plan specifically focuses on those activities that are currently planned or have already been identified which directly contribute to the effective management of the aquatic resources of Western Australia through the management of a specific fishery, aquaculture sector or any other activity directly managed through the FRMA. Consequently, it not only documents the research, monitoring and assessment activities being done directly by the Department, but covers any relevant activities being done by other agencies that have been identified as being directly relevant to a particular fishery/sector/asset or issue. Given the dynamic nature of aquatic resource management, this plan is updated on an annual basis based on current priorities and risks. This plan should, therefore, be read in conjunction with the most recent *State of Fisheries and Aquatic Resources* report where comprehensive analyses of the current status of each of WA’s fisheries and other aquatic resources (assets) are described.

The plan is generated from an aquatic resource management perspective and therefore may not cover all research and development activities required to assist the commercial operations of a fishery. Thus, many industry development activities such as marketing are not covered in a comprehensive fashion. The Department acknowledges that such priorities are best determined and managed directly by industry. Similarly, the plan does not document all marine related research being undertaken in WA especially where this is focused on the discovery of new scientific knowledge with no linkage to management.

The focus for the monitoring, assessment or research activities currently being undertaken within each of the sectors documented in this plan have been the result of deliberations and discussions by internal Departmental committees and, for many sectors, with direct input from relevant industry/sector working groups and advisory bodies. Thus, where specific industry/advisory group research plans exist, this document will have utilised this information.

Given the diverse levels of risk and differing relative community values associated with each of the various assets and sectors covered by the Department, there are large difference in the level of research, monitoring and assessment activities planned among the different fisheries and

¹ Commonwealth of Australia (2010) Working Together: the National Fishing and Aquaculture RD&E Strategy 2010. Fisheries Research and Development Corporation for the Strategy Working Group
<http://www.frdc.com.au/LiteratureRetrieve.aspx?ID=65590>

ecosystems. These differences also reflect differential levels of ongoing information required to enable each of the current management processes to operate effectively and generate acceptable, cost effective outcomes.

To determine priorities, the Department is now applying formal risk assessment and risk management techniques to each of the ecological, social and economic assets within each bioregion, using the Ecosystem Based Fisheries Management (EBFM) Framework (Fletcher *et al.*, 2010)². The annual update of the RMAD Plan will therefore be based on the updated risk profiles across the range of objectives listed within the FRMA which should ensure that resources are directed to those areas with the highest overall community priority. The risk values are as outlined in the current State of the Fisheries and Aquatic Resources Report (DoF, 2010). When the new internal and external consultation framework that is currently being developed by the Department, in conjunction with WAFIC and RecFishWest, is fully implemented, it is expected that these forums will be the basis for finalising priorities for future editions of the RMAD Plan. It is expected that these new processes will increase the consistency and transparency across all fisheries and sectors.



INTRODUCTION FIGURE 1

Map of Western Australia showing the general boundaries of the bioregions referred to throughout this document.

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

Potential uses of the plan

From an internal Departmental perspective, it is essential to have a consolidated document that outlines the agreed research, assessment and monitoring requirements for each aquatic resource asset and sector within WA. It needs to be recognised that most of the activities (about 80%) outlined in the plan are ongoing monitoring or assessment activities, not new 'research' projects. The frequency of some monitoring programs is being reviewed so that the resulting stock assessments can be scheduled to align with the timing of management reviews. This should optimise the use of limited capacity in areas such as stock assessment and simulation modelling.

The plan provides the mechanism to identify and track any major gaps in knowledge, resources and expertise which assists capacity planning, future funding applications and planning in a broader context. Each of the reports identifies what needs to be done, but also summarises what has already been done. This should minimise the development of unnecessary research proposals for issues already adequately covered by previous research or for issues where no management risks have been identified. Consequently, the current risk levels for each of the bioregional resource assets relevant to each report are now listed and updated annually.

The introductory section of the plan includes a report that outlines, from the Department's perspective, what new or additional research, assessment or monitoring initiatives will be needed for the management of Western Australia's aquatic resources in the coming few years. The introductory section also contains the consolidated list of projects and activities that have a material attribution to assisting manage the recreational sector. Finally, in recognition of the large number of collaborative projects that are underway, funded or proposed in WA, there is a list of the collaborative projects which will be used in management considerations. This includes all multi agency projects for which the Department is principal investigator (PI), and those where the lead agency is not the Department but we are a collaborator.

The information in this document should also be of benefit to a number of other groups:

- Each of the commercial industry and recreational sectors can use this document to facilitate their own discussions and formulation of their short and long term research priorities which they can then feed up through their relevant sector/peak body;
- Individual fishers can examine and compare the research that is occurring, or is proposed, in their fishery/sector. This knowledge may help increase the level of input received by the peak and sector bodies and therefore result in higher quality community and industry feedback;
- Other research institutes and universities can use the plan to assist in developing possible new projects to address the major research issues that have been identified;
- National research co-ordinating bodies such as the AFMF (including the RD&E framework) and major funding agencies such as the Fisheries Research and Development Corporation (FRDC), can use this information to assist in the future planning of national priorities and sub-program development;
- The general public and conservation groups will have the opportunity to comment upon the monitoring, assessment and research which is proposed or underway, in one of their areas of great general interest, fisheries and aquatic resources.

Description of the report structure

The new EBFM based framework identifies and assesses aquatic resources (assets) at a bioregional level, but for practical purposes many of the individual reports in this plan remain at the fishery or activity level. There are separate reports for each of the main wild-capture fisheries and each of the main aquaculture industries. Many of these reports do, however, report on all the activities associated with the management of one or more ecological assets (e.g. West Coast Demersal).

Within each bioregion there are reports outlining the activities examining broader ecosystem and biodiversity issues and some that cover Statewide issues. Given the overlapping nature of issues, when a project is dealing with more than one level of asset or more than one objective, the project can be repeated in more than one report.

Each of the reports has a brief overview of the sector/issue/resource asset being addressed plus a short summary description of previous relevant research or monitoring, including a list of recent publications. The current risk levels associated with the resource assets being addressed and therefore the focus of research are updated each year.

Following these background descriptions, most reports have a detailed matrix that is divided into a number of categories (based on EBFM/ESD principles) to clearly detail proposed activities. The categories used are:

- Retained/Key Species Stock Analysis (biology, stock assessment, fishery monitoring)
- Habitat and Ecosystem (bycatch, protected species interactions, habitat impacts, ecosystem effects and the environment)
- Management Analysis (Socio-economic surveys, Resource Access issues, Compliance Research, Management strategy evaluation)
- Industry Development (Production technology, post Harvest, Marketing, OHS)

Within the matrix each report documents:

- research topics already completed to at least a sufficient level for management,
- research/monitoring activities currently underway and the time frame for completion
- topics for which proposals have been submitted but not yet confirmed
- risk issues that have been identified by management which may require research/monitoring but are to yet be addressed.
- Comments concerning each of the issues relevant to the section (e.g. identifying any EPBC requirements) are also recorded.

The most common shorthand assessments are listed below:

Complete – Activity/project is complete, no more currently needs to be done.

Ongoing – Monitoring or assessment activity is continuing and occurs annually

Periodic – Monitoring or assessment activity occurs at regular intervals

Underway – A short term project has commenced and will continue for a defined period

Proposed – Research is proposed but unfunded

Not Needed – Risk level is too low to warrant dedicated research or monitoring activities.

Indicative priorities for new research and development projects 2010-2012

The following list of topics summarises the areas where new research or development requirements have been identified that are likely to be useful for resource management purposes and for which obtaining external funding will be required, or a significant shift in the allocation of internal funds will be needed. This list does not include studies that have been underway for more than a year; it also does not cover minor changes or planned shifts in ongoing monitoring projects.

The topics have been annotated to indicate where the research initiative is already:

* part funded, ** fully funded, # funding proposal pending.

If no annotation is provided it indicates that no funding is yet been found and no project proposal development has been initiated.

While this list will contain topics that are in the R&D priorities generated by the WA FRAB, in some cases there may be additions or omissions given the different scope of the Department's RMAD Plan requirements compared to the largely FRDC based scope of the WA FRAB list of priorities.

To assist in the use of this document, there is a distinction made between those issues that were listed last year from the new issues that have more recently been identified. Where the funding status has changed, *these items are indicated by being in italics*. It is encouraging that most of the projects listed last year have already had some success in attracting resources.

Statewide

- *Spatial and temporal dynamics of Western Australia's commercially important sharks, examining stock recovery and movement***
- *Developing mechanisms for cost effective monitoring of shore based and boat based recreational fishing at a Statewide level ***
- *Understanding environmental effects (and effect of climate change) on recruitment and other biological parameters for key indicator fish stocks***
- Developing a fully integrated project management platform*

New

- Management implications of climate effects on fisheries in WA**
- Understanding community preferences and expected outcomes for the use and access to WA's aquatic resources
- Minimising the complexity of fishery management systems #
- Aligning the planning for monitoring, stock assessment analysis and management review cycles for all wild capture fisheries in WA.*
- Determining the difficulties and benefits of expanding the EBFM framework to the EBM level.*
- Marine Pest monitoring at major WA ports

West Coast

- *Generating a better understanding of the relationships between rock lobster puerulus settlement, oceanographic conditions and spawning stock levels ***
- *Improved robustness for fishing efficiency for modelling rock lobster egg production.***
- *Determining the stock status of key nearshore finfish stocks***
- *Understanding the impact of management changes on behaviour of recreational fishers in West Coast demersal and nearshore fisheries ***
- *Stock assessment of developing minor fisheries (octopus) ***
- *Bio-economic assessments of WRL fishery***
- Developing indicators of natural and anthropogenic pressures on critical marine habitats at the Abrolhos Islands*

New

- Developing cost effective rock lobster habitat mapping methods #
- Determining critical habitat for juvenile Dhufish**
- Determining the relationship between algal habitats and juvenile lobster recruitment and potential impacts of range contraction. #

Gascoyne

- Stock assessment of Shark Bay crabs

North Coast

- *Stock status of key nearshore species, including barramundi and other recreational species (extending the threadfin work). **
- Updating and streamlining the monitoring and assessment mechanisms for demersal fish stocks in Pilbara and Kimberley regions.
- Investigating the long term recovery of demersal fish stocks and their associated habitats in the North West Shelf region.#

South Coast

- South Coast finfish stock status (inshore demersal)
- *Bio-economics of abalone stock enhancement***

New

- Assessment of brownlip abalone population parameters
- Commercialisation of abalone stock enhancement **

Inland

- *Baseline surveys of threatened native fish in South West Region***

Aquaculture

- Innovative solutions to support octopus production **

Collaborative Projects 2010/11

To improve the effective utilisation of research expertise and enhance the outcomes generated for management and the community in general, many projects now involve more than one agency. The proportion of collaborative projects undertaken to meet Departmental objectives has increased dramatically in the last decade and especially through the formation and funding by the WA State Government of the WA Marine Science Institution (WAMSI). The Department is a supporter of collaborative projects where there are clear benefits either in terms of efficiency or where the scope and comprehensiveness of the problem requires a broader range of expertise.

The following is the current list of collaborative projects listed within this RMAD Plan for which the Department is directly involved (i.e. has a formal and active involvement in at least one of the collection, analysis or interpretation of data) either as the lead agency (i.e. Principal Investigator) or as a formal co-investigator or even as a participant. The symbol (W) indicates a WAMSI project.

Project Title	Lead Agency	Collaborators
STATEWIDE		
Determination of catch and effort by recreational boat based fishers	DoF	Murdoch ECU
Applying the EBFM framework: Using the West Coast and Gascoyne Bioregions as case studies (W)	DoF	Murdoch Uni DEC
Qualitative modelling for development of EBFM case study (W)	DoF	Murdoch Uni CSIRO
Develop survey methods that can be used in an ongoing manner to cost effectively measure the catch of non commercial fishing sectors (W)	DoF	Murdoch TAFI
Modelling Recreational Fishing Behaviour (W)	UWA	Murdoch DoF
Assessment and monitoring methods for bycatch species composition and abundance (W)	DoF	Murdoch
Exploration of the effectiveness of alternative management responses to variable recruitment of fish	Murdoch	DoF
Understanding environmental effects (and effect of climate change) on recruitment and other biological parameters for key indicator fish stocks	DoF	CSIRO
Characterisation of native viruses in Australian prawns	DoF	SARDI
WEST COAST		
Examination of the impacts of the western rock lobster fishery on ecosystems within deep-water regions. (W)	DoF	Murdoch Uni ECU UWA
Examination of the impacts of the western rock lobster fishery on ecosystems within shallow water regions. (W)	ECU	DoF UWA
Development of bioregional level assessments of the status of community structure based on fishery dependent and/or fishery independent data (W)	UWA	DoF CSIRO
Establishment of indicator regions for long term monitoring of marine ecosystems (W)	UWA	DoF
Establishment of fishery dependent indicators of climate change (W)	DoF	CSIRO UWA
Fish indicators for monitoring estuarine health and that of black bream stocks and the implications for fish of algal blooms	Murdoch Uni	DoF Swan River Trust

Project Title	Lead Agency	Collaborators
Monitoring fish community structure in the Abrolhos Islands	UWA	DoF
Development of ecosystem models for the high priority estuarine regions of the Swan River, Peel Harvey and Leschenault Inlets and the coastal embayment of Cockburn Sound. (W)	Murdoch Univ	UWA DoF SRT ECU CSIRO
Evaluating how food webs and the fisheries they support are affected by fishing closures in Jurien Bay, temperate Western Australia (W)	Murdoch Uni	CSIRO DoF
Assessment of marine communities and the impact of anthropogenic influences (W)	UWA	DoF Murdoch Uni
Development of bioregional level assessments of the status of community structure based on fishery dependent and/or fishery independent data (W)	UWA	DoF Murdoch Uni
Evaluating the use of novel statistical techniques for determining harvest rates and efficiency increases in the Western Rock Lobster Fishery	DoF	VIMS TAFI
Decision-support tools for economic optimization of western rock lobster fishery	DoF	WRRLC
Evaluating source-sink relationships of the Western Rock Lobster Fishery using oceanographic modelling.	DoF	CSIRO
Identifying factors affecting the low western rock lobster puerulus settlement in recent years.	DoF	CSIRO
The effect of climate change on the western rock lobster fishery off WA	DoF	CSIRO
Evaluation of population genetic structure in the western rock lobster.	UWA	DoF CSIRO
The Biological Oceanography of Western Rock Lobster Larvae	UWA	DoF CSIRO Murdoch Uni
Assessing possible environmental causes behind the reduced colonization of puerulus collectors by a wide suite of species	DoF	UWA, WA Museum
Implications of mobility and stock structure of key indicator species for management of demersal scalefish in the West Coast Bioregion. (W)	DoF	Murdoch Uni CSIRO
Pink Snapper diet composition	Murdoch Univ	DoF
Predicting the impact of shifting recreational fishing effort toward inshore species	Murdoch Univ	DoF, RFW
Identification of critical habitats for juvenile West Australian Dhufish.	DoF	UWA
Assessment of stock structure and movement of nearshore finfish species	DoF	Murdoch University
Passive acoustic techniques to monitor aggregations of sound producing fish species	Curtin Uni	DoF
Socio-economic assessment of fisheries in the West Coast Bioregion (W)	UWA	Murdoch Uni DoF
GASCOYNE		
Population genomics tools for detecting and monitoring fine scale population patterns in recreational fish species at Ningaloo. (W)	CSIRO	DoF DEC
Ningaloo Reef - Biodiversity Assessment, Ecosystem Impacts of Human Usage and Management Strategy Evaluation. (W)	CSIRO	Curtin U DoF DEC
Minimising resource sharing issues in the Shark Bay Scallop fishery	DoF	UWA
NORTH COAST		
Development of a DNA microarray to identify markers of disease in pearl oysters (<i>Pinctada maxima</i>) and to assess overall oyster health	DoF	Uni Qld Macquarie Uni
Enhancing settlement and survival of <i>Holothuria scabra</i> for fishery enhancement	Tasmanian Seafoods	DoF, NT Fisheries
Sustaining productivity of tropical red snappers using new monitoring and reference points	QDPI	DoF NT
Relative efficiency of fishing gears and investigation of resource availability in tropical demersal scalefish fisheries (NDSF).	DoF	UWA

Project Title	Lead Agency	Collaborators
Connectivity and stock structure of reef species between WA and IOTs	JCU	DoF
Connectivity of shared stocks of deepslope snappers between WA locations, IOTs and the Indo-Pacific	Univ. Hawaii	DoF
Demography of serranids	JCU	DoF
SOUTH COAST		
Bioeconomics of abalone stock enhancement	DoF	WA Chem Ctr.
Using GPS technology to improve fishery dependent data collection in abalone fisheries	TAFI	DoF
Informing risk assessment through estimating interaction rates between Australian sealions and WA temperate demersal gillnet fisheries.	Murdoch Uni	DoF
INLAND		
Developing native fish research and policy strategies	DoF	DoW DEC
Native fish Breeding	DoF	UWA
Dam rehabilitation	DoF	DoW
Native fish surveys in south west	DoF	UWA

Recreational Fishing Related Projects 2010/11

The following is the current list of projects listed within this RMAD Plan for which there is a direct application to the management of recreational fisheries. Note, the activities listed below have been collated to a much greater degree than have been outlined in the main fishery level reports.

Project Title	Lead Agency	Collaborators
STATEWIDE		
Estimation of catch and effort by recreational boat based fishers	DoF	Murdoch ECU
Monitoring of catch and effort by Charter Boat based recreational fishers	DoF	Charter boat sector
Applying the EBFM framework: Using the West Coast and Gascoyne Bioregions as case studies (W)	DoF	Murdoch Uni DEC
Qualitative modelling for development of EBFM case study (W)	DoF	Murdoch Uni CSIRO
Develop survey methods that can be used in an ongoing manner to cost effectively measure the catch of non commercial fishing sectors (W)	DoF	Murdoch TAFI
Modelling Recreational Fishing Behaviour (W)	UWA	Murdoch DoF
Exploration of the effectiveness of alternative management responses to variable recruitment of fish	Murdoch	DoF
Understanding environmental effects (and effect of climate change) on recruitment and other biological parameters for key indicator fish stocks	DoF	CSIRO
WEST COAST		
Estimation of catch for metropolitan recreational abalone fishery	DoF	
Stock assessment of metropolitan abalone	DoF	
Monitoring of recruitment and breeding stock plus annual stock assessment and catch prediction for Cockburn Sound blue swimmer crab fishery	DoF	
Annual stock assessment of Peel Harvey blue swimmer crab fishery	DoF	
Recreational catch estimates for western rock lobster fishery	DoF	
Monitoring of recruitment levels and annual stock assessment of western rock lobster fishery	DoF	
Age structure monitoring of indicator species for nearshore finfish	DoF	
Age structure monitoring of indicator species for demersal finfish	DoF	
Long term beach seining & volunteer angling projects to monitor recruitment of some key species (whiting, tailor, herring, mullet, others)	DoF	
Research Angler program	DoF	
Fish indicators for monitoring estuarine health and that of black bream stocks and the implications for fish of algal blooms	Murdoch Uni	DoF Swan River Trust
Movement of pink snapper associated with spawning aggregations in Cockburn Sound (DoFWA).	DoF	UWA
Development of ecosystem models for the high priority estuarine regions of the Swan River, Peel Harvey and Leschenault Inlets and the coastal embayment of Cockburn Sound. (W)	Murdoch Univ	UWA DoF SRT ECU CSIRO
Pink Snapper diet	Murdoch Univ	DoF

Project Title	Lead Agency	Collaborators
Predicting the impact of shifting recreational fishing effort toward inshore species	Murdoch Univ	DoF, RFW
Egg survey/DEPM model for pink snapper in Cockburn Sound, BRUVS survey of juvenile recruitment.	DoF	UWA
Identifying factors affecting the low western rock lobster puerulus settlement in recent years.	DoF	CSIRO
The effect of climate change on the western rock lobster fishery off WA	DoF	CSIRO
Implications of mobility and stock structure of key indicator species for management of demersal scalefish in the West Coast Bioregion. (W)	DoF	Murdoch Uni CSIRO
Identification of critical habitats for juvenile West Australian Dhufish.	DoF	UWA
Assessment of stock structure and movement of nearshore finfish species	DoF	Murdoch University
Passive acoustic techniques to monitor aggregations of sound producing fish species	Curtin Uni	DoF
Socio-economic assessment of fisheries in the West Coast Bioregion (W)	UWA	Murdoch Uni DoF
GASCOYNE		
Egg production estimates of pink snapper spawning stock in each of the Shark Bay Gulf stocks.	DoF	
Integrated stock assessment model based estimates of pink snapper stocks	DoF	
Population genomics tools for detecting and monitoring fine scale population patterns in recreational fish species at Ningaloo. (W)	CSIRO	DoF DEC
Biodiversity Assessment, Ecosystem Impacts of Human Usage and Management Strategy Evaluation. (W)	CSIRO	Curtin U DoF DEC
Age based assessments and monitoring of spangled emperor in northern Gascoyne region	DoF	
NORTH COAST		
Age based assessment of nearshore finfish indicator species	DoF	
Defining the stock structure of northern Australia's threadfin salmon species	JCU	DoF
Demography of serranids	JCU	DoF
SOUTH COAST		
Research Angler program	DoF	
Annual trends in juvenile recruitment of nearshore finfish	DoF	
Monitoring of recreational catch of brown and greenlip abalone	DoF	
Age-based assessment of indicator species using 'weight-of-evidence' approach for nearshore (herring) and demersal finfish	DoF	
INLAND		
Annual stocking of trout fingerlings	DoF	
Annual assessment of recreational angling catch and effort	DoF	
Annual catch estimates of recreational marron fishing	DoF	
Fishery independent surveys of marron stocks	DoF	

State-wide

State-wide – Strategic Research and Development Activities

Description and Scope of Issues

This section covers the research and development initiatives being undertaken that are strategic in nature. In most cases the outcomes of these activities will be applicable across multiple fisheries and frequently across all or most bioregions. It also covers the activities that are being completed to improve the governance of the research needed to meet the requirements for fisheries management.

Summary of historical research and development completed

- Developed a framework for the completion of ESD based assessments of individual wild capture fisheries and aquaculture sectors within Western Australia.
- Developed risk analysis methodologies for assessing ecological, social and economic issues.
- Developed a multi-criteria analysis and spreadsheet system to prioritise research project applications
- Developed the methods to determine what are the most cost efficient ageing methods and sampling strategies to use to monitor the age structure of different fish stocks.
- The division of each bioregion into (for finfish) 5 suites of fishery resources - estuaries, nearshore, inshore demersal, offshore demersal and pelagic
- Generated a multi criteria system to identify which should be the key indicator species within each resource suite
- Development of the Weight of evidence approach using the small number of species and its application to WCDSF and transfer to other fisheries
- Use of TACCs for total catch and indicator species at a zonal and bioregional level as limits and for the application of IFM to a multi-species fishery

Current Research and Management Focus

- Developing the methods to apply the EBFM framework at a bioregional level
- Determining methods to generate risk and priority levels for at an agency level
- Trialling the use of qualitative modelling for use in fisheries management
- Examining the potential methods to enable market based transfer of shares between commercial and recreational sectors within an IFM framework
- Developing new cost effective methods to survey non-commercial fishing activities
- Implementing multi level project management systems
- Undertaking reviews of research priorities and programs
- Testing the benefits of social and economic research for fisheries management decision making
- Identification and collation of relevant existing environmental and oceanographic

information and datasets for Western Australia.

Priority Setting Process and Review Timeline.

- These projects are usually developed and prioritized by internal Departmental processes. The projects are usually stand alone and their outcomes are generally reviewed once the outputs can be examined as to whether they should be used to change the ongoing activities of the Department.

Recent Publications

- Craine, M., Rome, B., Stephenson, P., Wise, B., Gaughan, D., Lenanton, R. and Steckis, R. (2009). Determination of a cost effective methodology for ongoing age monitoring for the management of scalefish fisheries in Western Australia. Final FRDC Report – Project 2004/042. Fisheries Research report 192. 98 p.
- Dambacher, J.M., Gaughan, D.J., Marie-Joëlle Rochet, M-J., Rossignol, P.A. and Trenkel, V.M. (2009). Qualitative modelling and indicators of exploited ecosystems. *Fish and Fisheries* DOI: 10.1111/j.1467-2979.2008.00323.x
- Fletcher, W.J. (2009) ESD Reporting and Assessment Subprogram –Stage 2 Final report FRDC 2004/006. Fisheries Research Report 190, WA Department of Fisheries
- Fletcher, W.J. (2009) Implementing an ecosystem approach to fisheries management: lessons learned from applying a practical EAFM framework in Australia and the Pacific. Chapter 8 pp 112-124 *The Ecosystem Approach to Fisheries*. FAO Publications.
- Lenanton, R. C., Caputi, N. & Kangas, 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
- Green, J.T., Jones, B.J., Adlard, R.D., Barnes, A.C. 2008. Parasites, pathological conditions and mortality in QX-resistant and wild-caught Sydney rock oysters, *Saccostrea glomerata*" Aquaculture 280: 35-38.
- Millington, P. & Fletcher, W (2008) Geelong Revisited: from ESD to EBFM – future directions for fisheries management. Final Workshop Report FRDC Project 2008/057.
- Zepeda, C., Jones, J.B., Zagmutt, F.J. 2008. Compartmentalisation in aquaculture production systems. OIE Scientific and technical review 27(1): 229-241.
- Fletcher, W.J., Shaw, J., Metcalf, S.J. & Gaughan, D.J. (2010). An ecosystem based fisheries management framework: the efficient, regional-level planning tool for management agencies. *Marine Policy* 34:1226-1238

Key to symbols in the matrix/summary tables:

- Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

Strategic- State-wide Research and Development Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Identification of Indicator Species in each Bioregional Suite	Completed						This internal project was completed in 2004
Cost Efficient Ageing methodology and sampling strategies	Completed						An FRDC project was completed on this issue in 2008.
1.3 Stock Assessment							
Developed weight of evidence approach	Completed						First used in west coast demersal – method has been independently reviewed twice
1.4 Fishery Monitoring							
Cost effective surveys of non commercial fishing	Underway	█	█				Current FRDC project is nearly finished but a WAMSI funded component is still underway
Electronic collection of data	Proposed	O	O				This is a likely focus for future years
2. Habitat & Ecosystem							
Risk analysis procedures for assessing habitat and ecosystem issues	Completed						This was complete as part of the ESD subprogram work.
2.4 Ecosystem/Environment							
Collation of datasets	Underway	█	█				This is being done as part of a WAMSI 4.2 project
Potential impacts of climate change	Underway	█	█				This study examined the likely impacts of shift in temperature on species distributions in WA
2.5 Oceanography							
Potential scenarios for oceanographic conditions due to climate change	Underway	O					This is part of WAMSI Node 2 – It is intended that once this modelling is completed it will be linked to the impacts on species to develop fishery level scenarios
Collation of oceanographic datasets	Underway						This is being done as part of a WAMSI 4.2 project
3. Management Analysis							
3.1 Socio-economic							
Case Studies of the potential value of this information to management	Underway	█					This is part of WAMSI 4.5
3.2 Resource Access (Shares)							
A case study to determine how to shift shares between sectors	Underway	█					This is an FRDC project with rock lobsters as the case study
Developed method to monitor IFM shares in a multispecies fishery	Completed						Use of TACs at whole of suite and indicator level at the zonal and whole of bioregion to monitor catch shares.
3.3 Compliance							
Ongoing monitoring of compliance activities and levels of non conformance	Ongoing	█	█	█	█		
Compliance risk assessments	Ongoing	█	█	█	█		
3.4 Management Systems							
EBFM Frameworks	Underway	█					This is a WAMSI funded study. West coast case study nearly completed.

Strategic- State-wide Research and Development Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Qualitative modelling	Underway	<input checked="" type="checkbox"/>					This is examining how valuable this approach can be to assist in management decision making
Project Management Systems	Underway	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		
4. Industry Development							
5. Priority Review							
Research project application prioritisation criteria	Completed						This is located in Fisheries Occasional paper No. 4
Whole of agency prioritisation procedure	Underway	<input checked="" type="checkbox"/>					This links to the Departments risk register and the EBFM outcomes
6. Science Review							
Develop regular review program for each research project	Underway	<input checked="" type="checkbox"/>					

State-wide – Ecosystem Based Fisheries Management

Description and Scope of Issues

Ecosystem Based Fisheries Management (EBFM) is the latest phase in extending fisheries resource management systems to embrace the wider environmental, social and economic issues at the spatial scale of an ecosystem. The Department of Fisheries in Western Australia (WA) has followed the premise that EBFM deals with the aggregate management of all fisheries-related activities within an ecosystem or bioregion. EBFM requires the integrated management of all fishing activities within a region, not just single fisheries, to ensure that the cumulative impacts and the allocation amongst sectors are adequately managed to assist in achieving Ecologically Sustainable Development (ESD, Fletcher 2006) for all bioregions within WA.

The Department of Fisheries' commitment to EBFM emerged following the widespread international acknowledgement that traditional resource management may be unable to prevent unacceptable risks to targeted fish stocks, bycatch and ecosystems. EBFM also considers the impacts of non-fishing related change, such as pollution, coastal development and mining, on fishery resources and their associated ecosystems. It is recognised that any fisheries agency can only directly manage "fisheries related" activities (i.e. covered by the relevant Act/Legislation) and cooperation with other responsible Departments and Agencies is necessary to achieve EBFM.

Western Australian waters support a wide range of fisheries including the valuable western rock lobster fishery (West Coast and Gascoyne Bioregions), as well as demersal scalefish (West Coast, Northern and Gascoyne Bioregions), pearl oyster (Northern Bioregion) and abalone fisheries (multiple spp., Southern and West Coast Bioregions). In addition, WA contains a number of highly valued marine ecosystems, such as the Houtman Abrolhos Islands, Ningaloo Reef, Rottnest Island

as well as the Swan-Canning, Peel-Harvey and Blackwood estuaries. With the continuation of fisheries harvest, in conjunction with increasing coastal development, mining, pollution and climate change, EBFM is necessary to underpin the sustainability of aquatic resources and ecosystems in WA.

Summary of historical research completed

EBFM is an extension of ESD, which was adopted by the Australian Government under the *National Strategy for Ecologically Sustainable Development*, in 1992. ESD replaced the earlier concept of single sector, species or stock management, and drove science and management to consider additional issues. These additional issues related to the environmental, social and economic aspects of fisheries and included the direct effects of fishing activity on habitat, the loss of biodiversity and genetic diversity, food-chain effects, by-catch and other likely flow on effects and benefits from fishing activity. When setting sustainable harvest levels for specific fisheries, these effects, as well as those from other fishing sectors, were considered. ESD also required consideration of governance arrangements (including regulation, compliance and education programs) and the social and economic issues associated with fisheries.

The Department of Fisheries, Western Australia is currently developing a framework to assess the most appropriate methodologies for the implementation of EBFM in Western Australia. EBFM aims to assess and manage ecological impacts as well as social and economic outcomes related to fish and fisheries at a regional (or ecosystem) level, rather than the fishery level assessed under ESD. The degree to which EBFM will be implemented in terms of activities or processes, additional to those fishery management processes currently in place for the Department, has yet to be ascertained.

Current Research Focus

A number of research activities are underway with regard to EBFM in WA, including many activities being undertaken by agencies other than the Department of Fisheries. The majority of activities have occurred with regard to the West Coast Bioregion with a similar process expected to occur in other Bioregions in the future.

- Applying the EBFM framework to the West Coast Bioregion, as a case study. This project includes a conceptual framework for EBFM and the identification of EBFM linkages (DoF/WAMSI).
- The assessment of community structure, biodiversity, habitat and climate changes, and the impact of anthropogenic influences (WAMSI/UWA/MU/DoF). This project includes bioregional level assessments of community structure, the establishment of indicator regions for long-term monitoring and cost-effective ongoing monitoring methods.
- Investigation into trophic interactions and ecosystem modelling (WAMSI/MU)
- Captured species assessments (DoF/WAMSI) including monitoring methods for bycatch species abundance and composition, and implications of mobility and stock structure of species.
- Socio-economic implications (DoF/WAMSI/UWA/MU) of current and proposed resource allocation decisions.

Priority Setting Process

WAMSI projects were developed by executive direction of the Department with research input.

Review Timeline

The projects falling into this R & D summary are varied and mostly short-term. Peer review of the projects has mostly been at the point of their submission as final reports.

Recent publications

Dambacher, J.M., Gaughan, D.J., Marie-Joëlle Rochet, M-J., Rossignol, P.A. and Trenkel, V.M. (2009). Qualitative modelling and indicators of exploited ecosystems. *Fish and Fisheries* DOI: 10.1111/j.1467-2979.2008.00323.x

Mackie, M.C., McCauley, R.D., Gill, H.S. and Gaughan, D.J. (2009). Management and monitoring of fish spawning aggregations within the West Coast Bioregion of Western Australia. Final FRDC Report – Project 2004/051. *Fisheries Research Report* 187. 237 p.

Craine, M., Rome, B., Stephenson, P., Wise, B., Gaughan, D., Lenanton, R. and Steckis, R. (2009). Determination of a cost effective methodology for ongoing age monitoring for the management of scalefish fisheries in Western Australia. Final FRDC Report – Project 2004/042. *Fisheries Research report* 192. 98 p.

Metcalf, S.J., Gaughan, D.J. and Shaw, J. (2009) Conceptual models for Ecosystem Based Fisheries Management (EBFM) in Western Australia. *Fisheries Research Report No. 194*.

Vieria, S., Schirmer, J. and Loxton, E. (2009) Social and Economic evaluation methods for fisheries: a review of the literature. *Fisheries Research Contract Report No. 21*.

Gaughan D.J., Craine M., Stephenson P., Leary T., Lewis P. (2008). Regrowth of pilchard (*Sardinops sagax*) stocks off southern WA following the mass mortality event of 1989/99. Final FRDC Report - Project 2000/135. *Fisheries Research Report No. 176*. 82 p.

Muhling, B.A., Beckley, L.E., Gaughan, D.J., Jones, C., Miskiewicz, A.G., Hesp, A. (2008). Spawning, larval abundance and growth rate of *Sardinops sagax* off southwestern Australia: influence of an anomalous eastern boundary current. *Marine Ecology Progress Series* 364: 157 - 167

Lenanton, R. C., Fletcher, W. J., & Gaughan, D. (2007) Integrated Fisheries Management in Western Australia – a significant challenge for fisheries scientists. In Phelan M. J. & Bajhau H. (Eds) *A guide to monitoring fish stocks and aquatic ecosystems*. Australian Society for Fish Biology Workshop Proceedings, Darwin, Northern Territory, 11 – 15 July 2005. *Fisheries Incidental Publication No.25*, Northern Territory Department of Primary Industry, Fisheries and Mines, Darwin.

Gaughan, D.J. (2007). Potential mechanisms of influence of the Leeuwin Current eddy system on teleost recruitment to the Western Australian continental shelf. *Deep Sea Research (II)*. 54: 1129–1140

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

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EBFM Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
West Coast and Gascoyne Bioregions: Implications for mobility and stock structure	Underway	■					
1.3 Stock Assessment							
All Bioregions: Captured species assessments	Ongoing	■	■	■	■	■	
1.4 Fishery Monitoring							
West Coast and Gascoyne Bioregions: Developing new, more efficient methods to quantify recreational catches	Underway	■					
2. Habitat & Ecosystem							
2.1 Bycatch							
All Bioregions: Assessment and monitoring methods for bycatch species composition and abundance	Underway	■					South Coast trawl, Northern shark fishery, Nickol Bay and Kimberly prawn fisheries
2.2 Listed Species							
2.3 Habitat							
West Coast Bioregion: A multi-metric index of estuarine health (Swan estuary) based on fish assemblage characteristics	Underway	■					This index is being developed through the Centre for Fish and Fisheries Research at Murdoch University.
West Coast Bioregion: Determination of indicator regions							
2.4 Ecosystem/Environment							
Gascoyne Bioregion: Investigation into trophic interactions	Underway	■					
West Coast Bioregion: Ecosystem modeling to identify ecological, social and economic linkages	Underway	■					Conceptual models published (DoF Research Report No. 194), further modelling underway.
Gascoyne, North and South Coast Bioregions: Ecosystem modeling to identify ecological, social and economic linkages	Developing (some underway)						Modelling focussed initially on the West Coast Bioregion and models for other Bioregions are still to be produced.
West Coast Bioregion: Designing and establishing a monitoring and assessment program to examine the differences between areas 'closed' and 'open' to rock lobster fishing off Jurien Bay.	Underway	■					Investigating the effects of rock lobster on the ecosystem as well as the impact of fishery removal of rock lobster on the remaining ecosystem.
Gascoyne Bioregion: Modelling to determine indicator species/groups for trophic change in deepwater systems impacted by the rock lobster fishery	Underway	■					Qualitative modelling being undertaken by DoF/MU.

EBFM Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
3. Management Analysis							
3.1 Socio-economic							
West Coast Bioregion: Improving understanding of recreational fisher behaviour in response to fisheries management	Proposed	O	O				Recreational fishing paper currently in review. Survey of recreational fishers being developed.
3.2 Resource Access (Shares)							
3.3 Compliance							
3.4 Management Systems							
All Bioregions: Whole of Government (state) agreement on the key marine ecosystems in WA	Completed						
All Bioregions: Risk assessment and construction of 'component trees' to identify assets (i.e. fisheries, ecosystems) in each bioregion	Completed						Undertaken by DoF. Publication outlining the process undertaken for the West coast Bioregion completed
4. Industry Development							
5. Priority Review							
6. Science Review			█				Part of WAMSI science review

State-wide – Biosecurity (Diseases and Aquatic Health)

Description and Scope of Issues

Australia's fisheries and aquaculture are the fastest growing primary industry sectors in terms of both job creation and average growth in production. In addition there is a growing recreational involvement in fishing. Western Australia is fortunate to have an aquatic animal sector relatively free from many diseases that cause significant economic impact elsewhere in the world and in the eastern states. Increasingly, disease is becoming a trade issue. The Department has responsibility under the Fish Resources Management Act (1994) for the control of exotic and endemic aquatic animal diseases in the State. Protecting the disease status of the state and the aquatic industries within the state requires that there is ongoing surveillance and monitoring for endemic and exotic diseases, the regulation and certification of production, imports and exports, and the capacity to detect and respond to diseases as they occur.

Relevant Resource Assets and Risks from all Activities

Statewide – Diseases and Pests

Moderate Risk

Summary of Historical Research Completed

The Fish Health Unit was formed in 1988 following an outbreak of disease in the state trout hatchery. The unit, from its inception, has been co-located within the Animal Health Laboratory of the Department of Agriculture and Food, bringing economies of scale through sharing of equipment and personnel. The unit has provided a disease diagnostic service to the seafood industries; has undertaken disease surveillance for key fisheries, including trout; dhufish; pearl oysters; prawns; yabbies, rock lobsters; mulloway, ornamental fish and barramundi. In addition, protocols for high health hatchery status have been developed and adopted by key industries.

Current Research Focus

The Fish Health Unit of the Department of Fisheries was formed in 1988 and is based at South Perth within the Animal Health Laboratories of the Department of Agriculture and Food. The unit is accredited to ISO 17025 and provides a diagnostic service to the fishing and aquaculture industry in Western Australia, 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. Greater emphasis has been placed on staff visiting aquaculture farms to encourage sustainable farming practices. Key activities are as follows:

Undertakes diagnostic services for industry

- The provision of export health certificates for yabbies and marron.
- The provision of pearl and finfish translocation certificates.
- Centre for receipt of notifiable diseases. The diseases were mostly records of iridovirus in ornamental fish, but there were three submissions of the fungus disease “Epizootic Ulcerative Syndrome” in Siamese fighting fish in November.
- 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 continued.
- In collaboration with staff from the Department of Water and the Water and Rivers Commission, investigates reports of ‘fish kills’ throughout the State.
- Assist with a range of national committees including the national Aquatic Animal Health Committee, the National Animal Health Strategy Advisory Group and Biosecurity Australia frequently seek the expertise of the Fish Health Unit.
- Provide one of 6 regional resource centres for aquatic animal health within the Network of Aquaculture Centres (NACA) in the Asia-Pacific.

Priority Setting Process and Review Timeline

Meetings between the Department of Fisheries and industry

Key to symbols in the matrix/summary tables:

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State-wide – Biosecurity (Diseases and Aquatic Animal Health)	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained/Cultured Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
1.2 Other Biology							
OOD research	Underway	█	█				
1.3 Fishery Monitoring							
Translocation certification	Ongoing	█	█	█	█	█	Fee per service basis
Characterise native viruses in prawns	Proposed	O	O	O			Funded
2. Habitat & Ecosystem							
2.1 Other impacts							
Fish Kill investigations	Ongoing	█	█	█	█	█	In conjunction with DoW
Disease Surveillance and monitoring	Ongoing	█	█	█	█	█	National reporting requirement
3. Management Analysis							
National Coordination	Ongoing	█	█	█	█	█	
4. Industry Development							
4.1 Production Technology							
Diagnostic Services	Ongoing	█	█	█	█	█	Fee per service basis
4.2 Post Harvest							
Provision of Export Certifications	Ongoing	█	█	█	█	█	Fee per service basis
4.3 Marketing							
5. Priority Review							
6. Science Review							

State-wide – Biosecurity (Pest Incursions)

Description and Scope of Issues

The issue of biosecurity, particularly marine biosecurity, is becoming critical for Western Australia. There are a number of national and international agreements that bind the state, including the *National System for the Prevention and Management of Marine Pest Incursions* (Marine IGA).

Within Western Australia, the Department of Fisheries is the lead Agency to develop and implement the necessary management arrangements and activities to, where possible, reduce the risk of introduction and translocation of aquatic pest animals and plants as well as animal and plant pathogens and diseases. These obligations also extend to the Indian Ocean Territories through contract agreements with the Federal government.

There are three overarching functions associated with the management of aquatic biosecurity:

- **Prevention** to reduce the risk of introduction of non-indigenous aquatic organisms into Western Australia and to manage the translocation of non-indigenous aquatic organisms within Western Australia using a risk based approach;
- **Emergency Response Management** (preparedness and response) to provide a co-ordinated emergency response to new incursions of non-indigenous aquatic organisms; and
- **On-going, risk based Management** to control introduced aquatic organisms already within Western Australia.

Relevant Resource Assets and Risks from all Activities

Statewide Diseases and Pests

High Risk

Summary of historical research completed

A literature review was conducted to collate existing knowledge on introduced marine species relevant to Western Australia. Currently 60 introduced marine species have been identified. This report served as the basis for a popular publication outlining the natural values of the Western Australian marine environment, the threat presented by introduced marine species, and what we can do about it.

An analysis of the current risks to WA ports and marinas, based on assessment of vessel movements, has been completed. Three WA ports have been identified on the national list of ports at high risk for introductions.

Current Research Focus

- To develop and facilitate stakeholder programs for ongoing monitoring of high risk areas Dampier, Port Headland, Albany Fremantle and Indian Ocean Territories for the translocation and introduction of invasive species
- To evaluate and improve methods for detecting monitoring and controlling invasive species incursions.

Priority Setting Process and Review Timeline

Department of Fisheries meeting with stakeholders, including Federal Government.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

State-wide – Marine Pest Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
1.2 Other Biology							
1.3 Port Monitoring	Ongoing	█	○	○	○		In association with stakeholders
2. Habitat & Ecosystem							
2.3 Habitat		█	█	○	○		Monitoring habitat
2.5 Oceanography							
2.6 Other impacts on fishery		█	█	○	○		Evaluating pest status
3. Management Analysis							
3.1 Socio-economic							
3.2 Compliance							
4. Management Systems		█	█	○	○		Risk evaluation in association with stakeholders
5. Priority Review							
6. Science Review							

State-wide – Specimen Shell Managed Fishery

Description and Scope of Issues

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

Up to 550 different shellfish species are collected by hand by a small group of divers operating from small boats in shallow coastal waters. While the fishery covers the entire Western Australian coastline, there is some concentration of effort in areas adjacent to population centres such as metropolitan Perth, Bunbury, Albany and Port Hedland.

Relevant Resource Assets and Risks from Fishery

Statewide Nearshore Molluscs

Low Risk

Summary of historical research completed

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 were identified by Ponder and Grayson as potentially

vulnerable comprised 6 cowries and 2 volutes (*Amoria* spp.).

Current Research Focus

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

Priority Setting Process and Review Timeline

Meetings between the Department of Fisheries and industry

Annual reviews of data occur in June.

Given the small amount of activity no matrix is provided.

State-wide – Marine Aquarium Fish

Description and Scope of Issues

The Marine Aquarium Fish Managed Fishery (MAF) targets more than 250 species of fish under the management plan. Other management arrangements authorise fishers to 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 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 heavily weather-dependent due to the small vessels used. In addition, human constraints (i.e. physiological effects of compression) limit the amount of effort exerted in the fishery, the depth of water and the offshore extent where collections can occur.

Summary of historical research completed

Due to resourcing constraints the marine aquarium fish fishery is only assessed by compilation of catch data from the fishery in the form of the statutory monthly catch and effort returns.

Current Research Focus

Information provided by the fishery in the form of statutory monthly catch and effort returns is used as the basis to provide research advice for fisheries management. Statutory catch and effort reporting at the fine spatial scale of 10 minutes of latitude and longitude commenced in September 2004.

Priority Setting Process

Initial assessments were made through internal departmental meetings and forums discussing the history of research in the fishery, research activities that have been completed, current research as well as research and development gaps. Research issues have been discussed at annual industry consultation meetings once a year. Additional research needs have also been highlighted through the ESD assessment process.

Review Timeline

This fishery is of low priority relative to other fisheries in the State and is only reviewed when resources permit.

Given the small amount of activities no matrix is provided.

West Coast Bioregion

West Coast – Biodiversity & Ecosystem Issues

Description and Scope of Issues

The West Coast is characterised by exposed sandy beaches and a limestone reef system, which creates surface reef lines often about 5 km off the coast. Sea floors further offshore on the continental shelf are typically coarse sand interspersed with low limestone reef associated with old shorelines. There are few areas of sheltered water along the west coast, the exceptions being near the Abrolhos Islands, in the lee of some small islands off the mid-west coast, and behind Rottnest and Garden Islands off the 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 four significant estuarine systems, the Swan/Canning, Peel/Harvey and Leschenault estuaries and Hardy Inlet (Blackwood estuary), all of which are permanently open to the sea and form an extension of the marine environment except when freshwater runoff displaces the oceanic water for a short period in winter and spring.

Relevant Resource Assets and Risks from all Activities

WC Benthic - Estuaries	Severe (non fishing)
WC Benthic - Nearshore	Low
WC Benthic - Inshore Demersal	Low
WC Benthic - Offshore	Low
WC Protected species - non fish	Low
WC Protected species - non fish - mammals	Moderate
WC Protected species - fish	Negligible
WC Ecosystem - Estuarine	Severe (non fishing)
WC Ecosystem - Marine	Moderate
WC Abrolhos Ecosystem	Moderate
WC LN Ecosystem Estuarine	High (non fishing)
WC LN Ecosystem marine	Low
WC Introduced Pests & Diseases	Moderate (non fishing)

Summary of historical research completed

Bycatch: The Department of Fisheries conducted a study of the potential impacts on bycatch species and the benthic habitat of this region in the South West Trawl in the early 1990s and found minimal impact. Research to mitigate these interactions is developing such as the implementation of

Sea Lions Exclusion Devices (SLEDs) in 2006 in the Rock Lobster fishery.

Introduced Marine Pests (IMPs): Information has been gathered on the status of IMPs for Geraldton Port and Cockburn Sound.

Community structure and biodiversity: A long-term monitoring program to compare fish, rock lobster and sessile benthic communities inside and outside sanctuary zones of the NRM Swan region has been completed for the Swan Catchment Council (now Perth Region NRM). Marine Futures (NHT funded), the project collected baseline scientific data to develop marine resource indicators for marine habitats, biodiversity and human use patterns in SW Australia. The Strategic Research Fund for the Marine Environment (SRFME) undertook studies on several ecosystem topics in this bioregion including pelagic productivity cycles of oceanic waters, coastal and shelf biogeochemical modeling, and benthic ecosystem dynamics (algae, invertebrates and fish communities) in shallow (<20 m depth) waters. Focus areas for community ecology in this bioregion included Jurien Bay and Geographe Bay.

Current Research Focus

A number of research activities are underway within this bioregion, many are undertaken by agencies other than the Department of Fisheries.

- Interaction rates with threatened, endangered and protected species (TEPS) are now recorded on daily logbooks and Catch And Effort Statistics (CAES) forms.
- The physical impact of fishing with lobster pots on coral communities at the Abrolhos Islands, is being monitored. Information on a number of environmental variables is also being collected as part of this project to assess the impact of natural and anthropogenic effects on the marine habitats of the Abrolhos Islands.
- Bycatch Monitoring and Assessment - Establishing a risk analysis of interaction rates between the collective fisheries and bycatch to identify which species, species groups or fisheries require more detailed assessment (WAMSI 4.4.1).
- Deep water Lobster – (FRDC, WAMSI) this project focuses on determining the ecosystem effects of removing lobster from the ecosystem on the west coast bioregion.
- Introduced Marine Pests - A Monitoring Design Report (MDRT) for IMPs has been developed and approved by the National Introduced Marine Pest Coordination Group's (NIMPCG) Monitoring Design Assessment Panel (MDAP) for Fremantle Port. Implementation of this design has yet to commence.
- Jurien Bay studies – focuses on a host of projects in the marine environment on the West Coast of Western Australia.
- A substantial program of work on biodiversity and community structure in the Swan, Peel Harvey and Leschenault estuaries – WAMSI 4.2.1, 4.2.2 and 4.2.4.

Priority Setting Process

WAMSI projects were developed by executive direction of the Department with research input. The Department has developed a risk assessment process for the West Coast Bioregion under Its processes of considering Ecosystem Based Fisheries Management as a management goal.

Review Timeline

The projects falling into this R & D summary are varied and mostly short-term. Peer review of the projects has mostly been at the point of their submission as final reports.

Recent Publications

Bellchambers, L., Bridgwood, S., How, J., Lewis, P., de Lestang, S., Mackie, M., Coutts, T. (2009). Development of a long-term program to monitor coastal communities within the Swan region. *Fisheries Research Report 183*: 130 pp.

Gaughan, D.J., Pearce, A.F. and Lewis, P.D. (2009). Does the poleward boundary current off Western Australia exert a dominant influence on coastal chaetognaths and siphonophores? *Estuarine Coastal and Shelf Science* 83: 443–450

Wakefield, C.B., Johnston, D.J., Harris, D.C. and Lewis, P. (2009). A preliminary investigation of the potential impacts of the proposed Kwinana Quay development on the commercially and recreationally important fish and crab species in Cockburn Sound. *Fisheries Research Report 186*: 94 pp.

Johnston, D.J., Wakefield, C.B., Sampey, A., Fromont, J. and Harris, D.C. (2008). Developing long-term indicators for the sub-tidal embayment communities of Cockburn Sound. *Fisheries Research Report 181*: 113 pp.

Waite, A.M., plus many others including Gaughan, D.J. (2007). The Leeuwin Current and its eddies: an overview. *Deep-Sea Research II*. 54:789-996

Key to symbols in the matrix/summary tables:

█ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

West Coast Biodiversity Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
2. Habitat & Ecosystem							
2.1 Bycatch (Trawl fisheries)	Completed						Completed in the 1990s
Non – trawl Fisheries	Underway	█					WAMSI 4.4.1 - Captured species assessments: bycatch non trawl fisheries
2.2 Listed Species	Underway	█					WAMSI 4.4.1 - Captured species assessments: bycatch
Australian sea lion (ASL)	Completed						Studies to ameliorate catch of pups in rock lobster pots has been completed.
2.3 Habitat							
Developing RCTs for benthic habitats	Underway						MF – DoF, UWA WAMSI 4.2
Deepwater rock lobster habitat	Ongoing	█	█				Identification of deep and shallow water habitat is being conducted by WAMSI & FRDC funded projects

West Coast Biodiversity Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Habitat Mapping	Completed	O	O				Marine Futures mapped the habitat and biodiversity at the Abrolhos, Jurien, Rottnest and the Capes. Proposed to extend for lobster habitats
Coral habitats in Abrolhos	Ongoing						A DoF project is currently underway examining the effects natural and anthropogenic Impacts on sensitive coral habitats at the Abrolhos
Near shore seagrass	Ongoing						Seagrass communities are currently being studied by ECU as part of SRFME
Swan Catchment Council	Completed but part ongoing						A program to monitor rock lobster, fish and sessile benthic communities inside and outside of sanctuary zones at Rottnest Island, Marmion and Shoalwater Islands marine parks has been completed.
2.4 Ecosystem/Environment							
Trophic interaction, anthropogenic influences etc - Swan River, Peel Harvey, Leschenault	Underway						WAMSI 4.2 & 4.3.
Climate change, ecological processes	Underway						WAMSI Projects 1 & 2 (CSIRO, UWA, AIMS): e.g.
Western Rock lobster	Underway						FRDC deepwater ecology project and WAMSI are examining the effects of rock lobster fishing on the ecosystem It is likely that research will be ongoing in these areas
Ecosystem modelling	Underway						Currently being conducted by Murdoch University with FRDC and WAMSI funding in the estuaries and Jurien Bay region
Fish Kills	Ongoing						Gov't response to fish kills coordinated through Fisheries Research (Fish Health).
2.5 Oceanography							
Hydrodynamic modelling	Underway						Some fine- and broad scale work has been completed (e.g. CSIRO/DoF WRL larval dispersal model) WAMSI Projects 1, 2 & 3 (CSIRO, UWA, AIMS):
Nutrient/plankton cycles on shelf	Completed						Two Rocks transect - WAMSI node 1
Southern Surveyor Eddy cruise 1	Completed						cruise completed; papers accepted
Southern Surveyor Eddy cruise 2 – LC/shelf interactions	Underway						Data analysis underway. Another cruise is planned.
2.6 Other impacts on fishery							
Monitoring for Introduced marine pests	Proposed						This work has been developed under NRM and DAFF funding. Port monitoring plans will likely be funded by stakeholders In the future
3. Management Analysis							
3.1 Socio-economic							
Social assessment	Developing						WAMSI 4.5: implications of proposed resource allocations.
Economic Analysis	Developing						WAMSI 4.5: implications of proposed resource allocations
3.4 Management Systems	Underway						WAMSI 4.1. Applying EBFM framework.
	Developing						EPBC/NOO south west regional plan

West Coast Biodiversity Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
4. Industry Development							
5. Priority Review							
6. Science Review							

West Coast – Abrolhos Islands FHP Region

Description and Scope of Issues

The Houtman Abrolhos is a complex of islands and reefs located at the edge of the continental shelf between 28°15'S and 29°S, approximately 60km offshore from the mid-west coast of Western Australia and it is an extremely important component of the Western Australian environment. The “Abrolhos System” is of major significance for the conservation of flora and fauna, and is also significant in geological terms.

The adjoining State territorial waters contain some of the most highly valued marine systems in the State. Furthermore, these waters include the sites of some of the most important historic shipwrecks in Australia, with associated historic sites located on the islands themselves. In recognition of its importance, the Abrolhos was declared in 1999 as the first Fish Habitat Protection Area in Western Australia. It remains the largest in the State and is the only area in which DoF has primary management responsibility for the entire area (including the terrestrial component). A detailed overall management plan, released in 1998, is currently being revised. There are also management plans for tourism and aquaculture.

Relevant Resource Assets and Risks from all Activities

West Coast Abrolhos Ecosystem	Moderate
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West Coast Benthic Abrolhos	Low
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Summary of historical research completed

Chubb, C. F Webster, F. J., Dibden, C. J., Weir, K. E.2002. Towards an assessment of the natural and human use impacts on the marine environment of the Abrolhos Islands Volume 2: research and development plan. Western Australia Fisheries Department Fisheries Research Report 134 v2, 1-31.

Harriott, V. J. and Simpson, C. J.1997. Coral recruitment on tropical and subtropical reefs in Western Australia. *Proceedings 8th International Coral Reef Symposium*. 2, 1191-1196.

Harriott, V. J. 1998. Growth of the staghorn coral *Acropora formosa* at Houtman Abrolhos, Western Australia. *Marine Biology* 132, 319-325.

- Hatcher, B. G. 1985. Ecological research at the Houtman Abrolhos : high latitude reefs of western Australia. *Proceedings 5th International Coral Reef Symposium*. 6, 291-297.
- Hatcher, A. Hatcher, B.G. and Wright, G 1988. A preliminary report on the interaction between the major human activities and the marine environments at the Houtman Abrolhos Islands of Western Australia. Unpublished report for the Abrolhos Islands Task Force.
- Hatcher A. I., Wright, G. D. and Hatcher, B. G. 1990. resolving the conflict between conservation values and extractive use of the Abrolhos coral reefs. *Proceedings of the Ecological Society of Australia*. 16, 55-70.
- Sumner, N. 2008. An assessment of the finfish catch by recreational fishers, tour operators, commercial lobster fishers and commercial wetline fishers from the Houtman Abrolhos Islands during 2006. Fisheries Research Report 175, Department of Fisheries, Western Australia, 32pp.
- Van Herwerden, L., Choat, J. H., Dudgeon, C.L., Carlos, G., Newman, S. N., Frisch, A. and van Oppen, M. 2006. Contrasting patterns of genetic structure in two species of the coral trout *Plectropomus* (Serranidae) from east and west Australia: Introgressive hybridisation and ancestral polymorphisms. *Molecular Phylogenetics and Evolution*. 41, 420 - 435
- Van Herwerden, L., Choat, J. H., Newman, S. J., Leray, M. and Hillersøy, G. (2009) Complex patterns of population structure and recruitment of *Plectropomus leopardus* (Pisces: Epinephelidae) in the Indo-West Pacific: implications for fisheries management. *Marine Biology* **156**, 1595–1607.
- Watson, D. L., Harvey, E. S. and Nardi, K. 2008. Long term monitoring of the effects of fishing and protection on reef fish assemblages at the Houtman Abrolhos Islands. Final report for the Northern Agricultural Catchment Council (NACC). 72pp.
- Webster, F. J., Dibden, C. J., Weir, K. E., and Chubb, C. F. 2002. Towards an assessment of the natural and human use impacts on the marine environment of the Abrolhos Islands Volume 1: Summary of existing information and current levels of human use. Western Australia Fisheries Department Fisheries Research Report 134 v1, 1-120.
- Wells, F. 1997. 'The marine flora and fauna of the Houtman Abrolhos Islands, Western Australia. Western Australian Museum: Perth.

Current Research Focus

To develop programs to meet the following objectives:

- Assess the status of key indicator fish and invertebrate stocks distributed within FHPAs, particularly the Abrolhos FHPA.
- Satisfy the relevant fish and invertebrate abundance and biodiversity key performance indicators set to maintain the FHPAs, particularly the Abrolhos FHPA.
- Determine the effectiveness of the FHPA fish and fishery related management procedures.
- Establish a system of benthic habitat monitoring in the Abrolhos FHPA to provide a baseline against which future anthropogenic changes can be assessed.

Priority Setting Process

Assessments of required research are made through departmental meetings, which involve discussions of stock status, previous research conducted, current research and existing research gaps

required for more informed management. Relevant discussions of research outcomes and needs with stakeholder groups occur regularly.

Review Timeline

The management of the Abrolhos Islands was reviewed in 2007 (DoF 2007). – (FMP 220).

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

West Coast Abrolhos Islands FHP Regions Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reprod., diet, Natural mortality)							
Dhufish Regional Biology	Completed						
Dhufish Reproductive Biology	Completed						
Pink Snapper Biology	Completed						
Balchin Groper Biology	Completed						
Breaksea Cod Biology	Completed						
1.2 Other Biology							
Spawning Aggregations	Completed	■					Peer reviewed journal article In progress
Release Mortality	Completed						
Movement	Completed	■					Peer reviewed journal article In progress
Coral Trout Biology	Underway						PhD + ECU
Spangled Emperor Biology	Underway? Marriot In Gascoyne						
Red Throat Emperor	Underway	■	■	■			DoF and ECU
General fin fish assemblages	Ongoing	■	■	■	■	■	UWA
1.3 Stock Assessment							
Annual C & E Assessment	Ongoing	■	■	■	■		
Age Structure Models (indicator species)	Periodic						Every two years after management
1.4 Fishery Monitoring							
Commercial Catch & Effort	Ongoing	■	■	■	■		
Age Structure of Indicator Species	Ongoing	■	■	■			Baldchin Groper
Fishing Power							
Recreational Creel	Periodic						Periodic
Recreational Indicator	Developing						
Charter Boat Catch and Effort	Ongoing	■	■	■	■		Compulsory catch returns, annual reporting In SOF In relevant sections
2. Habitat & Ecosystem							

West Coast Abrolhos Islands FHP Regions Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
2.1 Bycatch							
2.2 Listed Species							
Foraging ecology of Australian sea lions	Completed	■					
2.3 Habitat							
Impacts on coral from potting	Ongoing	■	■	■			Study currently underway to examine the effects of anthropogenic and natural Impacts on sensitive habitats includes ROA's Further assessment of indicators will occur through WAMSI 4.2
Habitat mapping	Completed						Marine futures habitat mapping. Published In peer reviewed
QuickBird Assessment	Ongoing	■	■				Habitat mapping of the shallow water habitats (State NRM)
2.4 Ecosystem/Environment							
WC Bioregion ecosystem study							
WAMSI 4.2 developing indicator sites and measures	Ongoing	■	■				UWA and others
2.5 Oceanography							
2.6 Other impacts on fishery							
3. Management Analysis							
3.1 Socio-economic							
Social assessment							
Economic Analysis							
3.2 Resource Access (Shares)							
Detailed determination of access shares							
Monitoring of shares							
3.3 Compliance							
Validation of Catch Records							
3.4 Management Systems							
4. Industry Development							
4.1 Production Technology	None						
4.2 Post Harvest	None						
4.3 Marketing	None						
5. Priority Review							
6. Science Review							

West Coast – West Coast Demersal Scalefish Fishery

Description and Scope of Issues

The West Coast Demersal Scalefish Fishery (WCDSF) includes mostly line-fishing operations by commercial, charter and recreational sectors. Approximately 100 species are caught in the fishery each year, with fishers in each sector primarily targeting West Australian Dhufish (*Glaucosoma hebraicum*) and Pink Snapper (*Pagrus auratus*). Substantial catches are also taken of other species, such as Baldchin Groper (*Choerodon rubescens*), Red Throat Emperor (*Lethrinus miniatus*) and Bight Redfish (*Centroberyx gerrardi*). A range of species is taken in offshore waters, including Eightbar Grouper *Hyporthodus octofasciatus*, Hapuku *Polyprion oxygeneoisis*, Blue-eye Trevalla *Hyperoglyphe antarctica* and Ruby Snapper *Etelis carbunculus*.

Relevant Resource Assets and Risks from Fishery

West Coast Inshore Demersal finfish	High Risk
West Coast Offshore Demersal finfish	Moderate Risk
West Coast Protected Species	Negligible Risk
West Coast Inshore Habitats	Negligible Risk
West Coast Marine Ecosystems	Low Risk

Summary of historical research completed

Completed studies of the biology of the demersal indicator species include those of their reproductive biology, growth, age composition, mortality and diet. The biology of other demersal species has also been studied, including, for example, that of Breaksea Cod *Epinephelides armatus* and Western Blue Groper *Achoerodus gouldii*.

Recently completed work includes development of a modelling tool to allow simulations of behaviour and interactions between recreational fishers and demersal species (Murdoch University, FRDC) and a study of the genetic population structure of West Australian Dhufish in the West Coast Bioregion (CSIRO, WAMSI).

Current Research Focus

Focus - The current research focus is to monitor the degree to which the management actions are reducing the catch levels of the entire suite (and each of the indicator species) by each sector. The other focus of research is to determine if these reductions in catch are returning the level of harvesting (and stock abundance) of these species to acceptable levels.

Key Activities -

- Monitoring age compositions and assessments of fishing mortality of *G. hebraicum*, *P. auratus* and *C. rubescens* in the commercial and/or recreational sectors in the WCDSF for a stock assessment in 2012.
- Determining the stock structures of *G. hebraicum*, *P. auratus* and *C. rubescens* using genetic and otolith microchemistry techniques (WAMSI sub-project 4.4.2), in collaboration with Murdoch University, CSIRO and Department of Primary Industries Victoria. The project will also examine oceanographic influences on larval dispersal.

- Monitoring catch and effort by commercial fishers from daily/trip logbooks in conjunction with a vessel monitoring system.
- Onboard validation of logbooks is proposed.
- Monitoring of the numbers and species of fish taken as bycatch of the commercial rock lobster fishers is estimated annually from observer trips.
- Surveys of the numbers of *P. auratus* eggs in Cockburn Sound during the spawning season in 2010 to produce estimates of spawning stock biomass.
- Surveys of the relative abundance of recruited 0+ juvenile *P. auratus* in Cockburn Sound.
- Monitoring of movements to and from Cockburn Sound of adult *P. auratus*, tagged with acoustic transmitters, to investigate the fidelity of individuals to that embayment.
- Biology of *Plectropomus leopardus* at the Abrolhos Islands and investigation of spawning aggregations (ECU).
- The diet of *P. auratus* and *Pseudocaranx georgianus* as part of a study of food webs (Murdoch University).
- Identification of critical habitats for juvenile West Australian Dhufish (State NRM funded project)

Priority Setting Process

Assessments of required research are made through departmental meetings. Relevant discussions of research outcomes and needs with stakeholder groups occur regularly.

Review Timeline

Three indicator species (*G. hebraicum*, *P. auratus* and *C. rubescens*) are used to monitor and assess the health of the suite of species in the fishery. Two external independent reviews confirmed that these species were being overfished (Wise *et al.*, 2007; O'Neill, 2009).

A further stock assessment review of the indicator species will be completed in 2012.

Recent Publications

Coulson, P. G., Hesp, S. A., Hall, N. G., and Potter, I. C. (2009). The western blue groper (*Achoerodus gouldii*), a protogynous hermaphroditic labrid with exceptional longevity, late maturity, slow growth, and both late maturation and sex change. *Fishery Bulletin* **107**: 57-75.

Hesp, S. A., Burch, R. J., Tink, C. J. and Hall, N. G. (2010). *Development of an agent-based model to communicate implications of recruitment variability of finfish to recreational fishers*. Fisheries Research and Development Corporation Report, FRDC Project 2008/033, 81 pp.

Lenanton, R. C., Caputi, N. and Kangas, 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.

Langlois, T. J., Harvey, E. S., Fitzpatrick, B., Meeuwig, J. J., Shedrawi, G. and Watson, D. L. (2010). Cost-efficient sampling of fish assemblages: comparison of baited video stations and diver video transects. *Aquatic Biology* **9**, 155–168.

McLean, D.L., Harvey, E.S., Fairclough, D.V. and S.J. Newman (2010) Large decline in the abundance of a targeted tropical lethrinid in areas open and closed to fishing. *Marine Ecology*

Progress Series 418, 189-199.

- O'Neill, M. (2009). *Scientific review of the West Coast Demersal Scalefish Fishery, Western Australia*. Fisheries Occasional Publication No. 66, Department of Fisheries, Perth, Western Australia, 24 pp.
- Platell, M. E., Hesp, S. A., Cossington, S. M., Lek, E., Moore, S. E. and Potter, I. C. (2010). Influence of selected factors on the dietary compositions of three targeted and co-occurring temperate species of reef fishes: implications for food partitioning. *Journal of Fish Biology* **76**, 1255-1276.
- Wakefield, C.B. (2010). Annual, lunar and diel reproductive periodicity of a spawning aggregation of snapper, *Pagrus auratus* (Sparidae, Forster 1801), in a marine embayment on the lower west coast of Australia. *Journal of Fish Biology*. **77**, 1354-1378.
- Wakefield, C.B. and 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. *Cybium*, **32**, 321-324.
- Wakefield, C.B., Newman, S.J. and 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*, Advance Access.
- Watson, D. L., Anderson, M. J., Kendrick, G. A., Nardi, K. and Harvey, E. S. (2009). Effects of protection from fishing on the lengths of targeted and non-targeted fish species at the Houtman Abrolhos Islands, Western Australia. *Marine Ecology Progress Series*, **384**, 241-249.
- Watson, D. L., Harvey, E. S., Fitzpatrick, B. M., Langlois, T. J. and Shedrawi, G. (2010). Assessing reef fish assemblage structure: how do different stereo-video techniques compare? *Marine Biology* **157**, 1237–1250.
- Wise, B. S., St John, J. and Lenanton, R. C. (Eds, 2007). Spatial scales of exploitation among populations of demersal scalefish: implications for management. Part 1: Stock status of the key indicator species for the demersal scalefish fishery in the West Coast Bioregion. Final report to Fisheries Research and Development Corporation, Project 2003/052. Fisheries Research Report No. 163, Department of Fisheries Western Australia. 130 pp.

Key to symbols in the matrix/summary tables:

- Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

West Coast Demersal Scalefish Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, mortality)							
West Australian Dhufish biology (Adult)	Completed						Several studies completed.

West Coast Demersal Scalefish Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Juvenile West Australian Dhufish	Underway	█					Studies on juvenile recruitment indices, important locations for recruitment, mechanisms for larval dispersal (NRM & WAMSI). Limited data on larval biology.
Pink Snapper biology	Completed						Several studies completed.
Pink Snapper diet	Underway	█	█				Study of diet/food-webs (MU, FRDC)
Baldchin Groper biology	Completed						Studies completed in West Coast and Gascoyne Bioregions. No data on movement, larval biology, juvenile recruitment.
1.2 Other Biology studies							
Movement	Underway	█	█				Movement of pink snapper associated with spawning aggregations in Cockburn Sound (DoFWA).
Biology of Coral Trout	Underway	█					Abrolhos Islands, PhD at ECU
Stock structure of indicator species (genetics, microchemistry)	Underway	█					WAMSI 4.4.2
Food-webs of fishes in south-western Australia	Underway	█	█				FRDC (MU)
1.3 Stock Assessment							
Annual C & E Assessment	Ongoing	█	█	█	█	█	Commercial fishery, charter fishery
Fishing mortality assessments against benchmarks (indicator species)	Periodic		█				DoFWA
1.4 Fishery Monitoring							
Commercial, charter catch & effort	Ongoing	█	█	█	█	█	Logbooks (DoFWA)
Age Structure of indicator species	Ongoing	█	█	█	█	█	DoFWA
Recreational survey	Underway	█		█		█	West coast Bioregion boat ramp survey and phone/diary surveys based on boat license framework - repeated every second year
Recruitment strength	Ongoing	█	O	O	O	O	Egg survey/DEPM model for pink snapper in Cockburn Sound, BRUVS survey of juvenile recruitment.
Developing long term stock monitoring methods	Underway	█					Use of BRUVS to monitor demersal species, UWA/FWA.
Monitoring bycatch of demersal species in the Western Rock Lobster fishery.	Underway	█	█	█	█	█	Onboard observer programme (DoFWA)..
Testing use of passive acoustic methods for monitoring indicator species	Underway	█	█				Curtin (FRDC)
2. Habitat & Ecosystem							
2.1 Bycatch	Underway	█					WAMSI 4.4
2.2 Listed Species	Not needed						Low Risk
2.3 Habitat	Not needed						Low Risk from fishery.
2.4 Ecosystem/Environment Community structure	Underway	█					WAMSI WC Bioregion ecosystem study. Developing indicators of community structure for Abrolhos, Rottnest and Metropolitan regions
2.5 Oceanography	Underway	█					CSIRO (WAMSI) investigating oceanographic influences on dispersal of larvae of indicator species.
2.6 Other impacts on fishery							

West Coast Demersal Scalefish Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments		
3. Management Analysis									
3.1 Socio-economic									
Social assessment	Underway	█					WAMSI (UWA and MU)		
Economic Analysis	Underway	█					WAMSI (UWA and MU)		
Evaluation of Rec fisher incentives	Underway	█	O	O			WAMSI (UWA and MU)		
3.2 Resource Access (Shares)									
Determination of access shares	Underway	█							
Monitoring of shares	Ongoing	█	█	█					
3.3 Compliance research									
3.4 Management Systems									
	Underway	█					Exploration of the effectiveness of alternative management responses to variable recruitment (MU) - FRDC		
4. Industry Development									
5 Priority Review	Ongoing	█	█	█	█		Annual departmental industry meetings		
6. Science Review	Ongoing			█			Next review in 2012		

This assessment does not include the specific needs for the Abrolhos Islands region (see the Abrolhos Islands section for details).

West Coast – Western Rock Lobster

Description and Scope of Issues

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). With an annual production that averages about 11,000 t, this is Australia's most valuable single-species fishery.

Recreational: The recreational rock lobster fishery primarily targets western rock lobsters in the Perth metropolitan area and Geraldton, using baited pots and by diving.

Relevant Resource Assets and Risks from Fishery

West Coast Shelf Crustaceans (Lobsters)	Moderate Risk
West Coast Nearshore Molluscs (Octopus)	Moderate Risk
West Coast Protected Species (Sea lions)	Low Risk

West Coast Nearshore Habitats

Low Risk

West Coast Ecosystem (Marine)

Low – Moderate Risk

Summary of historical research completed

Research activities into the western rock lobster have been underway for decades with a large amount of research having already been completed. This research covers lobster biology, ecology, stock assessment and the examination of fleet and fishery dynamics. A comprehensive listing of all these projects is contained in the Draft Stock Assessment Document (<http://www.fish.wa.gov.au/docs/frr/frr180/index.php?0401>).

Current Research Focus

Focus - Research activities focus on the core business of assessing stock sustainability and the forecasting of future catch levels. Most recently the focus of research has been to try and explain the series of low puerulus settlements that have occurred during the past 4 years.

Activities - The main activities still involve undertaking fishery-independent monitoring of breeding stock levels and puerulus settlement. Industry performance is monitored through compulsory catch and effort records from both fishers and processors and comprehensive data from the voluntary logbook scheme, all of which are used for modelling and stock assessment.

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/docs/op/op071/fop71.pdf>).

The five projects listed below were submitted to the Fisheries Research and Development Corporation (FRDC) and were successful in securing funding. The objectives of the projects are to investigate various aspects of the possible causes and factors associated with the low puerulus settlements of 2007-08 and 2008-09.

Project 1 (FRDC 2009/018) Identifying factors affecting the low western rock lobster puerulus settlement in recent years.

Project 2 (FRDC 2008/087) Evaluating source-sink relationships of the Western Rock Lobster Fishery using oceanographic modelling.

Project 3 (FRDC 2009) Evaluating the use of novel statistical techniques for determining harvest rates and efficiency increases in the Western Rock Lobster Fishery.

Project 4 (FRDC 2009) Evaluation of population genetic structure in the western rock lobster.

Project 5 (FRDC 2008) Assessing possible environmental causes behind the reduced colonization of puerulus collectors by a wide suite of species.

An FRDC funded project to examine the effects of western rock lobster fishing on the deep-water ecosystem off the west coast of Western Australia has recently been completed. This project provided critical baseline data on the relationships between the abundance and size distributions of rock lobster and the different benthic habitats located in deeper waters, plus preliminary data on

diets and the trophic role of rock lobster within these depths. Further ecological research in deep waters will be based on comparing fished and unfished areas using research closures. This research is supported by the WAMSI and a new FRDC project that started in 2009. The aims of this project include negotiating a suitable closed area in deep water to assess the ecological impacts of fishing, developing cost effective methods to monitor benthic communities in deep water and the collection of baseline information on lobster stocks, habitats and community structure to facilitate comparisons between fished and unfished areas. The ultimate outputs of this project will enable any impacts of lobster fishing on deepwater ecosystems to be quantified.

Other projects examining lobster populations between fished and unfished zones is ongoing at Rottnest Island and in the Marmion Marine Park. These projects consists of annual sampling using pots and underwater dive surveys at Armstrong Bay and Parker Point sanctuary zones. Results from the first three years after the no-take regions were implemented have shown a rapid 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.

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. These trends, 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 been undertaken in most years. Estimates of recreational catch using this method are compared to the estimates from mail surveys. Phone diary surveys are considered to be more accurate than those from mail surveys because they eliminate the recall bias in the mail surveys and additionally, there is a higher participation rate in the survey from random sample selection. Sample sizes for the phone diary surveys have been increased since the 2006/07 survey to improve the accuracy of the result.

Research has commenced that aims to identify those parameters derived from mail surveys that are to be adjusted to lead to a catch estimate that is comparable to the diary survey estimates. Thus, mail survey effort estimates may be altered in the future. The comparison between effort levels from one season to the next season should, however, not be affected.

Priority Setting Process

Commercial: Until recently this was undertaken though the Rock Lobster Industry Advisory Committee (RLIAC) and subcommittees; annual RLIAC coastal tour. This will now occur through meetings between the Department of Fisheries and industry facilitated by WAFIC/Western Rock Lobster Council.

Recreational: Until recently this was undertaken by the Recreational Fishing Advisory Committee, a new process that will be facilitated by RecFishWest is in the process of being developed.

Review Timeline

A stock assessment workshop took place from 20 – 24 May 2010. The objectives of the workshop were motivated by the audit conditions set by the Marine Stewardship Council's auditors for the Western Rock Lobster Fishery (WRLF), as well as the need for regular review of the 2010 stock assessment. The workshop considered the structure of the current model to be appropriate, however its complexity could be simplified. The workshop also advised that more data sources and parameters should be incorporated within the model to improve its estimates of precision. A major outcome of the workshop was the development of an ITQ version of the model that also

incorporated many of the suggested changes made by the reviewers. This model is currently being tested with the aim of it forming the basis of future models. A report on this workshop will be released for public comment in 2010. The next MSC surveillance visit will be in November 2010.

Recent Publications:

Caputi, N., de Lestang, S., Feng, M. & Pearce, A. (2009). Seasonal variation in the long-term warming trend in water temperature off the Western Australian coast. *Marine and Freshwater Research*. 60: 129-139.

Caputi, N., Melville-Smith, R., de Lestang, S., Pearce, P. & Feng, M. (2009). The effect of climate change on the western rock lobster (*Panulirus cygnus*) fishery of Western Australia. *Canadian Journal of Fish and Aquatic Sciences*. in press

de Lestang, S., Caputi, N. & Melville-Smith (2009). Using fine-scale catch predictions to examine spatial variation in growth and catchability of *Panulirus cygnus* along the west coast of Australia. *New Zealand Journal of marine and Freshwater Research*. 43: 443-455.

Melville-Smith, R., de Lestang, S. & Thomson, A.W. (2009). Spatial and temporal changes in egg production in the western rock lobster (*Panulirus cygnus*) fishery. *New Zealand Journal of marine and Freshwater Research*. 43: 151-161.

Melville-Smith, R., de Lestang, S., Beale, N.E., Groth, D. and Thompson, A. (2009). Investigating reproductive biology issues relevant to managing the western rock lobster broodstock. Final Report to Fisheries Research and Development Corporation project 2003/005: 114 pp

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

West Coast Western Rock Lobster Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)	Ongoing	■	■	■	■	■	Still some work required
1.2 Other Biology							
Recruitment Dynamics	Underway	■	■				Investigating 2008/09 recruitment failure
Migration	Underway	■	■				
Lobster spawning rates	Underway	■					
By-product Octopus basic biology	Underway						The basic life history studied / recruitment
1.3 Stock Assessment							
Annual Assessment	Ongoing	■	■	■	■	■	
Develop New Model	Underway	■	■				New model being developed
Shallow Water Depletion Assess.	Underway	■	■				

West Coast Western Rock Lobster Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Deep Water Depletion Assessment	Underway	█	█				Initial trials underway
Change in Ratio and Index Removal	Proposed	█	█				Funded by the FRDC
1.4 Fishery Monitoring	Ongoing	█	█	█	█	█	
Commercial Catch & Effort	Ongoing	█	█	█	█	█	
Processor Returns	Ongoing	█	█	█	█	█	
Commercial Monitoring	Ongoing	█	█	█	█	█	
Puerulus Monitoring	Ongoing	█	█	█	█	█	
Research Logbooks	Ongoing	█	█	█	█	█	
Spawning Stock Survey	Ongoing	█	█	█	█	█	
Fishing Power	Ongoing	█	█	█	█	█	
Recreational Catch and Effort	Ongoing	█	█	█	█	█	
Stock & recruitment	Ongoing	█	█	█	█	█	
Meshed Pot monitoring	Ongoing	█	█	█	█	█	
2. Habitat & Ecosystem							
2.1 Bycatch	Ongoing	█	█	█	█	█	Monitoring
2.2 Listed Species	Ongoing	█	█	█	█	█	Monitoring of all interactions
Sea Lion Interactions and behaviour	Completed						Pot design to stop juvenile sea lions entering pots has been developed and implemented
2.3 Habitat	Ongoing	█	█	█	█	█	
Seagrass and Limestone reef effects	Completed						Sufficient for management
Coral Reef effects	Underway	█	█				Study at the Abrolhos Islands – annual monitoring of potential damage to coral
Habitat Mapping	Underway	█	█				FRDC proposal to use cameras as a method of obtaining habitat data now funded
Habitat - recruitment relationships	Proposal	O	O				FRDC proposal to understand relationship between habitat and puerulus recruitment requirements
2.4 Ecosystem/Environment	Ongoing	█	█	█	█	█	
Deep water ecosystem study	Underway	█	█	█			Closed area monitoring
Jurien Bay inshore	Completed						SRFME/WAMSI study
Dongara inshore	Completed						CSIRO studies in the 1980s
Rottnest and Metro Sanctuary zones	Underway	█	█	█	█	█	Comparing fished vs. unfished (DoF and ECU)
2.5 Oceanography	Underway	█	█				
Leeuwin Current monitoring	Ongoing	█	█	█			
Oceanographic Modelling	Underway	█	█				FRDC funded
Impacts of ocean conditions on catch rates	Underway	█	█				

West Coast Western Rock Lobster Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
2.6 Other impacts on fishery							Nothing identified
3. Management Analysis							
3.1 Socio-economic							
Bio-Economic modelling	Underway	█	█				CRC funding obtained
Economic Analysis (MEY)	Underway	█					Examination of Maximum Economic Yield
3.2 Resource Access (Shares)							
Determination of access shares	Periodic		█				Needed for IFM / ITQ
Monitoring of shares	Ongoing	█	█	█	█		Needed for IFM ITQ
3.3 Compliance							
Enforcement efficiency	Underway	█	█				
3.4 Management Systems							
Input vs output controls	Completed						Industry moving to Quota In 2010/11
4. Industry Development							
4.1 Production Technology							
Puerulus growout	First Stage Completed						Awaiting outcomes of policy on ownership of puerulus
More Efficient Lobster Pot Design		█					CRC project
4.2 Post Harvest							
4.3 Marketing							
5. Priority Review							
WRLC/WAFIC		█	█				Annual review of R&D plan
6 Science Review							
Stock Assessment	Ongoing		█	█	█	█	Last completed in detail in 2010
MSC audits	Ongoing	█	█	█	█		Yearly audits

West Coast – Nearshore and Estuarine Finfish Resources

Description and Scope of Fishery

The finfish resources in West Coast nearshore and estuaries waters are structurally complex, they are multi-sector (commercial, recreational and non-harvest), multi-species and some species comprise genetically distinct breeding stocks in different estuaries (e.g. black bream *Acanthopagrus butcheri* and cobbler *Cnidoglanis macrocephalus*). The commercial catch includes Australian salmon (*Arripis truttaceus*), whitebait (*Hyperlophus vittatus*), sea mullet (*Mugil cephalus*), Australian herring (*Arripis georgianus*), yellow-eye mullet (*Aldrichetta forsteri*), yellow-finned whiting (*Sillago schomburgkii*), southern sea garfish (*Hyporamphus melanochir*) and many other species. The recreational catch includes Australian herring, whiting (*Sillago* spp. and *Sillaginodes*

punctata), tailor (*Pomatomus saltatrix*), southern sea garfish, black bream and many other species.

The status of many stocks is strongly affected by non-fishing impacts, including coastal development, habitat degradation within estuary catchments and reduced river flows. These fisheries are small-scale and have relatively low commercial value but have high social, recreational and historical values.

Relevant Resource Assets and Risks from Fishery

West Coast Nearshore finfish	Moderate Risk
West Coast Estuarine finfish	Low Risk (Severe Risk from non fishing)
West Coast Protected Species	Negligible Risk
West Coast Nearshore Habitats	Negligible Risk
West Coast Estuarine Habitats	Negligible Risk (Severe from non fishing)
West Coast Estuarine Ecosystems	Low Risk (Severe from non fishing)

Summary of historical research completed

The basic biology is adequately understood for most captured species from an extensive set of research projects that have been undertaken mainly by the Department and Murdoch University over the past 30 - 40 years.

The recreational catch share of many key finfish species including herring, tailor, sea garfish and bream is >50%. The total recreational finfish catch share is now estimated to be at least 30% in the Peel/Harvey Estuary, 95% in the Swan/Canning Estuary, 50% in the Hardy Inlet/Blackwood River and 100% in all other estuaries of the region. This has implications for the collection of information because commercial catches can no longer be used to generate indices of abundance or provide samples.

Previous nearshore and estuarine recreational fishing surveys

There are a number of estimates of recreational fishing for finfish in nearshore waters of the West Coast Bioregion covering boat and shore based fishing dating back to the early 1970s. The most recent surveys in these regions have been restricted to boat based fishing.

Current Research Focus

The indicator species were selected for these resources using a risk assessment process. Indicators for estuaries are black bream, cobbler (estuary stocks only) and Perth herring. Indicators for the nearshore suite are Australian herring, tailor, whiting species, sea garfish, sea mullet and whitebait.

- Monitoring of these indicator species is based on fishery-independent surveys of annual recruitment, compulsory monthly catch and effort returns from commercial fishers and voluntary recreational logbooks.
- An NRM funded research project commenced in mid-2009 to develop a program to monitor the age structure and status of Australian herring and tailor, determine sources of recruitment to the West Coast fisheries and identify factors associated with annual recruitment variation.
- A recently funded NRM funded project will trial various methods to measure the

recreational catch of shore-based recreational fishers.

- Another project proposal is currently being considered by the FRDC Board that will examine other aspects of the West Coast nearshore fishery, focusing on various other nearshore species.
- There are a number of ecological projects also being completed by Murdoch University in the Swan-Canning, Peel-Harvey and Leschenault estuaries.

Priority Setting Process

A Departmental risk assessment was recently completed and issues are reviewed at regular internal meetings. Discussions are also held between the Department of Fisheries, industry members and peak bodies (Western Australian Fishing Industry Council, Recfishwest).

Review Timeline

Status of key nearshore stocks will be presented for internal review in late 2010. The science relating to whitebait stock assessments was reviewed extensively in 1996. This fishery was last reviewed in 2008 and is considered low risk. It will be reviewed within the next four years.

Recent Publications

Gaughan D, Ayvazian S, Nowara G, Craine M & Brown J. 2006. The development of a rigorous sampling program for a long-term annual index of recruitment for finfish species from southwestern Australia. Final Report FRDC Project 1999/153. Fisheries Research Report 154.

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

Smith K, Norriss J & Brown J. 2009. Population growth and mass mortality of an estuarine fish, *Acanthopagrus butcheri*, unlawfully introduced into an inland lake. Aquatic Conservation: Marine and Freshwater Ecosystems 19:4–13.

Key to symbols in the summary matrix:

- Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

West Coast Nearshore and Estuarine Finfish Resources Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Black bream	Complete						Adequate for management
Cobbler	Complete						Adequate for management
Sea mullet	Complete						Adequate for management
Whitebait	Complete						Adequate for management
King George & other whiting	Complete						Adequate for management

West Coast Nearshore and Estuarine Finfish Resources Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Tailor, Australian herring	Underway	█	O				Develop age-based monitoring of west coast fishery. Describe local growth rates and age structure. Available tailor data mostly from elsewhere, limited data from WA. NRM-funded project. FRDC funding application lead by Murdoch Uni. successful
Southern sea garfish	Proposed	O					Need to re-examine age structure, growth & reproduction. Available data mostly from other states, limited data from WA.
Perth herring	Proposed		O				Need to re-examine age & growth. Validate otolith annuli. Ages previously determined from scales & are unreliable.
Silver trevally	Funded	O	O	O			FRDC funding application lead by Murdoch Uni. funded
1.2 Other Biology							
Spawning, recruitment & stock structure of Australian herring and tailor	Underway	█					Examine spawning & recruitment dynamics to improve understanding of stock structure. NRM-funded project.
Whiting (other than KGW)	Funded	O	O	O	O		Review composition of 'whiting' suite of species in recreational catch. FRDC application lead by Murdoch Uni funded.
King George whiting	Funded	O	O	O			As above
Perth herring	Underway	█					Declining stock, highly vulnerable. Low fishery value but use as indicator species & important prey for higher value species. Studies of Swan R. larvae & genetics of West Coast populations underway.
1.3 Stock Assessment							
Annual trends in catch and CPUE	Ongoing	█	█	█	█	█	CAES data & recreational logbooks
Annual trends in juvenile recruitment	Ongoing	█	█	█	█	█	Beach seining, volunteer angling (tailor only)
Age-based assessment using 'weight-of-evidence' approach (herring)	Developing	█	O	O	O		Otoliths being collected (West & South Coasts). Develop ongoing monitoring. Update existing model. NRM-funded project. FRDC funded project lead by Murdoch Uni.
Age-based model (Swan River bream)	Underway	█					Murdoch Uni project.
1.4 Fishery Monitoring							
CAES	Ongoing	█	█	█	█	█	Limited. Minimal Swan R. & Hardy Inlet data, No Leschenault estuary data. No Geographe Bay data after 2009.
Boat based recreational survey	Underway	█	█		█		West Coast survey in 2010, state-wide phone diary survey in 2011 & then every 2nd year.
Shore-based trial recreational survey	Funded	█					Trial survey has been funded by State NRM
Voluntary recreational logbook	Ongoing	█	O	O	O		Research Angler Program (RAP)
Fishing tournament & club records	Ongoing	█	O	O	O		RAP
Age structure monitoring	Underway	█	O	O	O		Australian herring (W & S Coasts), tailor. Other Indicator species proposed
Cobbler	Proposed	O					Catch & release survey, use as indicator of estuary health
Recruitment Surveys	Ongoing	█	█	█	█	█	Long term beach seining & volunteer angling projects to monitor recruitment of some key species (whiting, tailor, herring, mullet, others)
2. Habitat & Ecosystem							

West Coast Nearshore and Estuarine Finfish Resources Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
2.1 Bycatch	Not needed						Low risk
2.2 Listed Species	Not needed						Low risk
2.3 Habitat	Proposed	O					Swan River fish communities (Murdoch Uni funded by, SRT & DoW)
2.4 Ecosystem/Environment							
Whitebait in Warnbro Sound	Completed						Critical prey for penguins (Murdoch Uni.). DEC developing project
Fish community surveys		■					Faunal surveys In Swan, Peel Harvey & Leschenault. Ecosystem modeling (Murdoch Uni projects).
Fish kills	Occasional	O					Opportunistic sampling, logistically difficult, limited resources available
Coastal habitat condition	Possible						Cumulative impacts of coastal developments
2.5 Oceanography	Not needed						Nothing identified
Leeuwin Current monitoring	Ongoing	■ ■ ■ ■ ■					Influence on larval dispersal & recruitment
2.6 Other impacts on fishery	Underway	O					Murdoch Uni. survey in Swan Estuary
3. Management Analysis							
3.1 Socio-economic	Not needed						
3.2 Resource Access (Shares)	Possible						
3.3 Compliance	Possible						
3.4 Management Systems	Underway	■ ■					Predicting impacts on shifting recreational fishing effort. (Murdoch)
4. Industry Development							Nothing identified
5. Priority Review		■ ■					
6 Science Review		■				O	

West Coast – Purse Seine Fishery

Description and Scope of Issues

The West Coast Purse Seine Fishery operates between latitudes 31°S and 33°S (the metropolitan fishery). There are also two purse seine development zones currently operating north and south of this area; the Northern Development Zone and the Southern Development Zone. The metropolitan fishery mainly targets both pilchards (*Sardinops sagax*) and sardinella (the tropical sardine *Sardinella lemuru*), the Northern Development Zone targets sardinella and the Southern Development Zone targets pilchards. There is no recreational fishery.

Relevant Resource Assets and Risks from Fishery

West Coast Pelagic

Low

Summary of historical research completed

Many aspects regarding the biology of this species, including its reproductive and distributional characteristics were determined through a major research project completed during the early-mid 1990s. This gathered data on the biology and stock assessment of pilchards in this region and other areas of WA. Directed research during the period 1999-2007 focused on fishery-independent spawning biomass surveys using egg production techniques and age structured samples, was completed as part of a six-year FRDC-funded project examining the regrowth of the pilchard stocks in WA following the two mass mortality events in the mid to late 90s. These biomass surveys and age monitoring programs have stopped.

Exploratory fishing for the *Sardinella lemuru*, offshore of Geraldton on the Midwest coast of Western Australia, in the early 1990s led to the establishment of a developmental purse seine fishery in this region. The biology and fishery for sardinella in WA was therefore investigated over a three-year period by the Department between July 1995 and June 1998 with the aim of providing stock assessment advice. Egg production techniques of estimating biomass were unsuccessfully attempted for this species.

Pilchards and other small pelagic fish are consumed by several species of seabirds, pinnipeds, cetaceans and protected sharks (white shark), but there is currently no evidence to indicate any major interactions between these and the purse seine industry in the West Coast Bioregion.

Current Research Focus

Given the current small size of the catch of both species in this region and the low risk to the stocks, the current level of research and monitoring is restricted to an annual examination of the commercial catch and effort data supplied by the fishers. The resources previously allocated were shifted to other, higher-risk fisheries in the southern bioregions.

Priority Setting Process

Priorities are reviewed on an annual basis through consultation between Scientists of the Finfish Branch (Research Division) and Fishery Managers.

Review Timeline

The science was reviewed extensively in the late 1990s and early 2000s while the fishery was recovering after the mass mortality events. This fishery was last reviewed in 2008 and is considered low risk will be reviewed within the next four years.

Recent Publications

Gaughan D.J., Craine M., Stephenson P., Leary T., Lewis P. (2008). Regrowth of pilchard (*Sardinops sagax*) stocks off southern WA following the mass mortality event of 1989/99. Final FRDC Report - Project 2000/135. Fisheries Research Report No. 176. 82 p.

Muhling, B.A., Beckley, L.E., Gaughan, D.J., Jones, C., Miskiewicz, A.G., Hesp, A. (2008). Spawning, larval abundance and growth rate of *Sardinops sagax* off southwestern Australia: influence of an anomalous eastern boundary current. Marin Ecology Progress Series 364: 157 - 167

Rogers, P., Gaughan, D. & Ward, T. (2006). Small pelagic fishes. In S. McClatchie, J. Middleton,

C. Pattiaratchi & G. Kendrick (eds), The South-west Marine Region: Ecosystems and Key Species Groups. The National Oceans Office (DEH, Govt. of Australia).

Given the small amount of activities no matrix is provided.

West Coast – Abrolhos Islands and Midwest Trawl, South West Trawl and South Coast Trawl Fisheries

Description and Scope of Fishery

The catches in all these fisheries are taken using low opening otter trawl systems. The Abrolhos Islands and Mid West Trawl Managed Fishery (AIMWTF) 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 (SWTMF) Fishery (includes Fremantle and Geographe Bay) is a multi-species fishery that targets western king prawns and saucer scallops. The South Coast Trawl Fishery (SCTF) principally targets scallops and associated by-products but licensees have an option to use other trawl gear to target fish species. Scallop landings for the fishery have varied dramatically over the years, depending primarily on the strength of recruitment. While the fishery has theoretical access to a large section of the coastal waters, it is effectively restricted to small areas of higher scallop abundance.

Relevant Resource Assets and Risks from Fishery

West Coast Nearshore Crustaceans	Moderate Risk
West Coast Protected Species	Negligible Risk
Abrolhos Habitats	Low Risk
LN Habitats	Low Risk
LN Ecosystem	Negligible Risk
Abrolhos Ecosystems	Negligible Risk

Summary of historical research completed

Research into the biological and environmental aspects of WA scallop stocks and commercial exploitation, has been carried out by the Department since the late 1960s, but mostly through work in Shark Bay and adapted to these other locations.

A survey of the bottom types in the Abrolhos Islands and mid-west Trawl fishery was undertaken in 1994. A detailed study of the SWTMF fishery in Geographe Bay was completed by the Department which examined the potential impacts on bycatch species and the benthic habitat of this region and found it had minimal impacts.

Current Research Focus

Prior to monitoring of the scallop stocks being undertaken using daily logbooks becoming mandatory in 2008, monthly catch and effort returns were used. In the AIMWTFM monitoring of the fishery through the use of daily logbooks and completing pre-season surveys is undertaken to forecast the following season's catch and to determine opening and closing dates. Due to low recruitment and apparent slow growth rate of scallops in parts of the Abrolhos Islands, additional sampling surveys have been undertaken in 2009 to collect scallop samples for analysis by Fish Health and monitor size composition. A small tagging study was undertaken in late 2009 to provide additional growth information. This additional sampling may continue into 2010 focussing on scallop health and meat quality. A funding proposal will be developed to allow further sampling in 2011 on a regular basis (in conjunction with sampling in Shark Bay) to investigate spatial and temporal trends in scallop growth and meat quality.

Square mesh cod-end trials were planned to take place in the Abrolhos Islands during the 2009 but due to low stock levels the fishery remained closed and the trials could not be undertaken. A short trial was completed during the 2010 fishing season but further commercial trials are required in Abrolhos Islands and/or in Shark Bay.

A comprehensive EPBC assessment of this fishery has determined that performance should be reported annually against measures relating to the `breeding stocks of target species (saucer scallop). Some information on ongoing bycatch levels and composition will be required to meet the requirements of the EPBC assessments. Some limited information has been gathered in the Abrolhos Islands during and the SC during a NHT funded project (UWA) in 2008. Some information on bycatch levels and composition will be required to meet the future requirements of the EPBC assessments for the SCTF if a re-application is made.

Priority Setting Process

Initial assessments were made through internal departmental meetings in 1998 discussing research undertaken, current research and research and development gaps and a plan was drafted for five years. Regular meetings (at least annually) have been held with the Research Division and the AIMWTFM licensees to discuss research priorities and planning. Additional research needs have also been highlighted through the ESD Assessment process for which a re-assessment has been completed in 2008.

Review Timeline

The five-year EPBC accreditation with the Commonwealth Department of Environment, Heritage, Water and the Arts was renewed in 2008 for the AIMWTFM. Some aspects of the research conducted in the Abrolhos Islands will be reviewed during the Shark Bay scallop research review held in August 2010.

Key to symbols in the matrix/summary tables:

- Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

West Coast Abrolhos Islands and Mid West Trawl Fisheries Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Scallop biology	Completed						Studies completed in the 1980's
1.2 Other Biology							
Recruitment Dynamics	Completed						Studies completed in the 1980's
1.3 Stock Assessment							
Stock-recruit-environ. effects	Ongoing	■	■	■	■	■	
Fishery independent surveys and monitoring	Annual	■	■	■	■	■	Determines forecasts of next years catch for AIMWTF
Survey indices-catch relationships	Ongoing	■	■	■	■		AIMWTF only
1.4 Fishery Monitoring							
Logbooks	Ongoing	■	■	■	■	■	
Pre-season skippers briefings	Ongoing	■	■	■	■	■	
Fishing power monitoring	Ongoing	■	■	■	■	■	
Processor returns	Ongoing	■	■	■	■	■	
Effort impact assessment (GIS)	Ongoing	■	■	■	■	■	EPBC requirement for AIMWTF
2. Habitat & Ecosystem							
2.1 Bycatch	-						
BRD Implementation	Completed						Implemented in 2003 for AIMWTF
Bycatch monitoring	Completed	○					NHT (MF) Funding for 07/08 –
Bycatch in trawled and untrawled areas	Completed						Study completed in 1990s for SWTMF Low Risk
2.2 Listed Species							
Listed species interactions - logbooks	Ongoing	■	■	■	■	■	EPBC requirement/MOU with DEWHA underway for AIMWTF, low risk in SWTMF
2.3 Habitat							
Habitat mapping and videoing – sensitive habitats	Completed						NHT (MF) Funding for 07/08, Low risk in SWTMF and study completed in 1990's.
2.4 Ecosystem/Environment							
Formal risk assessment	Periodic						EPBC requirement
2.5 Oceanography							
Leeuwin Current monitoring	Ongoing	■	■	■	■	■	
Modelling water movements and larval transport	Possible						In collaboration with UWA
2.6 Other impacts on fishery	Not needed						No other risk identified
Aquaculture sites	Possible						
3. Management Analysis							
3.1 Socio-economic							
Social assessment	Possible						
Economic Analysis –average price data	Ongoing	■	■	■	■		
Fuel consumption./expenses	Ongoing	■	■	■	■		

West Coast Abrolhos Islands and Mid West Trawl Fisheries Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
3.2 Resource Access (Shares)							
Rock Lobster – Scallop interaction	Underway						
Marine Park Planning	Ongoing	█	█	█	█		For all scallop fisheries
3.3 Compliance							
3.4 Management Systems							
4. Industry Development							
4.1 Production Technology							
Re-seeding	Ceased						FRDC funding – project now ceased.
Meat quality monitoring	Underway	O					Tri-monthly sampling in AIMWTF in 2009/10 Develop funding proposal for continued sampling In 20011
5. Priority Review							
Industry/Department Meetings	Annual	█	█	█	█	█	
6. Science Review	Periodic	█					Part of Scallop review in August 2010

West Coast – Blue Swimmer Crab Fishery

Description and Scope of Fishery

Blue swimmer crabs (*Portunus pelagicus*) are 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. Blue swimmer crabs are targeted using a variety of fishing gear. The commercial blue swimmer crab fisheries in the West Coast bioregion use traps in the Cockburn Sound Crab Managed Fishery, the Warnbro Sound Crab Managed Fishery, the West Coast Estuarine Managed Fishery (Swan, Peel Harvey), and the Mandurah to Bunbury Experimental Crab Fishery. Blue swimmer crabs are also retained by trawlers operating in Comet Bay.

Recreational crabbing is one of the most popular recreational fishing activities. In the West Coast bioregion it is centred largely on the estuaries and coastal embayments from Geographe Bay north to the Swan River and Cockburn Sound. While the majority of recreational fishers use either drop nets or scoop nets, diving for crabs is becoming increasingly popular.

Relevant Resource Assets and Risks from Fishery

West Coast Nearshore Crustaceans (Crabs)	Moderate - High Risk
West Coast Nearshore Habitats	Low Risk
West Coast Ecosystem (Marine)	Low Risk

Summary of historical research completed

Information on the biology and ecology of blue swimmer crabs in this region was generated through a number of FRDC-funded projects conducted by the Department of Fisheries and Murdoch University. An FRDC project completed in 2005 developed a catch prediction model for the Cockburn Sound blue swimmer crab fishery that forecasts future commercial catches within the Sound.

Data for the assessment of blue swimmer crab stocks in the West Coast Bioregion was mostly obtained from commercial catch and effort data. Additional programs now include on-board catch monitoring, and fishery independent trawl and trapping surveys conducted by the Department to provided information on the status of the spawning stock and subsequent strength of recruitment, along with data on the general crab population.

Current Research Focus

The decline in recruitment within the Cockburn Sound fishery resulted in the fishery being closed in December 2006. A comprehensive research program funded by the Minister through DIBF was developed for Cockburn Sound which included:

- Monitoring the recovery of the breeding stock and strength of recruitment in Cockburn Sound following the closure.
- Modifying and improving the juvenile index used in the catch-prediction model for the Cockburn Sound crab fishery including a residual index now incorporated into the model.
- An examination of the genetic difference between the Cockburn Sound stocks with those in Warnbro Sound and the Swan River was completed in 2008.
- Development of a commercial monitoring program for Warnbro Sound and Swan River crab fisheries.
- In addition, an assessment of the potential impact on Cockburn Sound crab stocks of the Fremantle Port Authority's Outer Harbour development proposed for the southern area of Jervois Bay was completed in early 2009.

Based on concerns, the sustainability of crab stocks in the Peel-Harvey Estuary, a research program for this region was also funded through DIBF. This involved:

- A comprehensive recreational survey undertaken between Nov. 2007 and Oct. 2008.
- A monthly commercial monitoring program to assess the impact of commercial fishing in the Peel-Harvey Estuary, Comet Bay and Mandurah-Bunbury fisheries.
- Fishery Independent monitoring of crab stocks inside and outside the Peel-Harvey estuary.

Priority Setting Process

Research priorities are set in consultation with management, and feedback obtained during meetings with industry and major stakeholder groups (WAFIC, RecFishWest) as required.

Review Timeline

Research advice has been presented to assist with the development of management guidelines for the 2007/08, 2008/09 and 2009/10 fishing seasons of the Cockburn Sound Crab (Managed) Fishery. The DBIF funded research project monitoring the recovery of the Cockburn Sound crab stock will

be completed at the end of 2010. The three year research project on crab stocks in the Peel-Harvey Estuary will be completed by the end of 2010. The recreational creel survey data on Peel-Harvey Estuary was made available during 2010.

Management arrangements in the Mandurah to Bunbury Inshore Developing Crab Fishery have been assessed as part of the Developing New Fisheries review process. Outcomes of this assessment are expected in late 2010.

Recent Publications

Johnston, D., Harris, D., Caputi, N. and Thomson, A. (2010). Decline of a blue swimmer crab (*Portunus pelagicus*) fishery in Western Australia – history, contributing factors and future management strategy. *Fisheries Research*. Submitted.

de Lestang, S., Bellchambers, L.M., Caputi, N., Thomson, A.W., Pember, M.B., Johnston, D.J. and Harris, D.C. (2010). Stock-recruitment-environment relationship for a *Portunus pelagicus* fishery in Western Australia. Proceedings from the Lowell Wakefield Symposium, Alaska. Submitted.

Wakefield, C.B., Johnston, D.J., Harris, D.C. and Lewis, P. (2009). A preliminary investigation of the potential impacts of the proposed Kwinana Quay development on the commercially and recreationally important fish and crab species in Cockburn Sound. *Fisheries Research Report 186*: 94 pp.

Johnston, D.J., Wakefield, C.B., Sampey, A., Fromont, J. and Harris, D.C. (2008). Developing long-term indicators for the sub-tidal embayment communities of Cockburn Sound. *Fisheries Research Report 181*: 113 pp.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

West Coast Blue Swimmer Crabs Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Blue swimmer crab biology, size at maturity and release mortality	Completed						Studies completed in 90's
1.2 Other Biology							
Genetic structure of populations	Completed						A study of genetic differences between Warnbro Sound, Cockburn Sound and Swan River was completed in 2008.
1.3 Stock Assessment							
Stock Assessment	Underway	■					For Cockburn Sound (DBIF funded)
	Underway	■					For Peel-Harvey Estuary (DBIF funded)

West Coast Blue Swimmer Crabs Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Annual C&E Assessment	Ongoing	■	■	■	■	■	For all commercial crab fisheries in West Coast Bioregion
1.4 Fishery Monitoring							
Commercial Catch & Effort	Ongoing	■	■	■	■	■	
Commercial Monitoring	Underway	■					Twice monthly for Cockburn Sound and Peel-Harvey, monthly monitoring in other west coast fisheries.
Recreational Catch and Effort – Cockburn Sound	Underway	■					Recreational crabbing survey for 2009/10 Cockburn Sound fishing season conducted.
- Peel-Harvey Estuary	Underway						Data collection for 12-month Peel-Harvey recreational survey completed in October 2008.
Fishery Independent Research Surveys – Cockburn Sound	Ongoing	■	■	■	■	■	Trawl surveys to determine recruitment and breeding stock levels.
– Peel-Harvey Estuary	Underway	■					Trap surveys to determine recruitment and breeding stock levels both inside and outside Estuary (DBIF funded project)
Stock & recruitment	Ongoing	■	■	■	■	■	Commercial catch prediction for Cockburn Sound only
Dedicated logbook	Ongoing	■	■	■	■	■	Mandurah-Bunbury fishery only
2. Habitat & Ecosystem							
2.1 Bycatch	Nil						Low Risk
2.2 Listed Species	Nil						Low Risk
2.3 Habitat	Underway	■					Relationship to be investigated for Cockburn Sound
2.4 Ecosystem/Environment							
2.5 Oceanography	Underway	■	■				Environmental data being compiled. Temperature loggers deployed
2.6 Other impacts on fishery							None identified
3. Management Analysis							
3.1 Socio-economic							
3.2 Resource Access (Shares)	O						This is a major management issue
3.3 Compliance Research							
3.4 Management Systems		■					Industry proposed study on co- management - funded
4. Industry Development							
5. Priority Review							
Industry/Department Meetings	Annual	■	■	■	■	■	
6. Science Review	Periodic	■					Science review held In October 2010

West Coast – Abalone Managed Fishery

Description and Scope of Issues

The Western Australian commercial abalone fishery is a dive fishery operating in shallow coastal waters along WA's western and southern coasts and is divided into eight management areas. In the west coast the commercial fishery targets mainly Roe's abalone, which are harvested by a diver working off 'hookah' using a diving 'iron' to prise abalone off rocks. 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.

The recreational fishery in the west coast is a dive and wade fishery that mainly operates in the metropolitan region and targets Roe's abalone. This fishery has a very restricted set of seasonal and daily opening times.

The sophisticated suite of management arrangements in place and the proactive management used in the Abalone Fishery have resulted in the maintenance of abalone stocks and the successful continuation of a fishery on a vulnerable species in a highly populated area.

Relevant Resource Assets and Risks from Fishery

West Coast Nearshore Molluscs (Abalone)	Moderate Risk
West Coast Protected Species	Negligible Risk
West Coast Nearshore Habitats	Negligible Risk
West Coast Marine Ecosystems	Negligible Risk

Summary of historical research completed

An extensive amount of research on the biology and stock status of Roe's abalone has been undertaken to support the management of this fishery. The basic biology (growth, reproduction, maturity) and ecological studies (population densities, settlement and recruitment) for Roe's abalone have been completed by researchers from the Western Australian Museum in the 1980s, and the Department of Fisheries in the 1990's and 2000's. Preliminary aquaculture studies on roe's abalone have been completed by Fremantle TAFE, however most of the aquaculture research has focused on the larger greenlip and brownlip species.

The historical time series of daily catch information on the total weight of abalone collected, the hours fished, the date and location of harvest and the person(s) harvesting has been used to generate a standardized catch per unit effort (CPUE) model to be developed that accounts for variation in spatial and temporal fishing effects, as well as technological improvements that aid fishing efficiency. An FRDC funded disease survey of entire Australian abalone stocks was completed in 2006 was also of relevance to this fishery.

Current Research Focus

Commercial

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. Commercial abalone

divers provide daily catch information which are used to assist in research, compliance and management matters. The standardized CPUE data are now being used in a decision-rule framework for quota setting in of the fishery on an annual basis.

Size and density of Roe's abalone across the near-shore sub-tidal reef habitat are measured annually at 11 indicator sites between Mindarie Keys and Penguin Island. Nine of these are fished while the other 2 are the Waterman's Reserve Marine Protected Area (MPA), and the Cottesloe Fish Habitat Protection Zone. The ability of this survey data to provide a predictive index for future stock abundance is a current topic of research.

Recreational

Current annual recreational catch and effort estimates are derived from an annual field survey in the Perth metropolitan fishery, and a biennial telephone diary survey covering the entire state (2007 was the last year of a state-wide survey). The field survey provides estimates of the catch and effort from each stock of Roe's abalone stock within the Perth fishery. This method provides a comprehensive assessment for this region but is too resource-intensive to be applied outside of the Perth metropolitan area. A catch prediction model based on environmental conditions and number of abalone licenses is currently being developed to assist in the management of the new 40 tonne TARC (Total Allowable Recreational Catch).

The telephone diary survey, which estimates the catch of all 3 abalone species on a state-wide basis, is completed about every second year. 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, or at the end of the season for those only involved in the Perth abalone season.

Priority Setting Process

Annual meetings are held between the Department of Fisheries and the commercial abalone industry. Input on the recreational program has previously been obtained from the RFAC and the IFAAC groups.

Review Timeline

The fishery and stocks are reviewed annually, with quota decisions made each February. A mid-season research update is carried out during August - September. The research associated with this fishery was last reviewed in December 2008, and is currently being externally reviewed by SARDI (South Australian Research and Development Institute).

Recent Publications

Hart AM, Fabris FP, 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, 40 p

Hart AM, Fabris FP, Brown J, Murphy D (2008). Digital video surveys of abalone (*Haliotis* sp.) stocks by commercial fishers in Western Australia. *Fisheries Research*. 93: 305-314.

Hesp A, Loneragan N, Hall N, Kobryn H, Hart AM, F. P. Fabris, J. Prince (2008). Biomass and commercial catch estimates for abalone stocks in areas proposed as sanctuary zones for the

Capes Marine Park. Fisheries Research Report No 170, Department of Fisheries, WA, 62 p

Hart AM, Fabris FP (2007). Digital video techniques for assessing population size structure and habitat of greenlip and roe's abalone. Final Report to the Fisheries Research and Development Corporation on Project No 2002/079. Fisheries Research Report No. 167, Department of Fisheries, Western Australia, 58 p.

Key to symbols in the matrix/summary tables:

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West Coast Abalone Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments		
		2010/11	2011/12	2012/13	2013/14	2014/15			
1. Retained Species Stock Analysis									
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)									
Roe's Biology - growth etc	Completed						Sufficient for management		
Early juvenile life history and habitat, natural mortality and predation	Underway	■	■				Natural mortality studies underway for roe's metropolitan stocks		
Reproduction/Fecundity, spawning Periodicity	Completed						Research by the Museum completed in the 1980s		
Disease survey/atlas	Completed						FRDC funded survey of entire Australian abalone stocks completed in 2006		
1.2 Other Biology									
Environmental effects on recruitment	Underway						Long-term datasets on annual recruitment and relevant environmental factors are being developed		
1.3 Stock Assessment									
Catch statistics (wildstock)	Ongoing	■	■	■	■	■	40 years of catch and effort statistics		
Mapping of areas	Underway						FRDC funded project using GPS trackers, headed up by TAFI		
Fishing efficiency	Ongoing	■	■	■	■	■	Environmental and technological factors continually monitored		
Commercial length frequency monitoring	Ongoing	■	■	■	■	■	Catch sampling from industry used to estimate F		
Population dynamics and harvest strategy assessment model	Ongoing	■	■	■	■	■	Model under development		
Recreational Impact	Ongoing	■	■	■	■	■	Annual monitoring of recreational catch		
Yield and egg-per-recruit analysis for size limits	Underway						Analysis in 2009 assessment		
1.4 Fishery Monitoring									
Research monitoring and recruitment sites	Ongoing	■	■	■	■	■	11 sites annually surveyed, including marine protected areas.		
Industry video monitoring sites	Ongoing	■	■	■	■	■	20 to 30 sites surveyed annually		
Recreational fishery monitoring – field surveys	Ongoing	■	■	■	■	■	perth fishery, annual counts of high density and plane surveys of low density zones		
Recreational Fishery Monitoring –phone surveys	Ongoing Biennially	■		■		■	Phone diary survey undertaken every two years		

West Coast Abalone Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
2. Habitat & Ecosystem							
2.1 Bycatch	Not Needed						No Bycatch
2.2 Listed Species	Not Needed						No interactions
2.3 Habitat	Not Needed						Low risk
2.4 Ecosystem/Environment	Not Needed						Low risk
2.5 Oceanography							Collaboration with CSIRO
2.6 Other impacts on fishery							
Abalone Health - Contingency plan and monitoring and diagnosis	Ongoing	█	█	█	█	█	
AVG (Abalone Viral Ganglioneuritus)	Ongoing	O	O	O	O		Watching brief
3. Management Analysis							
3.1 Socio-economic							
3.2 Resource Access (Shares)	Completed						IFAAC process completed for Perth fishery,
3.3 Compliance							
3.4 Management Systems							
3.5 Translocation/protocol	Ongoing	█	█	█	█	█	
4. Industry Development							None identified
5. Priority Review		█	█	█	█	█	Annual industry meetings
6. Science Review		█			█		Major assessment reports peer reviewed every three years

West Coast – Deep Sea Crab Fishery

Description and Scope of Issues

The West Coast Deep Sea Crab (Interim) Managed Fishery operates between Cape Leeuwin and the Northern Territory border and is managed by TAC of 140t for crystal crabs and 14t each for champagne and giant crabs which was introduced in 2008. The fishery targets giant (king) crabs, crystal (snow) crabs and champagne (spiny) crabs using baited pots operated in a longline formation in the offshore waters of the west coast.

In the late 1990s when this fishery first commenced, it targeted champagne crabs. However, within a couple of years the fishery moved into deeper waters targeting crystal crabs. Since 2001 catches of champagne crabs have been insignificant but recently (2009) this species has once again been targeted. Landings of giant crab have always been minimal (<1t per annum).

The FRDC has funded research on aspects of the crystal, giant and the champagne crab fisheries

and final reports are available on all three projects.

Relevant Resource Assets and Risks from Fishery

West Coast Crustaceans	Moderate
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Summary of historical research completed

Biological (growth, reproduction, movement patterns etc) and fisheries data are available for crystal crabs in Melville-Smith et al. (2007). That study showed the main distribution on the west coast to be between North West Cape and Fremantle although the range did go much further south. Tagging has shown the species to be slow growing with best estimates suggesting legal sized male crabs to be ~13-15 years old and some large crabs in the population being ~30 years old. The species is capable of substantial movement patterns, with the majority moving <50 km, but some moving >100 km while they were at large.

Reproductive data including size at maturity for both sexes and seasonality of spawning is available for champagne crabs in Smith et al. (2004)³.

Comprehensive biological information is available for giant crabs in Australian waters in Levings et al. (2001)⁴ although sampling was most intense in the centre of that species' distributional range off Victoria and South Australia and less so in Western Australia.

Current Research Focus

Research monitoring of the west coast deep sea crab fishery is currently undertaken utilising fishers' monthly returns data to monitor activities.

Priority Setting Process

Research and management meetings are held with industry as required.

Review Timeline

Within next five years

Recent Publications

Melville-Smith, R., Norton, S.M.G., Thomson, A.W. (2007). Biological and Fisheries Data for Managing Deep Sea Crabs in Western Australia. FRDC Final Report for Projects 2001/055.

³ Smith, K.D., Potter, I.C., Hall, N.G. (2004). Biological and fisheries data for managing the deep-sea crabs Hypothalassia armata and Chaceon bicolour in Western Australia. FRDC Final Report for Projects 1999/154 and 2001/055.

⁴ Levings, A., Mitchell, B.D., McGarvey, R., Mathews, J., Laurenson, L., Austin, C., Murphy, N., Miller, A., Rowsell, M., Jones, P. (2001). Fisheries Biology of the giant crab *Pseudocarinus gigas*. FRDC Final Report, Project 93/220 and 97/132.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

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West Coast Deep Sea Crab Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
		2010/11	2011/12	2012/13	2013/14	2014/15	
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Giant Crabs	Completed						
Crystal and Champagne Crabs	Completed						
Growth & Reproduction	Completed						
Migration	Completed						
1.2 Other Biology	Not needed						No other species caught in number
1.3 Stock Assessment							
Annual assessment	Ongoing	■	■	■	■	■	
1.4 Fishery Monitoring	Ongoing	■	■	■	■	■	
Commercial catch and effort	Ongoing	■	■	■	■	■	
Processor returns	Ongoing	■	■	■	■	■	
Commercial length freq monitoring	Ongoing	■	■	■	■	■	
2. Habitat & Ecosystem							
2.1 Bycatch	Nil						Negligible risk
2.2 Listed Species							
Whales; dolphins; turtles	Nil						Negligible risk
2.3 Habitat							
Benthic muds	Nil						Negligible risk
2.4 Ecosystem/Environment							
Ghost fishing; other trophic levels	Nil						Negligible risk
2.5 Oceanography							
2.6 Other impacts on fishery							Nothing identified
3. Management Analysis							
4. Industry Development							
5. Priority Review							
6. Science Review							

West Coast – Octopus Fishery and Aquaculture

Description and Scope of Issues

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: by-catch from the West Coast Rock Lobster Managed Fishery (WCRLF); the Cockburn Sound (Line and Pot) Managed Fishery (CSLPF); the Developmental Octopus Fishery (DOF); and recreational fishery. In addition to these 4 main sectors, numerous trawl and trap fisheries land small amounts of octopus as a by-catch.

There are significant gaps in knowledge about the fishery and biology of *Octopus cf. tetricus*, however many small scale biological studies have been carried out.

During the past decade, the octopus fishery in WA has doubled, while human consumption of octopus has increased 5-fold. This trend is reflected by an increase in market price from around \$4 to over \$12 per kilogram. The same trend can be observed overseas. Initial trials have indicated that the WA octopus *O. tetricus* can easily acclimate to captivity, has high growth rates, readily accepts frozen/moist foods, has high reproductive rates and high market price

Relevant Resource Assets and Risks from Fishery

West Coast Nearshore Molluscs	Moderate Risk
West Coast Protected Species	Negligible Risk
West Coast Nearshore Habitats	Negligible Risk
West Coast Marine Ecosystems	Negligible Risk

Summary of historical research completed

While predation on lobsters by octopus has been studied, minimal stock assessment research has been carried out on the octopus fishery. A daily catch and effort logbook has been tested and introduced into the DOF, and some sub-sections of the CSLP, and two recent University theses on aspects of the biology and fishery of *Octopus cf. tetricus* have been completed.

Current Research Focus

Two externally funded FRDC projects have been granted to the Department of Fisheries. These are FRDC project 2010/200, “Innovative development of the *Octopus tetricus* fishery in Western Australia” and FRDC project 2009/206 “Development of Octopus Aquaculture.” These projects will develop robust stock assessment and aquaculture methodologies for *O. cf. tetricus* to assist the future development of octopus as a sustainable fishery and important seafood product of Western Australia.

Priority Setting Process

Meetings between the Department of Fisheries and industry

Review Timeline

The Fisheries Research Division reviews the fishery and stocks annually in December.

Recent Publications

Larsen RJ (2008). The Western Australian Developmental Octopus Fishery: species composition and aspects of morphology and biology. Honours Thesis, School of Biological Sciences and Biotechnology, Murdoch University. 116 p.

Key to symbols in the summary matrix:

- Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

West Coast Octopus Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							Information on growth, density, size at maturity and mortality are needed to improve the management of West Coast stocks
Age and Growth	Underway	■	■	■			Current FRDC project
Size-at-maturity	Underway	■	■	■			Current FRDC project
Mortality	Underway	■	■	■			Current FRDC project
1.2 Other Biology							
Genetics	Low Priority						Genetics work on <i>O. cf. tetricus</i> would help establish species connection with East Coast
1.3 Stock Assessment							
Sustainability of stocks	Underway	■	■	■	■	■	
1.4 Fishery Monitoring							
Research logbook implementation	Underway	■	■	■	■	■	
1.5 Aquaculture							
Develop the hatchery techniques for octopus larvae and juveniles	Underway	■	■	■			Objectives of current FRDC project
Optimising octopus ranching and grow out	Underway	■	■	■			Objectives of current FRDC project
2. Habitat & Ecosystem							
2.1 Bycatch							Negligible Risk
2.2 Listed Species							Negligible Risk
2.3 Habitat							Negligible Risk
2.4 Ecosystem/Environment							Negligible risk
3. Management Analysis							

West Coast Octopus Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments		
4. Industry Development					Expansion of the DOF (developing octopus fishery) currently underway				
5. Priority Review									
6. Science Review -					At conclusion of current FRDC projects				

West Coast – Artemia Aquaculture

Description and Scope of Issues

Early life stage husbandry, and in particular larval nutrition is a key element for marine fish culture. The use of live food for successful hatchery culture of marine fish larvae is currently considered obligatory. Live food is expensive, especially during recent years where global harvests of Artemia cysts have decreased sharply leading to a worldwide shortage. Compounding this issue, new AQIS regulations and biosecurity issues in Australia may limit future importation. The reliance that Australian hatcheries have on imported Artemia is a major constraint to the sustainable development and expansion of this industry. Western Australia has unique environmental conditions that allows mass production of Artemia in relatively low costs. It is specifically beneficial to rural areas were salt ponds and lakes are located and there is no other commercial application or use of them.

Summary of historical research completed

FRDC project 2001/220 provided significant breakthroughs in Artemia culture using *Dunaliella salina* algae, which created the potential for commercial production of Artemia in Australia. A subsequent project aimed at commercializing the Artemia production at Hutt Lagoon, Western Australia is currently in its final stages. The first commercial system module has been commissioned. The company is currently expanding its operations and may extend to other locations.

Current Research Focus

The focus is now on new product identification and further development of the site aimed at expanding production including a substantial reduction in the production costs for their primary product –natural Beta-carotene. Artemia co-production is considered to have the best chance of successful delivery of cost savings. The objectives of the projects are as follow:

- To further develop new Artemia products with a focus on aquaculture
- To develop and improve methods for rearing and harvesting Artemia
- To assist in further developing the commercial production of Artemia

Priority Setting Process

The project is a direct result and continuation of the current project with Cognis Australia.

Review Timeline

Reviewed during the R&D plan 2009-10

Gascoyne Coast Bioregion

Gascoyne – Biodiversity Issues

Description and Scope of Issues

The naturally attractive features of the Gascoyne, including its protected coastal waters and productive fish stocks, have resulted in the area being a focus of marine management, beginning in the 1960s. The state's earliest marine habitat protection areas, in the form of extensive prawn nursery trawl closures over the sand flats and seagrass beds, were introduced in the 1960s in both Shark Bay and Exmouth Gulf. This system of fisheries closures, later expanded to cover all significant coral areas, has provided long-standing protection to virtually all fragile marine habitats in the bioregion. The subsequent development of marine parks over Ningaloo Reef and the inner gulfs of Shark Bay have added further, complementary protection to these highly valued areas.

Specific commercial fishing regulations implemented in the 1970s and 1980s also preclude the use of large-mesh gillnets and longlines throughout the Gascoyne, to prevent the incidental entanglement of the large populations 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 loggerhead turtle encountered on the trawl grounds.

Relevant Resource Assets and Risks from Fishing Activities

Benthic Habitats - Shark Bay Gulfs	Moderate Risk
Benthic Habitats - Ningaloo	Low Risk
Benthic Habitats - Zuytdorp	Low Risk
Protected species - non fish (turtles)	Low Risk
Protected species - non fish - mammals	Low Risk
Protected species - fish	Low Risk
Ecosystem- Shark Bay Gulfs	Low Risk
Ecosystem - Ningaloo	Low Risk
Ecosystem - Zuytdorp	Low Risk
Introduced Pests & Diseases	Low Risk

Summary of historical research completed

Bycatch – To date most of the research on bycatch in this bioregion has focused on the trawl fisheries, which extract large quantities of discarded bycatch relative to target and by-product species. All trawl fisheries in this bioregion now include Bycatch Reduction Devices (BRD) to reduce the incidental catch of turtles and other large fauna. The Department of Fisheries has undertaken a number of studies on the potential impacts on bycatch species and on the benthic

habitats, from prawn and scallop fisheries in Shark Bay and Exmouth Gulf. These published studies found the impact to be minimal. There was some concern during the 1990's that commercial pink snapper (*Pagrus auratus*) catches were declining in Shark Bay due to trawling bycatch of juveniles. The Department of Fisheries found no difference between *P. auratus* stocks, inside and outside trawled areas, and suggested the reason for declining adult stocks might be due to increased recreational fishing. Interaction rates with threatened, endangered and protected species (TEPS) have received attention in most fisheries with the inclusion of protected species interactions included on daily logbooks and Catch And Effort Statistics (CAES) forms.

Current Research Focus

Many of the studies in this region are being done as part of WAMSI Nodes 1, 3 & 4.

Bycatch Monitoring and Assessment - Establishing a risk analysis of interaction rates between the collective fisheries and bycatch to identify which species, species groups or fisheries require more detailed assessment (WAMSI 4.4.1). This assessment includes Threatened, Endangered and Protected species (TEPs), discarded undersize target species, and all other discarded species in this bioregion.

Priority Setting Process

WAMSI projects, of which the above bycatch project is associated, were developed by executive direction of the Department with research input.

Review Timeline

The bycatch project is a one-year project and it is being reviewed through the WAMSI project review process. When the project is finalized in mid 2010 it will be published in the Fisheries Department Research Report series and will receive peer review comment at that time.

Key to symbols in the matrix/summary tables:

- █ Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

Gascoyne Biodiversity Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
General finfish communities	Ongoing						Includes movement, habitat usage etc occurring as part of WAMSI
2. Habitat & Ecosystem							
2.1 Bycatch			█				WAMSI 4.4.1 - Captured species assessments & monitoring
	Underway						

Gascoyne Biodiversity Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
2.2 Listed Species							
	Underway	█					WAMSI 4.4.1 - Captured species assessments & monitoring
2.3 Habitat							NRP (*including WAMSI Project 3) – CSIRO, AIMS, Unis.
Habitat Mapping	Ongoing	█					Habitat Mapping at Ningaloo is occurring as part of WAMSI
2.4 Ecosystem/Environment							
Biodiversity, Trophic interaction, anthropogenic influences etc	Developing (some underway)	█					WAMSI 4.2 & 4.3
Climate change	Developing						WAMSI Project 1, 2 (CSIRO, UWA, AIMS)
Fish Kills	Ongoing	█	█	█	█	█	Gov't response to fish kills coordinated through Fisheries Research (Fish Health)
2.5 Oceanography							
Hydrodynamic modelling	Developing (some underway)						WAMSI Projects 1, 2 & 3 (CSIRO, UWA, AIMS):
Hydrodynamics & nutrient dynamics of shelf waters in relation to LC.	Completed						SRFME (including Southern Surveyor cruise). .
	Underway	█	█				Southern Surveyor – cruises completed; data analysis underway. Another cruise is planned.
2.6 Other impacts on fishery							
Introduced Marine Pests	Completed						Was funded by Natural Heritage Trust.
3. Management Analysis							
3.1 Socio-economic							
Social assessment	Underway	█					NRP/WAMSI, CSIRO Cluster, Sustainable Tourism CRC, NRM. E.g. Human Usage survey. Note: some underway but more work is planned
3.4 Management Systems	Completed						WAMSI 4.1. Applying EBFM framework.
	Developing						DEH/NOO south west regional plan
4. Industry Development							
5 Priority Review	Ongoing						Annual departmental industry meetings
6. Science Review	Just Completed						Next review due in 2013

Gascoyne – Gascoyne Demersal Scalefish Fishery

Description and Scope of Issues

The Gascoyne Demersal Scalefish Fishery encompasses commercial and recreational fishing for demersal scalefish (pink snapper, goldband snapper, spangled emperor etc.) in the continental shelf waters of the Gascoyne Coast Bioregion. This includes the activities of the Shark Bay Snapper

Managed Fishery (SBSF), commercial ‘open-access’ wetline fishing and recreational fishing from both licensed charter and private vessels.

Pink snapper in oceanic waters off Shark Bay ('oceanic' stock) and in waters off Kalbarri are currently treated as separate populations; the latter are managed under arrangements within the West Coast Demersal Scalefish Fishery. Management (commercial fishing only) arrangements for the Gascoyne Demersal Scalefish Managed Fishery that will incorporate the SBSF and wetline fishing will be implemented in two stages, the first of which is scheduled to commence on 1st September 2010. Integrated Fisheries Management (IFM) is scheduled for the Gascoyne in 2010-2011.

Relevant Resource Assets and Risks from Fishery

Gascoyne Demersal Scalefish	Moderate – High Risk
Gascoyne Protected Species	Low Risk
Gascoyne Shelf Habitats	Negligible Risk
Gascoyne Ecosystems	Low Risk

Summary of historical research completed

Detailed research on pink snapper in oceanic waters off Shark Bay and the associated SBSF was undertaken through the 1980s and early 1990s (see Marriott et al., 2010 for details). An integrated stock assessment model for pink snapper was developed by an FRDC-funded project in 2002. Preliminary biological information on spangled emperor and other key emperor species in northwest WA was obtained via an FRDC-funded project in the early 1990s. The first major survey of recreational fishing throughout the entire Gascoyne Coast Bioregion was undertaken in 1998/99 and was repeated (boat fishing only) in 2007/08.

Current Focus and Summary of Activities

The current focus is monitoring the recovery of the pink snapper (oceanic) spawning stock. Stock assessments have recently been completed (and awaiting external review) for the two other demersal indicator species for this Bioregion (goldband snapper and spangled emperor). Monitoring of spangled emperor in the north Gascoyne will need to continue as the current level of fishing has been determined to be unacceptable. Monitoring of the goldband snapper age structure will also need to continue given the uncertainty in the F-based stock assessments and the species biological vulnerability ahead of the next assessment (due in 2012). Some information on the status of red emperor in the Gascoyne may be required and concern remains for some vulnerable deeper-water species (ruby snapper, eightbar grouper) and the effect of any expansion of fishing operations by Commonwealth Western Deep Water Trawl licensed vessels. There is also a need for more regular monitoring of recreational fishing activity in the Gascoyne.

Current Activities - Commercial catch and effort information is obtained from daily/trip logbook returns for SBSF vessels and via monthly catch and effort returns for wetline boats and charter vessels. The analysis of results from the 2007/08 recreational boat-based fishing survey will be completed shortly as will the Gascoyne IFM stock status report. The stock assessments will be externally reviewed in August 2010 and available to public in late 2010.

Pink snapper: Commercial catches are sampled on a monthly basis to provide representative catch-

at-age data for use in updating the integrated stock assessment model (updated every 3 years, next assessment due early 2012). Limited at-sea monitoring (interactions with endangered species, bycatch) is undertaken to meet EPBC Act/WTO Exemption requirements (next review due 2014). WAMSI project has been using genetics and otolith chemistry to investigate the relationships between pink snapper stocks from Shark Bay to the South Australian border; results will be available in late 2010.

Goldband snapper and Spangled emperor: Comprehensive research on these species commenced in 2007. A ‘weight of evidence’ based assessment for both species has recently been completed and is pending external review (will be reported in Gascoyne IFM Stock Status Report).

Priority Setting Process

Overall priorities are set based on the current level of understanding of the key species, stock status and fishery, and potential future risks and issues identified, using a risk assessment approach and expert opinion. Specific priorities are discussed internally by researchers and managers prior to the SBSF AGM meeting. With the creation of the Gascoyne Demersal Scalefish Managed Fishery, the start of the Gascoyne IFM process and implementation of the new peak-body based consultation process will see this review process change in the near future.

Science Review Timeline

The ‘weight of evidence’ based assessments for both spangled emperor and goldband snapper will be externally reviewed in mid-2010. The stock assessment of pink snapper was externally reviewed in July 2006. Assessments for oceanic pink snapper and goldband snapper will be updated in 2012. The next EPBC related review is scheduled for 2014.

Recent Publications

- Marriott, R.J., Jarvis, N.D.C., Adams, D.J., Gallash, A.E., Norriss, J. and Newman S.J. (2010). Maturation and sexual ontogeny in the spangled emperor, *Lethrinus nebulosus*. *Journal of Fish Biology* 76: 1396-1414.
- Marriott, R.J., Adams, D.J., Jarvis, N.D.C., Moran, M.J., Newman, S.J. and Craine M. (in press). Age-based demographic assessment of fished stocks of spangled emperor in the Gascoyne Bioregion of Western Australia. *Fisheries Management and Ecology*.

Norriss, J.V. and Crisafulli, B. (2010) Longevity in Australian snapper *Pagrus auratus* (Sparidae) *Journal of the Royal Society of Western Australia* .

Marriott, R., Jackson, G., Lenanton, R. and Molony B. (2010). Biology and stock status of demersal indicator species in the Gascoyne Coast Bioregion. Fisheries Research Report, Department of Fisheries, Western Australia.

Key to symbols in the summary matrix:

- Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

Gascoyne Demersal Scalefish Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments		
		2010/11	2011/12	2012/13	2013/14	2014/15			
1. Retained Species Stock Analysis									
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)									
Pink snapper (oceanic stock) biology	Complete						Adequate for management		
Goldband snapper biology	Underway	█					Gascoyne IFM project, to be completed 2010.		
Spangled emperor biology	Underway	█					Gascoyne IFM project, to be completed 2010		
Red emperor biology	Proposed	O					Project Identified, some biological sampling occurring		
1.2 Other Biology									
Pink snapper juvenile recruitment	Ongoing	█	█	█	█	█	Shark Bay trawl surveys		
Stock structure – pink snapper (oceanic)	Underway	█	█				WAMSI 4.4.2, genetics (Murdoch PhD), otolith chemistry, oceanographic modeling		
Stock structure – spangled emperor	Underway	█					Collaboration with CSIRO/AIMS, publication of results imminent		
1.3 Stock Assessment									
Age-structured modelling for pink snapper	Periodic		█				Need to monitor stock recovery to 40% target level (next assessment 2012).		
Age-based assessments for goldband	Periodic		█				Need to re-run assessment in 2012.		
Age-based assessments for spangled emperor	Periodic		█				Need to re-run assessment in 2012.		
Age-based assessments for red emperor	Proposed	O					Project Identified		
1.4 Fishery Monitoring									
Pink snapper, age structure of catch	Ongoing	█	█	█	█	█	Need to monitor stock recovery to 40% target level (next assessment 2012).		
Goldband, age structure of catch	Ongoing	█	█	█	█	█	Need to re-run assessment in 2012.		
Spangled emperor, age structure of catch	Ongoing	█	O	O	O	O	Indicator species, will need additional resources to continue		
Red emperor, age structure of catch	Proposed	O	O				Project Identified		
CAES catch and effort data	Ongoing	█	█	█	█	█	Daily logbooks since Feb 2008		
Charter boat catch and effort	Ongoing	█	█	█	█	█	Monthly returns		
2. Habitat & Ecosystem									
2.1 Bycatch	Ongoing	█	█	█	█	█	EPBC Act, low level at sea monitoring,		
2.2 Listed Species	Not needed						Low risk		
2.3 Habitat	Not needed						Low risk		
2.4 Ecosystem/Environment	Not needed						Low risk		
Recruitment and environment	Proposed	O	O	O			Recruitment to oceanic snapper, potential project with UWA		
3. Management Analysis									
3.1 Socio-economic Research/Monitoring									
3.2 Resource Access (Shares)		O					IFM process re-scheduled for 2011-2012		
3.3 Compliance Research									
3.4 Management Systems Research									

Gascoyne Demersal Scalefish Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
4. Industry Development							
5. Management Review and Priority Setting	O						
6. Science Review		█	O				Goldband and Spangled Emperor stock assessment external review in late 2010. Snapper scheduled for 2012

Gascoyne – Blue Swimmer Crab Fishery

Description and Scope of Fishery

The blue swimmer crab (*Portunus pelagicus*) 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 m in depth. Crabbing activity in the Gascoyne Coast bioregion is centered in the embayment of Shark Bay and to a lesser extent Exmouth Gulf. The Shark Bay Crab Fishery has developed into the largest crab fishery in WA. It is a limited-entry fishery with a total of 5 trap permits targeting crabs. In addition, the Shark Bay prawn and scallop trawl fleet also retain crabs as a by-product. The Developing Fisheries Assessment Committee conducted a review of the Exmouth Gulf Developing Crab Fishery between 2007 and 2009 and recommended that the trap fishery was not economically viable due to poor performance and low catch and should not be continued. On this basis, this fishery was closed in June 2009. Crab trap fishers in the Shark Bay and Pilbara Developing Crab Fisheries are only permitted to use ‘hourglass’ traps. The Pilbara Developing Crab Fishery currently has one exemption holder operating up to a maximum of 400 traps.

Relevant Resource Assets and Risks from Fishery

Gascoyne Nearshore Crustaceans (Crabs)	Moderate Risk
Gascoyne Protected Species	Negligible Risk
Shark Bay Gulf Habitats	Negligible Risk
Shark Bay Gulf Ecosystems	Negligible Risk

Summary of historical research completed

Data for the assessment of blue swimmer crab stocks in the Gascoyne and North Coast bioregions are obtained from fishers' compulsory catch and effort returns and voluntary daily log books. Department of Fisheries' research staff also conduct quarterly catch monitoring surveys aboard commercial crab trap vessels in Shark Bay.

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.

A review of the available blue swimmer crab research data for Shark Bay conducted in 2009 suggests that the size structure of the blue swimmer crab population still appears healthy but 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.

Current Research Focus

The review of the Shark Bay Crab Interim Management Plan, which has been extended until 31 August 2011, requires an updated stock assessment to be completed as part of this process.

Priority Setting Process

Research priorities are set in consultation with management, and feedback obtained during meetings with industry groups and major stakeholders (WAFIC, RecFishWest) as required.

Review Timeline

An update of this stock assessment for the Shark Bay Crab (Interim) Managed Fishery was completed in 2010. Both the Exmouth Gulf and Pilbara Developing Crab Fisheries were formally (externally) reviewed in mid-2007 by the Developing Fisheries Assessment Committee (DFAC) as part of the 'Developing New Fisheries' process.

Recent Publications

Johnston, D., Harris, D., Caputi, N. and Thomson, A. 2010. Decline of a blue swimmer crab (*Portunus pelagicus*) fishery in Western Australia – history, contributing factors and future management strategy. *Fisheries Research*. Submitted.

de Lestang, S., Bellchambers, L.M., Caputi, N., Thomson, A.W., Pember, M.B., Johnston, D.J. and Harris, D.C. 2009. Stock-recruitment-environment relationship for a *Portunus pelagicus* fishery in Western Australia. Proceedings from the Lowell Wakefield Symposium, Alaska. Submitted.

Wakefield, C.B., Johnston, D.J., Harris, D.C. and Lewis, P. (2009). A preliminary investigation of the potential impacts of the proposed Kwinana Quay development on the commercially and recreationally important fish and crab species in Cockburn Sound. *Fisheries Research Report* 186: 94 pp.

Johnston, D.J., Wakefield, C.B., Sampey, A., Fromont, J. and Harris, D.C. (2008). Developing long-term indicators for the sub-tidal embayment communities of Cockburn Sound. *Fisheries Research Report* 181: 113 pp.

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Gascoyne Blue Swimmer Crab Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Blue swimmer crab biology	Completed						Many studies completed
1.2 Other Biology							
Genetic structure of populations	Completed						
1.3 Stock Assessment							
Detailed Stock Assessment	Periodic	■					An updated assessment is needed for management plan review
Annual C&E assessment	Ongoing	■	■	■	■	■	
1.4 Fishery Monitoring							
Commercial Catch & Effort	Ongoing	■	■	■	■	■	
Processor Returns	Ongoing	■	■	■	■	■	For Shark Bay only
Commercial Monitoring	Ongoing	■	■	■	■	■	3 – 4 times per year for Shark Bay
Recreational Catch and Effort	Periodic		■				Will be part of RFBL survey.
Stock & recruitment	Ongoing	■	■	■	■	■	
2. Habitat & Ecosystem							
2.1 Bycatch	Underway	■					Qualitative only
2.2 Listed Species							Negligible Risk
2.3 Habitat							Negligible Risk
2.4 Ecosystem/Environment							Low Risk
Heavy metal content of crabs	Completed						
2.5 Oceanography	Periodic						
2.6 Other impacts on fishery	Not needed						
3. Management Analysis							
3.1 Socio-economic							
3.2 Resource Access (Shares)		■					Determination of access shares will be critical in the next few years
4. Industry Development							A significant amount of work is undertaken in this area by industry in this region
5. Priority Setting	Periodic	■	■	■			Regular Industry Departmental meetings
6. Science Review	Periodic	■			■		Proposed

Gascoyne – Exmouth Gulf Prawn Fishery

Description and Scope of Fishery

The Exmouth Gulf Prawn fishery (EGP) is the second largest prawn fishery in WA and is located in the relatively sheltered waters in Exmouth Gulf. This otter trawl fishery targets western king prawns, brown tiger prawns, endeavour prawns and banana prawns when available.

Management of this fishery is based on input controls, which include limited entry, seasonal, and area openings and closures, moon closures, ban on daylight fishing and gear controls. These management arrangements are designed to keep fishing effort at levels that will maintain sufficient spawning biomass of prawns (particularly tiger prawns).

The yearly cycle of operation for the fishery is dynamic and multi-faceted. Opening and closing dates vary each year, depending on environmental conditions, moon phase and the results of fishery-independent surveys, which estimate tiger prawn recruitment and spawning stock.

Relevant Resource Assets and Risks from Fishery

Gascoyne Nearshore Crustaceans (Prawns)	Moderate Risk
Gascoyne Protected Species	Low Risk
Exmouth Gulf Habitats	Low Risk
Exmouth Gulf Ecosystems	Negligible Risk

Summary of historical research completed

Research and monitoring of the fishery has been conducted for about 40 years. Since the commencement of the fishery in 1963, catch and effort statistics (both target and byproduct species) has been collected for the EGP fishery including voluntary logbook information which provides a valuable long-term data that spans varying effort levels and environmental variations.

Fishery-independent surveys have been undertaken each year since the 1980s to determine the spawning stock and recruitment levels. The tiger prawn recruitment index is used to provide a catch prediction for tiger prawns for the season. A research risk assessment conducted in 2003 identified the need to collect additional information and re-analyse old data sets to provide a better understanding of the stock distribution, size and abundance of king prawns and preliminary assessment of variation in recruitment levels for this species.

Some inshore sampling in the nurseries for tiger pawns was conducted in 1998 and a FRDC (1999/222) project sampled for presence and abundance of seagrass and algal communities on both the eastern and western parts of Exmouth Gulf during 1999-2001 as part of a tiger prawn stock enhancement project. The Department continued sampling selected inshore sites for seagrass/algal abundance in 2003, 2005 and 2006.

The Department has completed direct comparisons of boats between twin and quad gear to ensure catch efficiencies are incorporated into tiger prawn catch rate thresholds.

A FRDC funded program on the implementation of bycatch reduction devices was completed in

2002 (Kangas and Thomson 2004⁵) with full implementation of grids during that year and of secondary devices by 2004. Another project funded by FRDC (2000/132), focussed on inshore fish assemblages of the Pilbara and Kimberley coasts, also quantified inshore and trawl caught fish species in Exmouth Gulf. The FRDC (2002/038) funded Biodiversity project compared faunal assemblages in trawled and untrawled areas within the Exmouth Gulf prawn fishery was completed in 2007 (Kangas et al. 2007).

Current Research Focus

Research activities continue to focus on stock assessment and surveys to monitor annual recruitment of tiger prawns and the residual spawning stock levels, and a pre-season survey of king prawns to assist with harvesting strategies. Monitoring of fleet fishing activity is undertaken to determine the timing of the closure of the tiger prawn spawning area. All boats complete daily shot by shot logbooks, which, together with survey data and factory catch unload records, provide the information sources for managing the fishery. In addition within season advice is provided on harvesting strategies and optimising value of catch whilst ensuring sustainability.

The joint evaluation and implementation of gear modifications (including square mesh cod-end trials) to reduce bycatch and improve product quality is ongoing. Sampling of bycatch composition and abundance has been undertaken during 2008 and 2009 during some square mesh cod-end trials to supplement the information gained through the Biodiversity study conducted in 2004.

Continued monitoring of seagrass abundance in nursery sites may be required to validate an apparent correlation between seagrass abundance and recruitment for tiger prawns.

The five-year Ecologically Sustainable Development accreditation with the Commonwealth Department of Environment, Heritage, Water and the Arts was renewed in late 2007. A comprehensive ESD assessment of this fishery has determined that performance should be reported annually against measures relating to the breeding stocks of target prawn species, bycatch species impacts, protected species interactions, habitat effects and provisioning effects.

Priority Setting Process

Initial assessments were made through internal departmental meetings in 1998 discussing research undertaken, current research and research and development gaps and a plan was drafted for five years. A formal risk assessment including reviewing research priorities was undertaken in late 2002 for the Exmouth Gulf prawn fishery. Annual meetings are still held with industry to discuss research priorities and planning. Additional research needs have also been highlighted through the ESD Assessment process for which a re-assessment has been completed in 2008.

The most recent Industry – Departmental meeting on research was held in 2007, next review due 2012.

Review Timeline

Apart from the review of information completed as part of the EPBC assessments there have not been any recent formal reviews. Early research and publications on the biology and spawning stock

⁵ Kangas, M. and Thomson, A. (2004) Implementation and assessment of bycatch reduction devices in the Shark Bay and Exmouth Gulf trawl fisheries. Final Report FRDC 2000/189. 70pp.

stock recruitment/environment relationships have been peer reviewed.

Recent Publications

Kangas, M.I., Morrison, S., Unsworth, P., Lai, E., Wright I. and Thomson A., (2007) Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia. Final FRDC Report 2002/038. *Fisheries Research Report* 160: 333pp.

Kangas, M., Sporer, E., O'Donoghue, S. and Hood, S. (2008) Co-management in the Exmouth Gulf Prawn Managed Fishery with comparison to the Shark Bay Prawn Fishery. In: Townsend, R, Shotton, R and Uchica, H. (Eds.) Case studies in fisheries self-governance. *FAO Fisheries Technical Paper*. 504: 231-244

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Exmouth Gulf Prawn Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet and Natural mortality)							
Brown tiger prawn biology	Completed						Completed in 1970-1990s
Western king prawn biology	Completed						Completed in 1970s
Endeavour prawn biology	Minimal						Low Risk
Banana prawn biology	Possible						Only caught infrequently. Low Risk
1.2 Other Biology							
Recruitment dynamics of western king prawns	Ongoing	■	■	■	■	■	
1.3 Stock Assessment							
Stock-recruit-enviro effects	Ongoing	■	■	■	■	■	Reports published 1980s and 1990s
Modelling (banana)	Ongoing	■	■	■	■	■	
Yield/recruit, \$/recruit	Ongoing	■	■	■	■	■	
Catch/effort relationships	Ongoing	■	■	■	■	■	
Recruitment-catch relationship	Ongoing	■	■	■	■	■	
1.4 Fishery Monitoring							
Logbooks	Ongoing	■	■	■	■	■	
Pre-season skippers briefings	Ongoing	■	■	■	■	■	
Processor returns (target spp. and byproduct)	Ongoing	■	■	■	■	■	
Database maintenance	Ongoing	■	■	■	■	■	
Recruit and spawning stock indices	Ongoing	■	■	■	■	■	
Effort impact assessment (GIS)	Ongoing	■	■	■	■	■	EPBC requirement
Juvenile habitat monitoring	Periodic		■				Every 2 or 3 years or if disturbance occurs
Fishing power monitoring	Ongoing	■	■	■	■	■	

Exmouth Gulf Prawn Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Commercial catch monitoring (king prawns)	Possible						
Electronic logbooks	Commenced but stalled						Transfer of industry data to DoF database required but this yet not facilitated at industry's end.
2. Habitat & Ecosystem							
2.1 Bycatch							
BRD implementation (grids)	Completed						Completed in 2002
BRD implementation (secondary devices)	Completed						Completed in 2004 with observer work Ongoing and additional trials to be done in 2009/10
Bycatch monitoring	Periodic	■					Review every 5 years. Need to establish an annual sampling program at an appropriate level.
Square mesh cod-ends	Underway						Industry initiative – requires observers to document effectiveness
2.2 Listed Species							
Listed species interactions - logbooks	Ongoing	■	■	■	■	■	EPBC requirement/MOU with DEWHA underway
2.3 Habitat							
Habitat/effort monitoring	Ongoing	■	■	■	■	■	EPBC requirement (area of trawling only)
Closure of sensitive habitats on trawl grounds	Possible						Requires industry consultation
2.4 Ecosystem/Environment							
Biodiversity of trawled and untrawled areas	Completed						Completed in 2007 – may review every 5-10 years
Formal risk assessment	Periodic			■			EPBC requirement
US TED Accreditation	Periodic	■		■			
2.5 Oceanography							
Tidal movement	Possible						Information available from other sources
2.6 Other impacts on fishery							
							Salt production potential on eastern gulf
3. Management Analysis							
3.1 Socio-economic							
Social assessment	Possible						Social assessment
Economic Analysis – average price data	Ongoing	■	■	■	■	■	Economic Analysis – average price data
Fuel consumption/expenses	Ongoing	■	■	■	■	■	Fuel consumption/expenses
Extension of Co-Management	Possible	○					FRDC report completed 2009 (P. Rogers, Murdoch University)
3.2 Resource Access (Shares)							
Byproduct	Underway						Trialling size limits for crabs and bugs. Need to finalise byproduct paper
3.3 Compliance							
4. Industry Development							
4.1 Production Technology							
Onboard handling							

Exmouth Gulf Prawn Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
5. Priority Setting		■					
6. Science Review			■				

Gascoyne – Inner Shark Bay Scalefish Fishery

Description and Scope of Issues

This fishery includes commercial and recreational fishing for scalefish species within the waters of inner Shark Bay (includes the Shark Bay Beach Seine and Mesh Net Managed Fishery [SBBMNF] and Inner Shark Bay Recreational Fishery). The SBBMNF uses a combination of beach seine and haul net gears to take four main species/groups: whiting, sea mullet, tailor and yellowfin bream. Most recreational fishing is boat-based with vessels launching from boat ramps at Denham, Monkey Mia or Nanga. The main recreational species are SB Gulf demersal finfish - black snapper (grass or blue-lined emperor), pink snapper plus Gascoyne nearshore finfish - whiting, tailor, western butterfish, school mackerel and blackspot tuskfish. A limited number of licensed charter vessels operate out of Denham and Monkey Mia.

Relevant Resource Assets and Risks from Fishery

Shark Bay Gulf Demersal Finfish	Moderate – High Risk
Gascoyne Nearshore Finfish	Moderate Risk
Gascoyne Protected Species	Negligible Risk
Shark Bay Habitats	Negligible Risk
Shark Bay Gulf Ecosystems	Low Risk

Summary of historical research completed

Considerable research has been conducted on the main SBBMNF target species since the 1960s. Performance indicators for these species were determined as part of an Ecological Risk Assessment (ERA) process completed in 2003. Comprehensive biological research on pink snapper in the inner gulfs was undertaken between 1996/97 and 2005 with an integrated stock assessment models now used to assess the status of the Eastern Gulf, Denham Sound and Freycinet Estuary stocks separately and determine appropriate levels of TAC.

The first major survey of recreational fishing across the Gascoyne Coast Bioregion, including the inner gulfs, was undertaken in 1998/99 and was repeated in 2007/08; recreational surveys focussed on the inner gulfs only were carried out at the main boat ramps each year from 2000-2007.

Current Research Focus

The current focus is monitoring the status of the three separate inner gulf pink snapper spawning stocks and the four main target species taken by the SBBMNF.

Pink snapper: Since 2002, integrated stock assessment models have been used to assess the status of the three stocks in relation to the management target. These assessments are now updated every 3 years (next assessment scheduled for 2011).

Whiting, Mullet, Tailor, Yellowfin bream: Assessment of these four target species is based primarily on analysis of the commercial and charter vessel catch and effort data obtained from monthly statutory returns.

A recreational fishing boat-ramp survey in Inner Shark Bay is currently underway and will be completed December 2010; use of cameras at boat ramps (to monitor effort) is also being trialled as part of the project.

Priority Setting Process

Research and Development priorities are reviewed every 3 years by the Inner Shark Bay Pink Snapper Working Group; Group is scheduled to meet again mid-2011. Inner Shark Bay pink snapper stock assessments will be updated prior to this meeting.

The creation of the Gascoyne Demersal Scalefish Managed Fishery, outcomes of Gascoyne IFM process, and the new peak-body representative structure may see this review process change in future.

Science Review Timeline

Stock status and management arrangements for pink snapper in the inner gulfs will be reviewed in mid-2011.

Recent Publications

Jackson, G., Norriss, J.V., Mackie, M.C. and Hall N.G. (2010) Spatial variation in life history characteristics of snapper (*Pagrus auratus*) within Shark Bay, Western Australia. *New Zealand Journal of Marine and Freshwater Research* 44: 1-15.

Mackie M., Jackson G., Tapp N., Norriss J and Thomson. A. (2009) Macroscopic and microscopic description of snapper (*Pagrus auratus*) gonads from Shark Bay, Western Australia. Fisheries Research Report No 184. Department of Fisheries, Western Australia, 32 pp.

Mitchell R.W.D., Baba O., Jackson G., and Isshiki T. (2008) Comparing management of recreational *Pagrus* fisheries in Shark Bay (Australia) and Sagami Bay (Japan): conventional catch controls versus stock enhancement. *Marine Policy* 32: 27-37

Key Research Issues

The most important need is for on-going estimates of recreational catch and effort in the inner gulfs of Shark Bay.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

Inner Shark Bay Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Whiting	Complete						Adequate for management
Sea mullet	Complete						Adequate for management
Tailor	Complete						Adequate for management
Western yellowfin bream	Complete						Adequate for management
Pink snapper	Complete						Adequate for management
1.2 Other Biology							Nil required
1.3 Stock Assessment							
CAES catch and effort data	Ongoing	█	█	█	█	█	
Egg production estimates of pink snapper in each gulf stock	Ongoing	█	█	█	█	█	Stocks completed on rotation
Model-based assessment for Pink Snapper	Planned	○	○				Next review due mid 2011
1.4 Fishery Monitoring							
CAES data	Ongoing	█	█	█	█	█	
Recreational fishing survey	Ongoing	█					Boat ramp survey is currently underway, to be completed December 2010. Includes cameras at boat ramps and shore-based survey.
2. Habitat & Ecosystem							
2.1 Bycatch	Not needed						Low risk
2.2 Listed Species	Not needed						Low risk
2.3 Habitat	Not needed						Low risk
2.4 Ecosystem/Environment	Not needed						Low risk
2.5 Oceanography	Not needed						Low risk
2.6 Other impacts on fishery	Not needed						Low risk
3. Management Analysis							Not a Priority
4. Industry Development							Not a priority
5. Priority Settings		○					
6. Science Review		○					

Gascoyne – Shark Bay Prawn Fishery

Description and Scope of Fishery

The Shark Bay Prawn fishery has the highest prawn production in Western Australia. The fishery targets western king prawns, brown tiger prawns and a variety of smaller prawn species including coral prawns and endeavour prawns in restricted areas of Shark Bay using otter trawls. Fishing during the season involves ‘real time’ flexible fishing arrangements based on advice from the Research Division through voluntary rolling area openings and assessments of king and tiger prawn size via fishery-independent surveys. These openings and closures are designed to increase size, quality and market value of prawns while protecting the stocks from recruitment over-fishing. 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.

Relevant Resource Assets and Risks from Fishery

Gascoyne Nearshore Crustaceans	Moderate Risk
Gascoyne Protected Species	Low Risk
Shark Bay Gulf Habitats	Low Risk
Shark Bay Gulf Ecosystems	Negligible Risk

Summary of historical research completed

Research and monitoring of the fishery has been conducted since 1962 when the fishery commenced. Catch and effort statistics (both target and byproduct species) and voluntary logbook information has been collected from fishers at the outset, providing a valuable long-term data set from which stock assessments can be made. Furthermore, this long-term data collection is valuable to the Department because it spans varying effort levels and environmental variations throughout the history of the SBP fishery.

Research was completed in the 1970’s on the biology of the main target species and the determination of the habitat requirements of each of the species and the stock recruitment dynamics were also completed in the 1980’s.

Fishery-independent data has also been collected since 1991 (with current sampling regime since 2000) to gauge the level of recruitment during March and April each year and to determine the level of tiger prawn spawning stock during June to August.

Between 2002 and 2004 bycatch reduction devices (BRDs) were implemented in this fishery and the implementation process included an observer program documenting the efficiency of BRD (Kangas & Thomson 2004). A Fisheries and Research Development Corporation (FRDC) funded project was finalised on the biodiversity of bycatch in trawled and untrawled areas within Shark Bay in 2007 (Kangas et al. 2007).

Fleet interaction issues have been and continue to need to be addressed including snapper bycatch

issues (Moran & Kangas 2003⁶) and scallop-prawn interactions.

A FRDC project, in collaboration with Edith Cowan University analysed prawn logbook data using geostatistics to provide a better understanding of stock and fleet dynamics and to assess the appropriateness of the tiger prawn spawning area was completed in mid 2008 (Mueller et al. 2008).

Current Research Focus

Stock assessment and monitoring of the status of prawn stocks, particularly tiger prawns is the primary focus but provision of advice on optimising the value of catch has also been a key research activity. This includes fisheries dependent monitoring (logbook program and processor unload records) and fishery-independent surveys that provide recruitment and spawning stock indices and within season prawn size and abundance information for ‘real-time’ management. Also harvesting strategies are being developed to optimise the value of catches with targeting of larger prawns whilst protecting smaller sizes. This requires ‘real-time’ management, closer industry liaison and monitoring. Additional within-season surveys are being conducted in the Extended Nursery Area, and Denham Sound to optimise size at capture.

The calibration of catch rates between twin and quad gear has been undertaken to measure changes in fishing efficiency.

A FRDC-funded project focusing on minimising gear conflict and resource sharing issues in the Shark Bay trawl fisheries commenced in 2008 and will be completed at the end of 2010. This will include hydrographic modeling of scallop and prawn larval movement within Shark Bay in collaboration with UWA.

Priority Setting Process

Initial assessments were made through internal departmental meetings in 1998 discussing research undertaken, current research and research and development gaps and a plan was drafted for five years. Current research and gaps were discussed in a 2006 review of the Shark Bay prawn and scallop fisheries through workshops with licensees and other stakeholders. In subsequent years, research issues were discussed with Shark Bay prawn fishery licensees during their association meetings. Additional research needs have also been highlighted through the EPBCAssessment process completed in 2007.

Review Timeline

A comprehensive EPBC assessment of this fishery and its underlying data and information was undertaken as part of the Commonwealth EPBC accreditation process in 2007. Early research and publications on the biology and spawning stock stock recruitment/environment relationships have been peer reviewed. A formal review process is scheduled for May 2011.

Recent Publications

Mueller, U., Kangas, M., Dickson, J., Denham, A., Caputi, N., Bloom, L. and Sporer, E. (2008) Spatial and temporal distribution of western king prawns (*Penaeus latisulcatus*), brown tiger

⁶ Moran, M. and Kangas M., (2003) The effects of the trawl fishery on the stock of pink snapper, *Pagrus auratus*, in Denham Sound, Shark Bay. *Fisheries Research Bulletin* 31:52 pp.

prawns (*Penaeus esculentus*) and saucer scallops (*Amusium balloti*) in Shark Bay for fisheries management. Final FRDC Report 2005/038. 214 pp. Edith Cowan University.

Chandrapavan, A. (2009) To square or not to square. Western Fisheries, June 2009:39-41.

Kangas, M.I., Morrison, S., Unsworth, P., Lai, E., Wright I. and Thomson A., (2007) Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia. Final FRDC Report 2002/038. Fisheries Research Report 160: 333pp.

Kangas, M., Sporer, E., O'Donoghue, S. and Hood, S. (2008) Co-management in the Exmouth Gulf Prawn Managed Fishery with comparison to the Shark Bay Prawn Fishery. In: Townsend, R, Shotton, R and Uchica, H. (Eds.) Case studies in fisheries self-governance. FAO Fisheries Technical Paper. 504: 231-244

Mueller, U., Bloom, L., Dickson, J., Kangas, M. and Sporer, E. (2006). Using geostatistics to analyse prawn and scallop catch. Western Fisheries Article November 2006 pp50-51.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

Shark Bay Prawn Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments		
1. Retained Species Stock Analysis									
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)									
Brown tiger prawn biology	Completed						Completed in the 1970s and 1980s		
Western king prawn biology	Completed						Completed in the 1970 and 1980s		
Coral prawn biology	Minimal						Low Risk		
1.2 Other Biology									
Juvenile habitat monitoring	Completed						Completed in 1970s		
1.3 Stock Assessment									
Tiger prawn spawning stock assessment (Catch rate analysis)	Ongoing	■	■	■	■	■	Provides key PIs for fishery		
Stock-recruit-environ effects	Ongoing	■	■	■	■	■	Undertaken for tigers and kings Since 1990s		
Modelling	Ongoing	■	■	■	■	■	Some work done in late 1990s		
Yield/recruit, \$/recruit	Ongoing	■	■	■	■	■	Review needed		
Spatial analysis	Completed						ECU FRDC project completed in early 2008		
1.4 Fishery Monitoring									
Commercial catch monitoring	Ongoing	■	■	■	■	■			
Fishery independent surveys/size composition and abundance surveys	Ongoing	■	■	■	■	■			
Logbooks	Ongoing		■	■	■	■			
Pre-season skippers briefing	Ongoing	■	■	■	■	■			
Effort – benthic impact assessment (GIS)	Ongoing	■	■	■	■	■	EPBC requirement		

Shark Bay Prawn Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Fishing power monitoring/gear modifications	Ongoing	█	█	█	█	█	
Processor returns (target spp. and byproduct)	Ongoing	█	█	█	█	█	
Database maintenance	Ongoing	█	█	█	█	█	
Electronic logbooks	Future	O					Continued request by industry to have e-logbooks implemented

2. Habitat & Ecosystem

2.1 Bycatch

BRD Implementation (grids)	Completed						Implemented in 2002
BRD Implementation (secondary devices)	Completed						Implemented in 2004 with limited Observer work Ongoing
Bycatch monitoring	Periodic						Review every 5 years, opportunistic sampling during surveys and any observer trips. Need to establish an annual sampling program at an appropriate level.
Square-mesh cod-end trials		█					Industry initiative – observers to document effectiveness

2.2 Listed Species

Listed species interactions - logbooks	Ongoing	█	█	█	█	█	EPBC requirement/MOU with DEWHA underway
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2.3 Habitat

Habitat/effort impacts	Ongoing	█	█	█	█	█	EPBC requirement
Coral/sponge habitat mapping	Required						DEC
Closure of sensitive habitats	Possible						Consultation required

2.4 Ecosystem/Environment

Biodiversity of trawled and untrawled areas	Completed	█					Review every 5-10 years
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2.5 Oceanography

Leeuwin Current monitoring	Ongoing	█	█	█	█	█	
Temperature loggers	Ongoing	█					To be reviewed

2.6 Other impacts on fishery

Spatial closures	Possible	O					Component of FRDC project
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3. Management Research

3.1 Socio-economic

Social assessment	Possible						Partly done during SB review in 2006/07
Economic Analysis – average price data	Ongoing	█	█	█	█	█	
Fuel consumption/expenses	Ongoing	█	█	█	█	█	

3.2 Resource Access (Shares)

Prawn – Scallop fleet interactions and catch share – Snapper interactions	Periodic Catch share commence 2011		█	█	█	█	Currently review of prawn scallop fishery management/research arrangements
Prawn-Scallop gear interactions	Underway	█					FRDC 2007/08 (2 yr project)
Byproduct	Underway						Trialling size limits for crabs and bugs. Need to finalise byproduct paper.

Shark Bay Prawn Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
World Heritage Areas							
3.3 Compliance							
4. Industry Development							
4.1 Production Technology							
Onboard handling							
OHS	Possible						Changes to fishing hours
Product quality certification							
Hoppers	Completed						Industry Lead initiative – all boats now using them
5. Priority Setting	Periodic	■	■				Industry Departmental Meetings
6. Science Review	Periodic	■		■			Also part of EPBC assessment

Gascoyne – Shark Bay Scallop Fishery

Description and Scope of Issues

The Shark Bay Scallop fishery (SBS) is a limited entry, otter trawl fishery that operates within the waters of Shark Bay which is located in the Gascoyne bioregion of Western Australia. This is usually WA's most significant scallop fishery and has significant overlap with the Shark Bay Prawn fishery, with many boats licensed to operate in both fisheries. .

Relevant Resource Assets and Risks from Fishery

Gascoyne Nearshore Molluscs	Moderate Risk
Gascoyne Protected Species	Low Risk
Shark Bay Gulfs Habitats	Low Risk
Shark Bay Ecosystems	Negligible Risk

Summary of historical research completed

Research carried out by the Department since the late 1960s determined the basic biology of the saucer scallop (*Amusium balloti*) to ensure that the scallops are being harvested at ecologically sustainable levels whilst achieving the best economic returns from the available scallop resource. Annual management arrangements are tailored to the expected abundance of scallops due to the significant correlation (0.81) that was determined between the abundance of recruits and the following year's catch (Joll and Caputi, 1995).

A number of fleet interaction issues, including snapper bycatch issues (Moran & Kangas 2003), and scallop-prawn interactions have been examined. Experimental approaches to harvesting and

protection of spawning stock and newly settled scallops are being investigated, including refining catch rate thresholds to cease fishing and further temporal and spatial closures.

Bycatch reduction devices (BRDs) were implemented in this fishery and the implementation process included an observer program documenting the efficiency of BRD (Kangas & Thomson 2004). An FRDC funded project was finalised on the biodiversity of bycatch in trawled and untrawled areas within Shark Bay (Kangas et al. 2007).

A FRDC project, in collaboration with Edith Cowan University was completed in mid 2008 (Mueller et al. 2008). This study analysed scallop logbook and survey data using geostatistics to provide a better understanding of stock and fleet dynamics and to assess the correlation of commercial catches and high abundance areas delineated in surveys. The study indicated that the annual survey was a good indicator of 'high' and 'low' scallop abundance areas within the fishery.

Current Research Focus

Focus: Fishing for scallops now commences earlier to optimise the meat size of scallops which requires real-time monitoring (daily) of catch rates so fishing can cease at an agreed threshold catch rate level to ensure sufficient spawning stock is left during the key spawning period

Activities: Research for monitoring the status of the scallop stock is based on detailed logbook records and factory receipts provided by industry. An annual research survey is carried out in November, which, together with existing detailed biological knowledge, enables an annual catch forecast to be provided. The Department has been conducting pre-season surveys that monitor the strength of recruitment in Shark Bay since 1982. These surveys measure the abundance of residuals and recruits to the Shark Bay population each year and provide an annual index of recruitment, which is independent of catch records (Joll and Caputi, 1995). Daily catch rate information (cumulative catch against CPUE) is used to determine the available stock within main fishing grounds and in conjunction with the catch prediction from the annual survey allows an assessment of residual scallop stock abundance. This information has in the last few years been used to determine how much stock can be taken after the spawning period closure. The methodology used will need to be reviewed in three years.

Research will continue investigating the environmental influences that affect recruitment to scallop stocks in Shark Bay. More specifically, research into the effects that the Leeuwin Current has on the scallop recruitment and spawning or fertilisation activities will be further investigated.

A two-year FRDC project on prawn/scallop gear interactions, scallop and prawn larval movement patterns (hydrodynamic modelling) in Shark Bay and usefulness of area closures in scallop/prawn management commenced in March 2008 and will be completed at the end of 2010.

Priority Setting Process

Initial assessments were made through internal departmental meetings in 1998 discussing research undertaken, current research and research and development gaps and a plan was drafted for five years. In 2006 a review of the Shark Bay prawn and scallop fisheries was undertaken which involved workshops with licensees and other stakeholders. In subsequent years, research issues have been discussed with Shark Bay scallop fishery licensees during their association meetings. Some additional research requirements were identified through the EPBC processs for which a re-assessement was completed in 2007.

Review Timeline

Early research on the biology and reproductive cycle of scallops have been peer reviewed through journal publication processes. The next formal review will be conducted in August 2010.

Recent Publications

Lenanton, R.C., N.Caputi, M.Kangas & M.Craine (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(2): 111-127.

Mueller, U., Kangas, M., Dickson, J., Denham, A., Caputi, N., Bloom, L. and Sporer, E. (2008) Spatial and temporal distribution of western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*) and saucer scallops (*Amusium balloti*) in Shark Bay for fisheries management. Final FRDC Report 2005/038. 214 pp. Edith Cowan University.

Chandrapavan, A. (2009) To square or not to square. *Western Fisheries*, June 2009:39-41.

Kangas, M.I., Morrison, S., Unsworth, P., Lai, E., Wright I. and Thomson A., (2007) Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia. Final FRDC Report 2002/038. *Fisheries Research Report* 160: 333pp.

Mueller, U., Bloom, L., Dickson, J., Kangas, M. and Sporer, E. (2006). Using geostatistics to analyse prawn and scallop catch. *Western Fisheries Article* November 2006 pp 50-51.

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Shark Bay Scallop Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Scallop Biology	Completed						Completed in the 1970s and 1980
Meat size and quality		█	█				Additional information on spatial and temporal differences in meat size and quality will be sought through a funding application to the seafood CRC
1.2 Other Biology							
Recruitment Dynamics	Completed						Studies Completed in the 1980's
Larval Advection	Underway						FRDC project UWA PhD student
1.3 Stock Assessment							
Stock-recruit-environ effects	Ongoing	█	█	█	█	█	
Fishery independent surveys and monitoring	Ongoing	█	█	█	█	█	
Survey indices-catch relationships	Ongoing	█	█	█	█	█	Review of methodology in 2008/09

Shark Bay Scallop Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Modelling/Depletion exp.	Ongoing	■	■	■	■	■	Partly Completed
Spatial GIS	Ongoing	■	■	■	■	■	
Spatial analysis	Completed						ECU FRDC project completed in 2008
Catchability	Underway						Partly Completed including day-night trials
Mesh selectivity trials	Underway						FRDC project
1.4 Fishery Monitoring							
Logbooks	Ongoing	■	■	■	■	■	
Pre-season skipper briefings	Ongoing	■	■	■	■	■	
Fishing power monitoring	Ongoing	■	■	■	■	■	
Processor returns	Ongoing	■	■	■	■	■	
Database maintenance	Ongoing	■	■	■	■	■	
Effort impact assessment (GIS)	Ongoing	■	■	■	■	■	EPBC requirement
Spatial analysis of survey and logbook data	Completed						ECU collaboration – student project
2. Habitat & Ecosystem							
2.1 Bycatch							
BRD Implementation	Completed						Completed in 2003
Bycatch monitoring	Periodic	■					Review every 5 years
2.2 Listed Species							
Listed species interactions - logbooks	Ongoing	■	■	■	■	■	EPBC requirement/MOU with DEWHA underway
2.3 Habitat							
Habitat/effort impacts	Ongoing	■	■	■	■	■	EPBC requirement
Closure of sensitive habitats	Possible						Consultation required
2.4 Ecosystem/Environment							
Biodiversity of trawled and untrawled areas	Completed		■				Review every 5-10 years
Formal risk assessment	Periodic						EPBC requirement
Marine Park Monitoring	Possible						
2.5 Oceanography							
Leeuwin Current monitoring	Ongoing	■	■	■	■	■	
Temperature loggers	Ongoing	■	■	■	■	■	
Modelling of currents	Underway	■					FRDC UWA PhD project
2.6 Other impacts on fishery							
Spatial closures	Possible	O					Will be reviewed after completion of FRDC project
3. Management Analysis							
3.1 Socio-economic							
Social assessment	Possible						Partly completed during SB Review 06/07
Economic Analysis – average price data	Ongoing	■	■	■	■	■	Bio-economic modelling revisited in 09/10
Fuel consumption/expenses	Ongoing	■	■	■	■	■	Bio-economic modelling revisited in 09/10

Shark Bay Scallop Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
3.2 Resource Access (Shares)							
Prawn – Scallop- fleet interactions and catch share - Snapper	Ongoing	█	█	█	█	█	Needed for the review of the three fisheries
Prawn-Scallop gear interactions	Underway	█					FRDC Project
4. Industry Development							
4.1 Production Technology							
Aquaculture /reseeding	Completed						Completed in 1990s
5. Priority Setting							
6. Science Review							
	Periodic	█			█		Aug 2010 review workshop

North Coast Bioregion

North Coast – Biodiversity Issues

Description and Scope of Issues

On the north coast, marine habitats have been locally affected by port developments, oil and gas exploration and extraction, and some fishing activities across the continental shelf. The offshore Pilbara area in particular, was heavily trawled by international vessels in the 1960s and 1970s; however, this activity was phased in the early 1980s. Since that time, extensive fisheries closures over coastal and most offshore waters have been introduced to manage fish trawl and trap fishing. Trawling for prawns is only permitted at a small number of locations associated with inshore nursery areas so that trawling occurs over a very small proportion of the habitat. In addition to the extensive fisheries closures protecting marine habitats, the bioregion has a number of Reef Protected Areas under Fisheries legislation and marine parks and reserves around offshore islands and reefs.

This region is currently of importance for the future oil and gas development initiatives. It is also the subject of another Commonwealth Regional Marine Planning exercise.

Relevant Resource Assets and Risks from all Fisheries

Benthic - Estuaries/Nearshore	Low Risk
Benthic - Pilbara	Moderate Risk
Benthic - Kimberley	Low Risk
Protected species - non fish	Low Risk
Protected species - non fish - mammals	Moderate Risk
Protected species - fish	Moderate Risk
North Coast Ecosystem - Estuarine	Negligible Risk
North Coast Ecosystem - Pilbara marine	Negligible Risk
North Coast Ecosystem - Kimberley marine	Negligible Risk
Introduced Pests & Diseases	High Risk

Summary of historical research completed

A summary of the research information available for this region was compiled as part of a WAMSI project undertaken by DEC. In addition, WAMSI Board commissioned a research plan for the Kimberley Browse region. Information on the status of introduced marine pest species (IMPs) has been gathered at the port of Dampier.

Current Research Focus

An introduced marine pest (IMP) Monitoring Design Report (MDR) for Dampier Port has been

completed and approved for implementation. This monitoring program has not yet commenced due to funding constraints. A project is underway, which will make recommendations and develop a strategic framework to inform and guide a future Coastal and Marine Resource Condition Monitoring Program for the Pilbara and Kimberley Regions. Respond to reports and investigate cause of fish kills.

A program of research will be developed for the proposed Camden Sound marine protected area.

Priority Setting Process

There is currently no formal priority setting process for this region.

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North Coast Biodiversity Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
2. Habitat & Ecosystem							
2.1 Bycatch (Trawl fisheries)	Completed						Completed in the early 2000s
2.2 Listed Species		■					WAMSI 4.4.1 - Captured species assessments: bycatch
Dolphins	Completed						Studies to ameliorate catch of dolphins in fish trawl nets has been completed.
2.3 Habitat							
Developing RCTs for benthic habitats	Underway						
2.4 Ecosystem/Environment							
	Underway	■					
2.5 Oceanography							
Hydrodynamic modelling	Underway	■					
Nutrient/plankton cycles on shelf	Completed						
2.6 Other impacts on fishery							
Monitoring for Introduced marine pests	Proposed						
3. Management Analysis							
3.1 Socio-economic							
Social assessment							
Economic Analysis							
3.4 Management Systems							
4. Industry Development							
5. Priority Review							
6. Science Review							

North Coast – Mackerel Fishery

Description and Scope of Issues

The commercial mackerel fishery includes the taking of all species of the genera *Scomberomorus*, *Grammatocynus* and *Acanthocybium*, but the main targeted species is Spanish mackerel (*Scomberomorus commerson*). Mackerel are usually taken by trolling close to the surface in coastal areas around reefs, shoals and headlands, with jigs also used to capture grey mackerel (*Scomberomorus semifasciatus*). Recreational fishers also use methods such as shore-based drift fishing with balloons and spear guns to target mackerel. The commercial fishery mainly operates between Geraldton and the Western Australia/ Northern Territory border, with the largest catches taken off the Kimberley and Pilbara coasts. The main area of the recreational fishery is Perth to Dampier.

Relevant Resource Assets and Risks from Fishery

North South Coast Pelagic Finfish	Moderate Risk
North Coast Protected Species	Negligible Risk
North Coast Habitat	Negligible Risk
North Coast Ecosystems	Negligible Risk

Summary of historical research completed

There were two major projects on mackerel funded by FRDC in 2002 which focused on the narrow-barred Spanish mackerel, *Scomberomorus commerson*. These projects provided descriptions of the biology, spatial structure and status of Spanish mackerel stocks in Western Australian waters, and served as a basis for developing the future management arrangements for this fishery.

Current Research Focus

Currently, a cooperative FRDC project focusing on the stock structure of grey mackerel (*Scomberomorus semifasciatus*) is underway between the Department of Fisheries WA and research groups in the Northern territory and Queensland. It will be finalised during the second half of 2010.

The fishery is monitored using the daily logbooks submitted by fishers and VMS (Vessel Monitoring System). Catch and effort has now been constrained under the management plan through the use of TACCs in a number of zones.

Priority Setting Process

Priorities are reviewed internally on an annual basis.

Review Timeline

The science underpinning this fishery was extensively reviewed in 2005. An internal review of the fishery is programmed from late 2010.

Key to symbols in the summary matrix:

- Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

North Coast Mackerel Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Narrow barred Spanish mackerel	Completed						
Grey/other mackerel	Proposed						Not optimal for management; low risk and therefore low priority
1.2 Other Biology							
Stock structure of Spanish mackerel	Completed						
Grey mackerel stock structure	Underway	■					As part of a QLD based FRDC research project. Due for completion in late 2010
1.3 Stock Assessment							
Annual Assessment	Completed						No planned update; currently monitored by catch and effort data and VMS
Biomass Dynamics and Yield/Egg Per Recruit Modelling	Completed 1998						No planned update; low priority
1.4 Fishery Monitoring							
Commercial Catch and Effort	Ongoing	■	■	■	■	■	Daily log books implemented in 2006
Charter Boat C&E	Ongoing	■	■	■	■	■	
Recreational Creel Surveys	Proposed						Unfunded
2. Habitat & Ecosystem							
2.1 Bycatch	Not needed						Low risk
2.2 Listed Species	Not needed						Low risk
2.3 Habitat	Nil						Nothing identified
2.4 Ecosystem/Environment	Nil						Nothing identified
2.5 Oceanography	Nil						Nothing identified
2.6 Other impacts on fishery							Shark predation of catch
3. Management Analysis							
3.1 Socio-economic							
3.2 Resource Access (Shares)							
Determination of access shares	Proposed	○					Between recreational and commercial sectors
Monitoring of shares	Proposed	○					Between recreational and commercial sectors
Review of IMP	Underway	■					
3.3 Compliance Research							
3.4 Management Systems	Proposed	○					Review of TACC with a view to increasing; may require additional monitoring
4. Industry Development	Nil						Nothing identified

North Coast Mackerel Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
5. Priority Review							
6. Science Review							

North Coast – Beche-de-mer Managed Fishery

Description and Scope of Issues

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 based in the northern half of the state, from Exmouth Gulf to the Northern Territory border. It is a hand-harvest fishery, with animals caught principally by diving, and a smaller amount by wading. There are six target species caught commercially in Western Australia, however 99% of the catch is sandfish (*Holothuria scabra*) and deep-water redfish (*Actinopyga echinata*).

Relevant Resource Assets and Risks from Fishery

North Coast Echinoderms	Moderate Risk
North Coast Protected Species	Negligible Risk
North Coast Habitat	Negligible Risk
North Coast Ecosystems	Negligible Risk

Summary of historical research completed

A daily catch and effort logbook has been tested and introduced into the fishery. There are significant gaps in knowledge about the biology of the species harvested in this fishery, and current size-limits are based on Northern Territory fisheries.

Current Research Focus

Current research is focused on: stock assessment using monthly catch and effort statistics and development of stock performance indicators that incorporate finer-scale, species-specific information.

Priority Setting Process

Meetings between the Department of Fisheries and industry

Review Timeline

The Fisheries Research Division reviews the fishery and stocks annually in January/February.

Key to symbols in the summary matrix:

- █ Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

North Coast Beche-de-mer Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							Information on growth and size at maturity are needed to improve the management of the Kimberley and Pilbara stocks
Growth	Proposed						
Size-at-maturity	Proposed						
1.2 Other Biology							
Genetics	Low Priority						Genetics work on <i>H. scabra</i> would help establish appropriate management boundaries
1.3 Stock Assessment							
Sustainability of stocks		█	█	█	█		
1.4 Fishery Monitoring							
Research logbook implementation		█	█	█	█		
2. Habitat & Ecosystem							
2.1 Bycatch							Negligible Risk
2.2 Listed Species							Negligible Risk
2.3 Habitat							Negligible Risk
2.4 Ecosystem/Environment							Negligible risk
3. Management Analysis							
4. Industry Development						Nothing Identified	
5. Priority Review							
6. Science Review -						Will coincide with EPBC – WTO assessment	

North Coast – Nearshore Fisheries

Description and Scope of Issues

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) extends 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 by any means.

The species taken are predominantly barramundi (*Lates calcarifer*), king threadfin (*Polydactylus macrochir*) and blue threadfin (*Eleutheronema tetradactylum*). The main areas of 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. Two exemption holders fished along the Eighty Mile Beach section of the Pilbara Coast in early 2008 before their exemptions were withdrawn. The catches from these exemption holders were very small and are not considered further.

Recreational fishing activities are concentrated around key population centres, with a peak in activity during the dry season (winter months).

Relevant Resource Assets and Risks from Fishery

North Coast Nearshore Finfish	Moderate Risk
North Coast Protected Species	Low Risk
North Coast Habitats	Low Risk
North Coast Ecosystems	Low Risk

Summary of historical research completed

The biological characteristics required for fisheries management of the King threadfin and the Blue threadfin have been completed by a joint project between the Department and Murdoch University. The bycatch of elasmobranchs in the KGBF and along the Pilbara coast fishing area was examined by the Department during 2002 and 2003.

Current Research Focus

CAES data are used to assess the status of barramundi stocks targeted by this fishery. This status report is compiled annually and provided to industry and regional management.

Priority Setting Process

Initial assessments were made through internal departmental meetings and forums discussing the history of research in the fishery, research activities that have been completed, current research as well as research and development gaps. Research issues have been discussed at annual industry consultation meetings once a year.

Review Timeline

Next planned review in late 2012.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

North Coast Nearshore and Estuarine Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments		
1. Retained Species Stock Analysis									
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)									
King threadfin	Complete						Sufficient for management		
Blue threadfin	Complete						Sufficient for management		
Barramundi	Proposed						Project identified		
1.2 Other Biology									
Sawfish	Proposed						Project identified		
Pig eye shark	Proposed						Project identified		
Lemon shark	Proposed						Project identified		
1.3 Stock Assessment									
Annual Catch and Effort Assessment	Ongoing	■	■	■	■	■	Ongoing		
Age Structured Models (indicator species)	Proposed	○	○	○	○	○	Project identified to develop a national model		
1.4 Fishery Monitoring									
Commercial Catch and Effort	Ongoing	■	■	■	■	■	Ongoing		
Age Structure of Indicator Species	Proposed	○		○			Periodic		
Commercial monitoring (vessel monitoring at sea)	Proposed	○		○		○	Periodic		
Recreational Creel	Proposed		○				Periodic		
Charter Boat Catch and Effort	Ongoing	■	■	■	■	■	Ongoing		
2. Habitat & Ecosystem									
2.1 Bycatch	Proposed		○				Periodic – Low risk – initial project completed		
2.2 Listed Species									
Sawfish	Proposed	○	○	○	○	○	Project identified – High risk		
2.3 Habitat	Not needed						Low risk – gillnet fishery		
2.4 Ecosystem/Environment	Not needed						Nothing identified		
3. Management Analysis									
3.1 Socio-economic									
3.2 Resource Access (Shares)	Proposed		○	○			Needed for IFM		
3.3 Compliance Research									
3.4 Management Systems									
4. Industry Development									

North Coast Nearshore and Estuarine Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
5. Priority Review		█	█	█	█	█	Annual industry meetings
6. Science Review			█				Major assessment reports peer reviewed every three years

North Coast – Pearl Oyster Managed Fishery and Pearl Production

Description and Scope of Issues

Wild capture - The Western Australian pearl oyster fishery is the only remaining significant wild-stock fishery for pearl oysters in the world. It is a dive fishery that dates back to the 1850s operating in shallow coastal waters along the North West Shelf. The species targeted is the Indo-Pacific, silver-lipped pearl oyster (*Pinctada maxima*) and they are harvested by drift diving.

There is an extensive amount of relevant and accurate information on the biology of the silver lipped pearl oyster, history of this fishery (in excess of 30 years for the culture shell fishery and almost 100 years for the Mother Of Pearl fishery), as well as oyster culture, genetics, disease and pearl production techniques

Relevant Resource Assets and Risks from Fishery

North Coast Molluscs – Pearls	Low Risk
North Coast Protected Species	Negligible Risk
North Coast Habitat – Kimberley	Negligible Risk
North Coast Ecosystems	Negligible Risk

Summary of historical research completed

Fishery: Biology (growth, reproduction, maturity), ecological studies (population densities, settlement and recruitment), environmental effects and oceanography studies (larval drift and circulation, source-sink relationships) have been completed.

Historical time series of daily catch information on number of pearl oysters caught, diver hours, date and location of harvest. Historical catches and effort over the past 100 years have also been reviewed. An annual standardized catch per unit effort (CPUE) model has been developed that accounts for variation in spatial and temporal fishing effects, as well as technological improvements that aid fishing efficiency. The standardized CPUE data are being used in a decision-rule framework for quota setting in the fishery

Large scale surveys of Mother-of-Pearl (MOP) stocks and genetic relationships within and between Western Australian stocks of *Pinctada maxima* have been established

A recently study examined the management of bio-eroding sponges (*Cliona* sp.) on wild stocks, the

project found no clear evidence that the incidence of this increasing.

Pearl oyster aquaculture and pearl production: studies on culturing of oysters and pearls were completed during the late 1980's and early 1990's, and a major review of the history of exploitation and culture of pearls has been completed.

Current Research Focus

Current stock assessment research is focused on:

- Stock assessment using catch and effort statistics (taking into account discard rates) and recruitment and length-frequency sampling to estimate the total allowable catch.
- Development of an index of recruitment for predicting future years catch levels using the relative number of piggy back spat.
- Decision rules for determining the TAC
- Environmental drivers (e.g. rainfall) of pearl oyster abundance

Current production research focuses on environmental management, pearl oyster health, and improved health and safety for pearl divers. Including:

- Comprehensive disease-testing program to the industry.
- 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.
- Demonstrate that the pearl industry operates in a manner acceptable to public standards for access to the marine environment;
- Demonstrate that the pearl industry operates in a manner acceptable to public standards for access to the marine environment;
- Develop a culture of best practice and continuous self-improvement with regard to environmental management and health and safety

Priority Setting Process

Meetings between the Department of Fisheries and industry

Science Review and Timeline

The Stock Assessment Working Group (SAWG) reviews the fishery and stocks annually, with quota decisions made in October/November. A mid-season review is also carried out during April. The science used for this fishery was last reviewed by the stock assessment working group in October 2010.

Recent Publications

Hart AM, Thompson A, Murphy D (in press). Environmental influences on stock abundance and fishing power in the silver-lipped pearl oyster fishery. ICES Journal of Marine Science.

Daume S, Fromont J, Hart AM (2009). Management of bioeroding sponges in wild stocks of *Pinctada maxima* in Western Australia. Fisheries Research Report No 196, Department of Fisheries, Western Australia, 44 p

Bearham, D. Spiers, Z. Raidal, S. Jones, J.B., Burreson, E.M., Nicholls, P.K. (2008). Spore

ornamentation in *Haplosporidium hinei* n.sp. (Haplosporidia) in pearl oysters *Pinctada maxima* (Jameson, 1901). Parasitology 135, 1-7.

Jones, J.B. (2008). Experiences in dealing with pearl oyster mortalities. In: Bondad-Reantaso, M., McGladdery, S.E., Berthe, F.C.J. (eds). Manual on South Sea Pearl Oyster Health Management. FAO Fisheries Technical Paper 503. Rome.

Jones, J.B. (2008). The Australian experience: pearl oyster mortalities and disease problems. In: Bondad-Reantaso, M., McGladdery, S.E., Berthe, F.C.J. (eds). Manual on South Sea Pearl Oyster Health Management. FAO Fisheries Technical Paper 503. Rome.

Southgate PC, Strack E, Hart AM, Wada KT, Monteforte M, Carino M, Langy S, Lo C, Acosta-Salmon H, Wang A (2008). Chapter 9: Exploitation and Culture of Major Commercial Species. pp. 303 – 356. In: The Pearl Oyster, Eds Southgate PC and Lucas J, Elsevier London.

Spiers, Z.B., Bearham, D., Jones, J.B., O'Hara, A.J., Raidal, S. 2008. Intracellular ciliated protozoal infection in silverlip pearl oysters, *Pinctada maxima* (Jameson, 1901). Journal of Invertebrate Pathology 99: 247-253.

Hart AM, Joll L (2006). Growth, mortality, recruitment, and sex ratio in wild stocks of the silver-lipped pearl oyster *Pinctada maxima* (Jameson)(Mollusca: Pteriidae) in Western Australia. *Journal of Shellfish Research*. 25 (1): 201-210.

Hart AM (2006). Predicting and assessing recruitment variation – a critical factor for management of the *Pinctada maxima* fishery in Western Australia. Final Report to the Fisheries Research and Development Corporation, Project No 2000/127. 86 p.

Key to symbols in the summary matrix:

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- Indicates that the activity is part of a proposal but is not yet funded.

Pearl Oyster Fishery and Pearl Production Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)	Completed						A number of studies using tag-recapture, monthly monitoring, and histological studies have been completed
Environmental effects on recruitment	Ongoing	■	■	■	■	■	Annual monitoring of recruitment and environmental variable such as rainfall, temperature, wind and SOI indices
MOP (FRDC)	Completed						A major project on demography and potential fishery completed in 2004
Growth rate of wildstock (FRDC)	Completed						Growth established in the northern, central, and southern sections of fishery
Heavy metals	Completed						
1.2 Other Biology							
Genetics (FRDC)	Completed						Two FRDC projects on connectivity completed

Pearl Oyster Fishery and Pearl Production Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1.3 Stock Assessment							
Annual Assessment of catch rates and sizes	Ongoing	█	█	█	█	█	Annual assessments and analysis of diver CPUE and size-frequency
1.4 Fishery Monitoring							
Statistics (wildstock)	Ongoing	█	█	█	█	█	120 year time-series of catch and effort in the fishery
2. Habitat & Ecosystem							
2.1 Bycatch	Not Needed						Negligible Risk
2.2 Listed Species	Not needed						Negligible Risk
2.3 Habitat	Not Needed						Negligible Risk
2.4 Ecosystem/Environment							
Environmental impact of pearl oyster fishing	Not Needed						Low Risk
Environmental impact farm site	Underway						PPA project with University of Newcastle, looking at impacts on benthic habitat
Environmental impact/monitoring	Underway						PPA project with University of Newcastle, looking at impacts on benthic habitat
Site survey/food availability/density	Needed						
Site selection parameters	Needed						
EMS Template Pilot Project	Completed						Environmental monitoring studies
2.5 Oceanography							
NW Shelf study	Completed						On going CSIRO modelling research at a bioregional scale
Kimberley inshore bio-oceanography	Completed New proposal	O					Larval drift studies for <i>Pinctada maxima</i> spawning and settlement areas.
2.6 Other impacts on fishery							
3. Management Analysis							
3.1 Socio-economic							
Occupational Health & Safety							WAFIC/PPA issue
Diver safety/farm profiles	Completed						Studies on pearl diving and decompression protocols
3.2 Resource Access (Shares)	Not Needed						No recreational fishery
3.3 Compliance							
Compliance evaluation	Completed						Independent report completed in 07/08
3.4 Management Systems							
EMS	Completed						EMS was completed by industry for farming operations
4. Industry Development							
4.1 Pearl Culture Development							
Culture development (move to longlines)	Completed						Move from bottom culture to long-line culture completed in early 1990s
Irukandji Jellyfish Stings	Proposed						Protection for divers
Antifouling	Proposed	█	█				Industry project
Seeding techniques (private)							

Pearl Oyster Fishery and Pearl Production Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Hatchery development project (FRDC)	Completed						Major FRDC projects by the Dept. of Fisheries on spawning and hatchery culture
Growth rates/nursery spat (FRDC)	Completed						Major FRDC projects by the Dept. of Fisheries on nursery culture
MOP nuclei production (FRDC)	Completed						Examination of use of MOP shell to produce nuclei for pearl seeding
4.2 Post Harvest & Marketing							Completed by industry
Market research/intelligence (Private)		O	O				
Promotion/Branding Mkt Resch		■	■				
4.4 Fish Health							
Fish health and diagnostics	Ongoing	■	■	■			general fish health and diagnostic services for the pearl industry
Husbandry wildstock							
Disease survey/atlas (FRDC)	Completed						FRDC funded Australia-wide survey of wild stock diseases
Translocation/protocol	Periodic	■					
Ciliate Project	Underway						Characterize the Intracellular ciliate found In Zone 1 pearl oysters
Haplosporidian Project	Underway						Characterize the haplosporidian found In pearl oysters and rock oysters
Cliona Management in wild stocks (FRDC)	Completed						FRDC funded project on bioeroding sponges in wild stocks
Diagnostic test for OOD	Underway	■	■	■	■		FRDC funded projects on Chlamydiales-like organisms, stress response; industry funded work on oedema disease.
Test for Oyster Stress (Miroarrays)	Underway	■					FRDC project looking at generic stress response in <i>P. maxima</i>
5. Priority Review		■	■	■	■		Annual industry meetings
6. Science Review			■				Major assessment reports peer reviewed every three years

North Coast – Demersal Fisheries

Description and Scope of Issues

The demersal fisheries in this region targets, to varying degrees, 10 main species, bluespot emperor (*Lethrinus punctulatus*), threadfin bream (Nemipteridae), flagfish (*Lutjanus vitta*), crimson snapper (*Lutjanus erythropterus*), red emperor (*Lutjanus sebae*), saddletail snapper (*Lutjanus malabaricus*), goldband snapper (*Pristipomoides multidens*), spangled emperor (*Lethrinus nebulosus*), frysman snapper (*Argyrops spinifer*) and Rankin cod (*Epinephelus multinotatus*).

In the Pilbara there are three separate commercial fisheries for these species - trawl, trap and line fisheries. In the Kimberley there is a single trap based fishery (NDSF). The trawl and trap fisheries are all managed primarily by the use of input controls in the form of individual transferable effort allocations monitored with a satellite-based vessel monitoring system.

Relevant Resource Assets and Risks from Fishery

North Coast Demersal Finfish	Moderate Risk
North Coast Protected Species	Moderate Risk
North Coast Habitat – Pilbara	Moderate Risk
North Coast Habitat – Kimberley	Negligible Risk
North Coast Ecosystems	Low Risk

Summary of historical research completed

Pilbara: Baseline research for managing the demersal fish stocks was undertaken in two FRDC funded projects from 1993 to 1999, providing the basis for long-term monitoring of the stocks of the indicator species.

The catch of protected species has been a focus of research from 2002 to 2009. Three projects have been completed that collected baseline data (NHT project) and evaluated mitigation devices (FRDC and DBIF). In 2008 a project to analyse the behaviour of bottlenosed dolphins was completed (Endeavour Grant project) and in 2009 Murdoch University completed a FRDC funded project (no. 2008/048) aimed at reducing dolphin bycatch in the Pilbara trawl fishery. This project identified the need to trial a top-opening in the trawl nets to potentially further mitigate the incidental capture of dolphins and turtles. A top-opening net configuration is currently being developed by industry and is scheduled for scientific trials in late 2010.

Kimberley: Baseline research for managing the demersal fish stocks was undertaken in an FRDC funded project from 1997 to 2000, providing the basis for long-term monitoring of the stocks of the indicator species. Age-based demographic data has been published on red emperor (Newman and Dunk, 2002) and goldband snapper (Newman and Dunk, 2003).

Current Research Focus

Pilbara: Monitoring and assessment of the Pilbara trawl, trap and line fisheries includes the collection of spatial data on effort and catch of 10 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 using various assessment methods. These methods include trend analysis of catch rates using two measures of effort for five indicator species and the total catch in each of the trawl managed areas. In addition, otoliths are collected and ages determined for the indicator species, red emperor, rankin cod, bluespotted emperor, and goldband snapper in each of the trawl-managed areas and the trap fishery. Estimates of fishing mortality are derived from each of these age structures and compared to internationally recognised Exploitation Reference Points (ERPs). Every three to four years the spawning biomass of two indicator species, red emperor and rankin cod, is assessed using the age-composition and catch rate data in an age-structured model.

Discussions are in progress on developing a collaborative project with CSIRO to update the work conducted by CSIRO in the 1980's on the North West Shelf benthos abundance and scalefish species composition. The monitoring of two shorter lived indicator species, bluespotted emperor and brownstripe snapper, have been increased from a Tier 2 (catch rate) to a Tier 3 (fishing mortality based) assessment. Collection of age structure data from different sources (fishery

independent and markets) is scheduled for the next 12 months.

Kimberley: The status of the demersal fish stocks in the NDSF is determined annually using catch and catch rates of the major species or species groups, and every three to four years using an age-based stock assessment model to assess the status of the two indicator species, red emperor and goldband snapper based on age-composition data collected in the previous years. Ongoing monitoring of this fishery is being undertaken using both CAES and VMS data.

An FRDC-funded research project commenced in late 2006. This project aims to examine the relative catching efficiency of traps in the NDSF and to investigate resource availability and contribute to the stock assessment process in the NDSF.

The future catch from the NDSF may also include 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 production potential of these longer-lived, deeper-slope reef fish, and the sustainable catch from this zone is likely to be low.

Priority Setting Process

Commercial: Department–industry meetings for the fish trawl and trap fisheries.

Recreational: Regional Recreational Fishing Advisory Committee

Review Timeline

Pilbara: Pilbara stock assessment review was undertaken in 2008. It is anticipated that the next review will be undertaken in 2011.

Kimberley: An independent review of the stock assessment of the key target species in the NDSF was completed in mid 2009. It is anticipated that the next review will be undertaken in 2012.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

North Coast Demersal Fisheries Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Red emperor	Completed						Sufficient for management
Goldband snapper (Pilbara)	Proposed	○	○	○	○		Project identified – current gap – High risk
Rankin cod	Completed						Sufficient for management
Bluespotted emperor (Pilbara)	Proposed	○	○				F-based assessment - High risk
Brownstripe snapper (Pilbara)	Proposed	○	○				F-based assessment - High risk
Rosy threadfin bream	Completed						Sufficient for management

North Coast Demersal Fisheries Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
		O	O	O	O	O	
Crimson snapper (Pilbara)	Proposed	O	O	O			Low priority
Saddletail snapper	Completed						Sufficient for management
Spangled emperor	Completed						Sufficient for management
Cod species (Kimberley)	Proposed	O	O	O	O		Project identified – High risk
Cod species (Pilbara)	Proposed	O	O	O	O		Project identified – High risk
1.2 Other Biology							
Stock structure – Red emperor/Rankin cod using stable isotopes	Completed						Sufficient for management
Stock structure – Goldband snapper stable isotopes	Completed						Sufficient for management
Genetics – goldband snapper	Completed						Sufficient for management
Genetics – red emperor	Completed						Sufficient for management
1.3 Stock Assessment							
Annual catch and effort assessment	Ongoing	█	█	█	█	█	Ongoing
Age structured models (indicator species)	Ongoing	█	█	█	█		Periodic for indicator species
1.4 Fishery Monitoring							
Commercial catch and effort	Ongoing	█	█	█	█	█	Ongoing
VMS data	Ongoing	█	█	█	█	█	Ongoing
Age composition data for indicator species	Ongoing	█	█	█	█		Periodic
Commercial monitoring (vessel monitoring at sea)	Ongoing	█		█			Periodic
Recreational survey	Proposed	O	O				Periodic
Charter Boat Catch and Effort	Ongoing	█	█	█	█	█	Ongoing
Catching efficiency of gears (Kimberley)	Underway	O					FRDC Project
2. Habitat & Ecosystem							
2.1 Bycatch							
Monitoring and review (Pilbara)	Proposed	O	O	O	O		Joint Project proposal identified
Monitoring (Kimberley)	Ongoing	█		█			Periodic – low risk
2.2 Listed Species							
P: Dolphins (moderate risk), turtles (low risk). Sygnathids (low risk), sea snakes (low risk), sea horses (low risk). Sawfish (moderate risk)	Underway	█					Trials of top-opening In trawl net
P: Protected species mitigation - acoustic pingers	Completed						Acoustic pingers were ineffective
P: Selection grids	Completed						Dolphin catch has halved since 2005
K: Monitoring	Ongoing	█	█				Periodic – low risk
2.3 Habitat							
P: Survival of benthos	Completed	O	O	O			Work completed in the 1990s. part of joint proposal
K:	Not needed						Low risk
2.4 Ecosystem/Environment	Proposed	O	O	O			Part of joint proposal.
2.5 Oceanography							
Use of drifters to evaluate on-shelf oceanographic processes	Proposed	O	O	O	O		Project identified

North Coast Demersal Fisheries Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
2.6 Other impacts on fishery							
K: Effects of Indonesian impacts	Proposed	O	O	O	O		Project identified – low priority
3. Management Analysis							
3.1 Socio-economic							
Social assessment	Possible	O					May be needed for IFM
Economic analysis	Possible	O					May be needed for IFM
3.2 Resource Access (Shares)							
Detailed determination of access shares	Proposed	O					Needed for IFM
Monitoring of shares	Proposed	O					Needed for IFM
3.3 Compliance							
Validation of catch records	Proposed	O	O				Required for ESD assessment
3.4 Management Systems							
Management of recreational sector	Proposed	O					May be needed for IFM
Effort monitoring by VMS	Ongoing	█	█	█	█	█	Ongoing – gap for Pilbara line fishery
4. Industry Development							
4.1 Production Technology							
4.2 Post Harvest							
Seafood quality enhancement	Proposed	O	O	O	O		Project identified
4.3 Marketing							
5.1 Priority Review		█	█	█	█	█	Annual industry meetings
6. Science Review							
6.1 Pilbara			█				Major assessment reports peer reviewed every three years
6.2 Kimberley				█			An Independent review of the stock assessment for the NDSF was undertaken

North Coast – Shark Fisheries

Description and Scope of Issues

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. Until July 2005, when new management arrangements were proposed for the two fisheries, the primary fishing method was demersal longlining in the WANCSF with only a small and intermittent amount of pelagic gillnetting in the JANSF. The intent of the proposed management revisions was to reduce the total effort capacity of the fisheries and re-target fishing towards more productive blacktip whaler stocks in the Kimberley.

Implementation of the proposed new management arrangements has been delayed by negotiations by the Joint Authority (comprising the Western Australian and Commonwealth ministers), although there has been lower than anticipated effort in the fisheries since 2005.

Recent analyses of data relating to the status of northern shark stocks have identified additional sustainability concerns for multiple shark stocks taken by the northern shark fisheries, including the intended target stocks of blacktip sharks. Concerns for blacktip shark stock sustainability relate to new genetic research that suggests the species composition of the “stock” (or at least catches) has changed dramatically over the last three decades; questionable assumptions in the assessment model and inaccurate time-series of CPUE data (on which previous assessments have been based). Nominal CPUE data from the WANCSF prior to July 2005 also suggest that several other long-lived shark stocks may have been significantly depleted by a combination of documented and undocumented catches by domestic target and non-target fisheries and illegal foreign fishing vessels. Other stakeholders have also expressed concerns about mackerel stock sustainability and broader ecological impacts from increased pelagic gillnetting off the Kimberley and Pilbara coasts. In 2008 the JANSF’s Wildlife Trade Operation (WTO) export approval was revoked by the Minister for the Environment, Water Heritage and the Arts. The WTO for the WANCSF expired in 2009.

Relevant Resource Assets and Risks from Fishery

Statewide North-West Sharks	Moderate – High Risk
North Coast Protected Species	Low Risk
North Coast Habitat	Low Risk
North Coast Ecosystems	Low Risk

Summary of historical research completed

Research to monitor the status of northern shark stocks was initiated as an extension of the south and west coast shark research project. A three-year FRDC funded project, provided an age-structured demographic assessment of the fisheries’ principal target species (sandbar shark) and an improved general understanding of the fisheries and the biology of northern shark stocks. Additional information from the WANCSF and other fisheries that are permitted to land sharks on the north coast was collected during a series of NHT and FRDC funded research projects that began in 1999. Results from those projects, which have been published in several project reports, have further improved our understanding of the various elasmobranch sustainability risks across the northern half of Australia.

Current Research Focus

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 shark, sandbar shark and mackerel catches, as well as Threatened, Endangered and Protected (TEP) species interactions require careful evaluation. Further research to estimate key biological parameters and fishing mortality rates for numerous species would therefore be required as a high priority if the proposed transition to pelagic gillnets was to proceed. To support these requirements and to facilitate the proposed fishery management

arrangements, a new daily/trip catch and effort reporting system was introduced in 2006/07. However, the transition to this new reporting regime has proven problematic and discrepancies have been identified in the reported daily/trip logbook data for 2006/07, 2007/08 and 2008/09. The transition to this new reporting regime proved problematic for some fishers and discrepancies were identified in the logbook data reported for 2006/07, 2007/08 and 2008/09. Missing, misreported and confounded data from this period have now been recovered and corrected. However, more efficient automated data validation and correction procedures still need to be developed and if fishing continues, ongoing industry extension and training will be necessary to ensure that data reporting standards improve.

Priority Setting Process

Research priorities are generally identified through the annual stock assessment processes and periodic analyses of data from the fisheries. Alternatively, research priorities are identified by the Northern Science and Management Working Group, NAFM, fishery managers and through external processes, eg. National Shark Recovery Group, EPBC approval, Marine Bioregional planning, NPOA, etc.

Review Timeline

Independent scientific reviews of the sandbar shark stock assessment were completed in 2005 (Professor Carl Walters) and 2007 (ICES Journal of Marine Science). The blacktip shark assessment was last reviewed in 2008 (Northern Science and Management Working Group). A comprehensive review of Sharks and Rays (Chondrichthyans) in the North-west Marine Region was undertaken for the Department of the Environment, Water, Heritage and the Arts in 2007 (Heupel and McAuley, 2007). A review of Western Australian shark management arrangements was undertaken for the national Shark Assessment Report (2009).

Key to symbols in the matrix/summary tables:

- Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

Northern Shark Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Sandbar shark	Complete						
Dusky shark	Complete						
Common blacktip	Incomplete						Only available for western North Atlantic population.
Australian blacktip	Complete						
Spottail shark	Complete						

Northern Shark Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1.2 Other Biology							
Other spp. reproduction	Partially complete						Data collected in the 1980s from Taiwanese-operated fishery
Other spp. age and growth	Proposed						
1.3 Stock Assessment							
Catch and Effort Assessment	Ongoing	█	█	█	█	█	
Sandbar	Proposed						HIGH RISK: Fishing mortality rates last estimated in 2003/04 and require re-estimation to assess sustainability of current catches. Recent logbook-derived CPUE trend are contradictory and require further evaluation.
Blacktip age structured	Proposed						HIGH RISK: evidence for dramatic change in species or catch composition renders existing assessment model outputs unreliable.
Multi-species risk assessment (Productivity Susceptibility Analysis)	Complete						Several species identified at high risk from the northern shark fisheries
1.4 Fishery Monitoring							
Daily logbook	Ongoing	█	█	█	█	█	HIGH RISK: Validity of species identification in logbook records is highly questionable. Discarding levels need to be quantified but previously observed to be very high
At sea observers	Proposed	O					
Landing inspections	Proposed	O					
VMS	Partially complete	O					
DNA fingerprinting	Complete for some spp.	O					
2. Habitat & Ecosystem							
2.1 Bycatch							
Elasmobranchs	Proposed	O					Recently described for WANCSF demersal longline catches, uncertain for pelagic gillnet catches.
Teleosts	Proposed	O					Concern about pelagic gillnets' mackerel catch rates.
2.2 Listed Species							
Dolphins	Proposed	O					Stated reason for Commonwealth Govt. restricting pelagic gillnets in the 1970s-1980s.
Sawfish	Proposed	O					
2.3 Habitat							Low Risk
2.4 Ecosystem/Environment							
Trophic effects	Proposed	O					
Ghost fishing	Proposed	O					
2.6 Other impacts on fishery							
Illegal, Unreported and Unregulated (IUU) fishing	Proposed	O					Estimates of FFV impacts are not available.

Northern Shark Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Indigenous fishing	Proposed	O					NPOA actions and WTO recommendation (for temperate demersal gillnet and demersal longline fisheries)
3. Management Analysis							
3.1 Socio-economic							
Full utilisation (finning)	Proposed	O					NPOA objective
Mercury and other contamination	Proposed	O					
3.2 Resource Access (Shares)							
Indigenous fishing	Proposed	O					NPOA actions and WTO recommendation (for temperate demersal gillnet and demersal longline fisheries)
Recreational (game) fishing	Proposed	O					NPOA actions and WTO recommendation (for temperate demersal gillnet and demersal longline fisheries)
3.3 Compliance Research							
3.4 Management Systems research							
4. Industry Development							
5. Priority Review							
6. Science Review							

North Coast – Northern Prawn Managed Fisheries

Description and Scope of Fisheries

There are a number of small prawn fisheries in the north coast region. The Onslow (OPMF) and Nickol Bay (NBPMF) Prawn Managed Fisheries operate along the western part of the North-West Shelf and OPMF targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and whereas NBPMF primarily targets banana prawns (*Penaeus merguiensis*). The Broome Prawn Managed Fishery (BPMF) operates in a designated trawl zone off Broome and targets western king prawns 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 but also catches tiger prawns, endeavour prawns and western king prawns. All fishing is undertaken using low opening otter trawl systems.

Relevant Resource Assets and Risks from Fishery

North South Coast Shelf Crustaceans	Moderate Risk
North Coast Protected Species	Low Risk
North Coast Habitat – Pilbara	Low Risk
North Coast Habitat – Kimberley	Low Risk
North Coast Ecosystems	Low Risk

Summary of historical research completed

The biology of king and brown tiger prawns was completed in other fisheries within the state in the 1970's. Some research on the biology, including the distribution and life history of the banana prawn and endeavour prawn has been completed in northern Australia by CSIRO and QDPI.

The defined trawling area for the BPMF was surveyed by Department of Fisheries Research Division and industry divers prior to establishing the boundaries to ensure minimal impact on the adjacent pearl fishery habitats. The relationship between catch and moon phase was investigated during 1997/98 which resulted in modification of management arrangements to optimise fishing times (catch rates) over the new moons. Some opportunistic data has been collected on bycatch species and exploratory trawling outside the 'box' have been undertaken in recent years to determine if alternative trawl habitats are available to supplement low prawn stocks.

Between 2002 and 2005 bycatch reduction devices (BRDs) were implemented in these fisheries. A Fisheries and Research Development Corporation (FRDC) funded project was finalised on the biodiversity of bycatch in trawled and untrawled areas within part of the Onslow fishery in 2007 (Kangas et al. 2007).

Current Research Focus

Research programs are focused to underpin the sustainable management of these small fisheries involves stock monitoring and assessment utilising information from daily logbooks (including AFMA logbooks for some NPF boats licensed to operate in the Kimberley fishery), utilising monthly return data provided by industry and information from boat skippers.

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 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. This can involve fishery independent surveys.

ONPMF since 2007, a pre-season survey and within season surveys have been undertaken to determine prawn abundance and distribution and size composition to assist with harvesting strategies.

NBPMF the introduction of Size Management Fish Grounds and permanently closed areas will require further consultation with fishers during the next few years and may require limited fishery independent surveys to monitor prawns size and abundance as well as record bycatch/byproduct species.

BPMF the biology of the western king prawn has been researched but there is significantly less information available on the life history of coral prawns and this should be addressed. For the

BPMF daily logbooks have been compulsory since its inception and a De Lury depletion analysis is usually undertaken which assists in the assessment of the king prawn stocks within the permitted fishing area.

KPMF a relationship has been identified between rainfall and catches of banana prawns (the dominant species taken in this area) that provides a degree of forecasting and this is updated annually.

Priority Setting Process

Initial assessments were made through internal departmental meetings in 1998 discussing research undertaken, current research and research and development gaps and a plan was drafted for five years. Regular meetings (at least annually) have been held with the Research Division and industry to discuss research priorities and planning. The comprehensive EPBC assessment of each fishery has determined that performance should be reported annually against measures relating to the breeding stocks of target prawn species (banana, tiger, king and coral). The most recent Industry – Departmental meeting on research was held in 2009.

Review Timeline

The five-year EPBC accreditation with the Commonwealth Department of Environment, Heritage, Water and the Arts for these fisheries is due for renewal in late 2009. Early research and publications on the biology and spawning stock stock recruitment and environment relationships have been peer reviewed.

Recent Publications

Kangas, M.I., Morrison, S., Unsworth, P., Lai, E., Wright I. and Thomson A., (2007) Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia. Final FRDC Report 2002/038. *Fisheries Research Report* 160: 333pp.

Key to symbols in the summary matrix:

- Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

Northern Prawn Trawl Fisheries Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
King prawn biology	Completed						Completed in 1970's and 1980's
Coral prawn biology	Possible	○	○				Low Risk, mainly for BPMF
Banana prawn biology	Minimal						Mainly for KPMF and NBPMF, occasionally caught in higher numbers in OBP MF, opportunistic sampling in NPB MF

Northern Prawn Trawl Fisheries Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Brown tiger prawn biology	Completed						Completed in 1970-1990s
Endeavour prawn biology	Minimal						Low risk
1.2 Other Biology							
Biology of bugs	Completed						Desktop study done – trialling size limits in ONPMF
1.3 Stock Assessment							
Lunar Phase	Ongoing	■	■	■	■		For BPMF
De Lury Depletion Analysis	Ongoing	■	■	■	■		When appropriate for BPMF
C&E Stock Assessment	Ongoing	■	■	■	■		All northern prawn fisheries
1.4 Fishery Monitoring							
Logbooks	Ongoing	■	■	■	■		All northern prawn fisheries
Processor returns	Ongoing	■	■	■	■		All northern prawn fisheries
Pre-season skipper briefings	Ongoing	■	■	■	■		For ONPMF and NBPMF
Database maintenance	Ongoing	■	■	■	■		All northern prawn fisheries
Effort impact assessment (GIS)	Ongoing	■	■	■	■		EPBC requirement
2. Habitat & Ecosystem							
2.1 Bycatch	-						
BRD Implementation (grids)	Completed						Completed in 2004
BRD Implementation (secondary devices)	Completed	○	○				Further evaluation/trialling may take place
Bycatch monitoring	Periodic/ Possible		■				Limited - opportunistically, Review every 5 years
2.2 Listed Species							
Listed species interactions - logbooks	Ongoing	■	■	■	■		EPBC requirement/MOU with DEWHA underway
2.3 Habitat							
Habitat/effort impacts	Ongoing	■	■	■	■		EPBC requirement
Habitat mapping outside 'box'	Completed						For BPMF, no significant areas identified in 2007 but industry wish to revisit
2.4 Ecosystem/Environment							
Formal risk assessment	Periodic	■					EPBC requirement
2.5 Oceanography	Not needed						None Identified
2.6 Other impacts on fishery	Not needed						None identified
3. Management Analysis							
3.1 Socio-economic							
3.2 Resource Access (Shares)							
Byproduct rules	Underway	■					For all northern prawn fisheries
Marine Park Planning	Ongoing	■	■	■	■		For all northern prawn fisheries
3.3 Compliance							
VMS	Ongoing	■	■	■	■		
3.4 Management Systems							
375 rule/unitisation	Underway						
Size Management Areas and	Underway						Implemented in ONPMF and

Northern Prawn Trawl Fisheries Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Permanent Closures							KPMF, consultation with licensees required for the NBPMF
Gear development/changes	Ongoing	■	■	■	■		For all northern prawn fisheries
Latent effort/effort trends	Underway	■					For the KPMF
4. Industry Development							
5. Priority Setting	Periodic		■				
6. Science Review							

South Coast Bioregion

South Coast – Biodiversity Issues

Description and Scope of Issues

The inshore marine habitats of the south coast are largely unaffected by human activities, the exceptions being some estuaries and marine embayments (e.g. Princess Royal Harbour and Wilson Inlet) where significant eutrophication associated with farming has occurred. There are few fishing operations in this region that directly impact on marine habitats with only one very small scallop trawl fishery focused in the Esperance region. There are reef protected area closures cover the *Sanko Harvest* wreck site, the end of the old Esperance Jetty and the HMAS *Perth* wreck site. This region has been the focus of a number of marine planning exercises from NRM, DEC and most recently DEWHA. The latter is in the process of determining potential closures as part of the Commonwealths' system of marine parks.

Relevant Resource Assets and Risks from all Fisheries

Benthic - Nearshore & Estuaries	Low Risk
Benthic - Shelf	Negligible Risk
Protected species - non fish	Moderate Risk
Protected species - mammals	Moderate Risk
Protected species - fish	Negligible Risk
Ecosystem - Eucla	Negligible Risk
Ecosystem - Estuarine	Moderate Risk
Ecosystem - Marine	Low Risk
Introduced Pests & Diseases	High Risk

Summary of historical research completed

The Marine Futures project habitat mapping and biodiversity sampling was undertaken. Information regarding the status of introduced marine pest species (IMPs) on the south coast has been gathered at the ports of Albany and Esperance. The DEWHA process generated some research summaries of the key ecological features in this region.

Current Research Focus

A WAMSI project is determining cumulative bycatch taken by various fisheries in this region in order to develop an appropriate long term monitoring scheme so as to better understand the level of impact of interactions between fisheries and bycatch species, particularly protected and endangered species. Respond to reports and investigate cause of fish kills.

Priority Setting Process and Review Timeline

No formal process in place.

No Research Activity matrix was generated due to small amount of current and planned work.

South Coast – Greenlip and Brownlip Abalone Fishery

Description and Scope of Issues

The commercial abalone fishery on the south coast of WA is a dive fishery operating in shallow coastal waters along WA's western and southern coasts and is divided into eight management areas. The fishery targets three species: greenlip abalone, brownlip abalone and to a lesser degree in this bioregion, Roe's abalone. This quota based fishery operates using a sophisticated suite of management arrangements. A number of predictive systems have resulted in the maintenance of abalone stocks and a profitable fishery.

Relevant Resource Assets and Risks from Fishery

South Coast Molluscs	Moderate Risk
South Coast Protected Species	Negligible Risk
South Coast Habitats	Negligible Risk
South Coast Ecosystems	Negligible Risk

Summary of historical research completed

An extensive amount of research on the biology and stock status of greenlip abalone has been undertaken to support the management of this fishery. The basic biology (growth, reproduction, maturity) and ecological studies (population densities, settlement and recruitment) have been completed by researchers from the Western Australian Museum in the 1990s, and the Department of Fisheries in the 1990's and 2000's. Major relevant work has also been completed for greenlip abalone in South Australia.

Hatchery, nursery, and grow-out culture systems to support aquaculture of greenlip abalone have also been extensively researched by the Department of Fisheries during the early 2000s. An FRDC funded disease survey of entire Australian abalone stocks was completed in 2006.

Using historical time series of daily catch information has enabled an annual standardized catch per unit effort (CPUE) model to be developed that accounts for variation in spatial and temporal fishing effects, as well as technological improvements that aid fishing efficiency for used in a decision-rule framework.

Current Research Focus

Current research is focused on stock assessment using catch and effort statistics, meat weight indices, length-frequency sampling, and stock surveys. Commercial abalone divers provide daily catch information on the weight and number of abalone collected, and effort in hours fished. The divers also supply a random selection of abalone shells from each fishing day, and these are measured and used to estimate fishing mortality. Fishery independent surveys are undertaken by industry divers, who survey randomly selected sites with an underwater video camera, and research

staff who survey from 180 sites across the fishery on a biennial schedule.

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, is used to assess long term fishery trends. These trends are then applied in a harvest control rule to set annual TACCs (Total Allowable Commercial Catches). A new tag-recapture study of brownlip abalone (*Haliotis conicopora*) growth and mortality was initiated in 2009. Results will be used to assess stocks and estimate fishing mortality in this fishery.

The biannual telephone diary survey estimates the catch of greenlip and brownlip abalone 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) 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 and greenlip abalone habitat continued in 2009, with funding successfully obtained from the Australian Seafood Cooperative Research Centre (Seafood CRC) for a 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.

Priority Setting Process

Annual meetings are held between the Department of Fisheries and the commercial abalone industry. Input on the recreational program has been obtained from the RFAC and the IFAAC groups.

Review Timeline

The fishery and stocks are reviewed annually, with quota decisions made each February. A mid-season research update is carried out during August - September. The research associated with this fishery was externally reviewed by SARDI (South Australian Research and Development Institute) in October 2010.

Recent Publications

Hart AM, Fabris FP, 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, 40 p

Hart AM, Fabris FP, Brown J, Murphy D (2008). Digital video surveys of abalone (*Haliotis* sp.) stocks by commercial fishers in Western Australia. *Fisheries Research*. 93: 305-314.

Hesp A, Loneragan N, Hall N, Kobryn H, Hart AM, F. P. Fabris, J. Prince (2008). Biomass and commercial catch estimates for abalone stocks in areas proposed as sanctuary zones for the Capes Marine Park. *Fisheries Research Report No 170*, Department of Fisheries, WA, 62 p

Hart AM, Fabris FP (2007). Digital video techniques for assessing population size structure and habitat of greenlip and roe's abalone. Final Report to the Fisheries Research and Development Corporation on Project No 2002/079. *Fisheries Research Report No. 167*, Department of Fisheries, Western Australia, 58 p.

Hart AM, Fabris FP, Daume S (2007). Stock enhancement of *Haliotis laevigata* in Western

Australia - a preliminary assessment. Fisheries Research Report No 166, Department of Fisheries, Western Australia, 40 p.

Jones, J.B., Stephens, F. 2006. Aquatic animal health subprogram: development of a national translocation policy using abalone and prawns as templates for other aquatic species. *Fisheries Research and Development Corporation Final Report 2004/080*, 86p.

Key to symbols in the summary matrix:

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- Indicates that the activity is part of a proposal but is not yet funded.

South Coast Abalone Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments		
1. Retained Species Stock Analysis									
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)									
Roe's Biology - growth etc	Completed						Sufficient for management		
Green lip - Early juvenile life history and habitat, natural mortality and predation	Underway	■	■				Large scale experiments on released animals underway		
Growth rate of Green Lip abalone – spatial, juveniles (hatchery)	Underway	■	■				Large scale experiments on released animals underway		
Green Lip Reproduction/Fecundity, spawning Periodicity	Completed						Research by the Museum and Dept of Fisheries completed in the 1990s		
Disease survey/atlas	Completed						FRDC funded survey of entire Australian abalone stocks completed in 2006		
Brownlip abalone growth and mortality	Proposed								
1.2 Other Biology									
Environmental effects on recruitment	Underway	■	■				Long-term datasets on annual recruitment and relevant environmental factors are being developed		
1.3 Stock Assessment									
Catch statistics (wildstock)	Ongoing	■	■	■	■	■	40 years of catch and effort statistics		
Mapping of areas	Completed						FRDC funded project using GPS trackers, headed up by TAFI		
Fishing efficiency	Ongoing	■	■	■	■	■	Environmental and technological factors continually monitored		
Commercial length frequency monitoring	Ongoing	■	■	■	■	■	Catch sampling from industry used to estimate F		
Population dynamics and harvest strategy assessment model	Ongoing	■	■	■	■	■	Model under development		
Recreational Impact	Ongoing	■	■	■	■	■	Annual monitoring of recreational catch		
Yield and egg-per-recruit analysis for size limits	Completed	■							
1.4 Fishery Monitoring									
Research monitoring and recruitment sites	Ongoing	■	■	■	■	■	140 sites surveyed every two years		
Industry video monitoring sites	Ongoing	■	■	■	■	■	30 to 40 sites surveyed annually		
Recreational Fishery Monitoring –phone surveys	Ongoing Biennially	■		■			Phone diary survey undertaken every two years		

South Coast Abalone Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
2. Habitat & Ecosystem							
2.1 Bycatch	Not Needed						No Bycatch
2.2 Listed Species	Not Needed						No interactions
2.3 Habitat	Not Needed						Low risk
2.4 Ecosystem/Environment	Not Needed						Low risk
Abalone Health - Contingency plan and monitoring and diagnosis	Ongoing	█	█	█	█	█	
AVG (Abalone Viral Ganglioneuritus)	Ongoing	O	O	O	O	O	Watching brief
3. Management Analysis							
Translocation/protocol	Ongoing	█	█	█	█		
4. Industry Development							
Stock enhancement	Underway	█	█	█			CRC project
4.1 Production Technology	Completed						Hatchery and grow out work in 1990s
5. Priority Review		█	█	█	█	█	Annual industry meetings
6. Science Review		█				O	Major assessment reports peer reviewed every five years

South Coast – Crustacean Fisheries

Description and Scope of Issues

The south coast crustacean fisheries cover a series of pot-based fisheries, which operate from Windy Harbour to the South Australian border. They include Windy Harbour/Augusta Rock Lobster Managed Fishery, the Esperance Rock Lobster Managed Fishery (ERLF), the rock lobster pot fishery (a Regulation fishery) operating in the Albany and Great Australian Bight (GAB) sectors, and the deep-sea crab fishery (a Section 43 Order fishery). The fisheries are multi-species and take southern rock lobsters and western rock lobsters as well as deep sea crab species including giant crabs, crystal crabs and champagne crabs.

Relevant Resource Assets and Risks from Fishery

South Coast Crustaceans	Moderate Risk
South Coast Protected Species	Negligible Risk
South Coast Habitats	Negligible Risk
South Coast Ecosystems	Negligible Risk

Summary of historical research completed

Data on the biology of southern rock lobsters exists for South Australia, Victoria, Tasmania and New Zealand but little exists for Western Australia. Biological data for these other areas need to be used with extreme caution because growth rates, L_∞ , size at maturity and other variables are highly influenced by water temperature. A comprehensive study was undertaken on larval transport and recruitment processes of southern rock lobsters in Australia (Bruce *et al.* 2007). Modeling data produced by that study suggested that recruitment of southern rock lobsters in Western Australia is largely supported by parent stock in this state and any contribution from the east is minimal.

Research has been undertaken on the biology of champagne crabs on the south coast (Smith *et al.* 2004). Conditions on the south coast are not conducive for spawning by this species and females migrate from the south to lower west coast for spawning.

An evaluation of the crystal crab resources on the south coast has been undertaken (Chuwen and Stevens 2006). That report suggested potentially sustainable long term landings of 20 –108t depending on assumptions. The Department produced a different estimate of ~12t, also with caveats attached (Melville-Smith and Thomson unpub. Data). Comparatively good data are available on the biology of giant crab in Western Australia and in other areas of that species' distributional range (Levings *et al.* 2001).

Current Research Focus

Only compulsory commercial catch and effort returns and a few voluntary catch log books are obtained from these fisheries. Given the downturn in southern rock lobster landings (which are the mainstay of the fishery) in recent years, there is a need for basic biological research to be undertaken, as well as for a regular length frequency monitoring programme to be established.

Priority Setting Process

Internal Departmental Risk Assessment.

Review Timeline

Not applicable.

Recent Publications

Bruce, B., Griffin, D., Bradford, R. (2007). Larval transport and recruitment processes of southern rock lobster. FRDC Final Report, Project 2002/007: 104pp.

Chuwen, B.M and Stevens, R. (2006). Evaluation of crystal crab (*Chaceon bicolour*) resources on the south coast of Western Australia. FRDC Final Report, Project 2003/077: 60pp.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

South Coast Crustacean Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Crystal crabs	Preliminary						Information on growth, movement patterns, size at maturity, are available for stocks on the west coast (probably similar on south coast)
Reproduction champagne crabs	Completed						
Movement champagne crabs	Completed						Only some data
Movement giant crabs	Completed						
Reproduction giant crabs	Completed						
Growth data giant crabs	Completed						
Western rock lobster	Completed						
Southern Lobster genetic structure of the populations							Information is needed for management
Southern rock lobster biology							Information is needed on size at maturity, growth rates, movement patterns
1.2 Other Biology	Nil						
1.3 Stock Assessment							
Annual assessment (rock lobster)	Ongoing	█	█	█	█	█	Rudimentary
Rock Lobster Model	Prelim. model						Requires updating
Crystal crabs	Preliminary						One-off survey funded by FRDC.
1.4 Fishery Monitoring							
Commercial catch and effort	Ongoing	█	█	█	█	█	
Processor returns	Ongoing	█	█	█	█	█	
Commercial length freq monitoring							At least some sampling is essential for future monitoring of stocks
2. Habitat & Ecosystem							
2.1 Bycatch							
Fin fish and sharks	Nil						Negligible risk
Octopus	Nil						Negligible risk
Spider crabs, hermit crabs starfish	Nil						Negligible risk
Cuttlefish	Nil						Negligible risk
2.2 Listed Species							
Seals and sea lions	Monitoring	█	█				Low risk
Whales and dolphins	Nil						Negligible risk
2.3 Habitat	Nil						
2.4 Ecosystem/Environment							
Debris							Negligible risk
2.5 Oceanography							
2.6 Other impacts on fishery	Nil						
3. Management Analysis							
4. Industry Development							
5. Priority Review							
6. Science Review							

South Coast – Nearshore and Estuarine Finfish Resources

Description and Scope of Fishery

Estuaries: The finfish resources in South Coast estuaries are multi-sector (commercial, recreational and non-harvest) and multi-species. South Coast estuarine fisheries are small-scale and have relatively low commercial value but have high social, recreational and historical values. Most south coast estuaries are intermittently open to the sea. Therefore, recruitment by marine-spawned fish is determined by sand bar openings and water levels within each estuary, independent of estuarine fishing pressure. Cobbler (*Cnidoglanis macrocephalus*) and black bream (*Acanthopagrus butcheri*) are the only true estuarine species with discrete stocks in each estuary.

The South Coast Estuarine Fishery (SCEF) has 13 estuaries and inlets open to commercial fishing, with Wilson Inlet being the most important. The fishery captures cobbler, bream, sea mullet (*Mugil cephalus*), Australian herring (*Arripis georgianus*), King George whiting (*Sillaginodes punctata*), flathead (Platycephalidae), leatherjackets (Monacanthidae) and many other species. Recreational fishing occurs in each of the 25 major estuaries on the south coast, including those commercially fished. The recreational catch includes the same species as in the commercial catch (except cobbler which is rarely taken recreationally).

Nearshore: The Australian herring trap net fishery and the South Coast Salmon Managed Fishery are the two main commercial fisheries operating in nearshore waters in the South Coast Bioregion. These commercial fishers mainly operate on beaches in the western portion of the Bioregion. The salmon and herring fisheries have historically been relatively large but the commercial catch and catch rates of both species on the South Coast have been declining since 2002 and have reached historically low levels in recent years. Recreational fishers in nearshore waters on the South Coast capture Australian herring, Australian salmon, trevally (*Pseudocaranx* spp.), King George whiting, southern school whiting (*Sillago bassensis*) tarwhine (*Rhabdosargus sarba*) and many other species.

Relevant Resource Assets and Risks from Fishery

South Coast Nearshore Finfish	Moderate Risk
South Coast Protected Species	Negligible Risk
South Coast Habitats	Negligible Risk
South Coast Ecosystems	Negligible Risk

Summary of historical research completed

Estuaries: The most recent estimates of recreational fishing catch are from a creel survey conducted by the Department in 17 estuaries/inlets in 2002/03.

Nearshore: The commercial fisheries for salmon and herring were established on the South Coast in the 1930's and 1940's, respectively. There is a substantial level of historical biological and catch data available on these fisheries, including factory sampling and salmon logbook information since the 1970s. An FRDC project in the 1990s examined aspects of herring age, growth, reproduction and stock structure from which a stock assessment model for herring was developed but which still needs to be validated. Another FRDC project in the 1990s developed a method to monitor juvenile recruitment for Australian herring, salmon, mullet and whiting. Recruitment indices are used to

predict fishery landings.

Estimates for recreational catches in nearshore waters are only available from the National Recreational and Indigenous Fishing Survey conducted in 2000/01.

Current Research Focus

Indicator species were selected for these resources using a risk assessment process. Indicators for estuaries are black bream (various estuaries) and cobbler (Wilson Inlet, Oyster Harbour) and sea mullet. Indicators for the nearshore suite are Australian salmon and Australian herring.

The status of nearshore and estuarine finfish stocks in the South Coast Bioregion are currently assessed using CAES data, recreational logbook data and fishery-independent surveys of annual recruitment for some species. Fishery data is limited for most south coast estuaries, especially in recreational-only estuaries. Trends in commercial catch and catch rates, where available, form the basis of estuarine assessments. Annual fishery-independent monitoring of cobbler recruitment in Wilson Inlet commenced in 2007/08. Sampling of the age structure of the Wilson Inlet cobbler catch commenced in 2009/10.

A State NRM-funded research project commenced in mid-2009 to develop methods to monitor the age structure and status of Australian herring. It will also examine nursery signatures in otoliths to determine sources of recruitment to West Coast and South Coast Bioregions and identify factors associated with annual recruitment variation.

Murdoch University also regularly undertakes ecological projects relating to fish in South Coast estuaries.

Priority Setting Process

A Departmental risk assessment was recently completed and issues are reviewed at regular internal meetings. Through this process, salmon was assessed as a low risk (i.e. no concerns regarding stock sustainability) and no additional salmon research is planned in the next 5 years. Discussions are also held between the Department of Fisheries, industry members and peak bodies (Western Australian Fishing Industry Council, Recfishwest).

Review Timeline

An internal risk assessment of nearshore and estuarine finfish resources in the South Coast Bioregion was completed in 2009.

Key to symbols in the summary matrix:

- Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

South Coast Estuarine and Inshore Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
		2010/11	2011/12	2012/13	2013/14	2014/15	
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Australian herring	Complete						Adequate for management
Australian salmon	Complete						Adequate for management
Black bream	Complete						Adequate for management
Cobbler	Complete						Adequate for management
Sea mullet	Complete						Adequate for management
1.2 Other Biology							
Australian herring	Underway	■	○				Develop age-based monitoring. Examine recruitment dynamics & stock structure. Identify nursery signatures in otoliths NRM-funded. FRDC application lead by MU was funded.
1.3 Stock Assessment							
Annual trends in catch and CPUE	Ongoing	■	■	■	■	■	CAES data. Insufficient recreational data.
Annual trends in juvenile recruitment	Ongoing	■	■	■	■	■	Fishery-independent annual trapping & beach seining programs.
Age-based assessment using 'weight-of-evidence' approach (herring)	Developing	○	○	○			Otoliths being collected (west & south coasts). Develop ongoing monitoring. NRM-funded 1-year project. FRDC funding application with Murdoch Uni. pending.
1.4 Fishery Monitoring							
CAES	Ongoing	■	■	■	■	■	Data from commercial estuarine fisheries only.
Boat-based recreational survey	Underway	■		○			State-wide phone diary survey in 2011 & then every 2nd year.
Voluntary recreational logbook	Ongoing	■	○	○	○	○	Research Angler Program (RAP).
Juvenile recruitment surveys	Ongoing	■	■	■	■	■	Annual trapping & beach seining programs.
Voluntary commercial logbooks (salmon)	Ongoing	■	■	■			Providing minimal data due to low level of effort in fishery recently.
Observer program (salmon)	Underway	■	■	■			ESD requirement. Logistically difficult due to low & infrequent fishing operations & catches.
Age structure monitoring	Underway	■	■	■	■	■	Herring (W & S coasts) & cobbler (Wilson Inlet).
Commercial daily logbook (estuary)	Underway	■	○	○			Trial underway. Voluntary.
2. Habitat & Ecosystem							
2.1 Bycatch	Not needed						Low risk
2.2 Listed Species	Not needed						Low risk
2.3 Habitat							
Benthic habitat quality	Possible						Seagrass variation possible cause of cobbler stock fluctuations in Wilson Inlet
2.4 Ecosystem/Environment							
Climate change, river flows & eutrophication	Possible						Ecological flow requirements for estuaries are unclear. Flow effects on bream reproduction & early life history may be major determinant of recruitment success.

South Coast Estuarine and Inshore Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Fish Kills	Ongoing	[]	[]	[]	[]	[]	Respond to reports and investigate cause of fish kills. Opportunistic sampling, logistically difficult, limited resources available.
2.5 Oceanography							
Leeuwin current monitoring	Ongoing	[]	[]	[]	[]	[]	Qualitative use of data. Influence on larval dispersal & recruitment
2.6 Other impacts on fishery	Not needed						Low risk

3. Management Analysis

3.1 Socio-economic	Not needed					
3.3 Compliance	Not needed					
3.4 Management Systems						
Stock enhancement	Possible					Black bream
Adaptive management	Possible					Pallinup & other closures. Mainly bream. Responding to fluctuating stock levels due to recruitment, fish kills, bar openings.

4. Industry Development

4.1 Production Technology	Not needed					
4.2 Post Harvest						
Salmon	Possible					Develop new value-added products. Low price for raw product.
4.3 Marketing						
Salmon	Possible					Develop new markets. Address negative public perception.
5. Priority Review		[]				
6. Science Review		[]		[]		

South Coast – Purse Seine Fishery

Description and Scope of Issues

The South Coast Purse Seine Managed Fishery is based on the capture of pilchards (*Sardinops sagax*) by purse seine nets. The fishery is divided into three primary management zones – Albany, Bremer Bay and Esperance. The management plan also covers the take of yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus teres*). This fishery was the largest tonnage fishery during the late 1980s and early 1990s, until a pilchard virus hit in 1995 and 1998 which decimated stocks. The fishery is yet to fully recover.

Relevant Resource Assets and Risks from Fishery

South Coast Pelagic	Low
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Summary of historical research completed

An extensive set of studies were completed into the biology and stock assessment of pilchards for this fishery in the 1980s and 1990s. This included growth, ageing, plankton studies, stock assessment by age-structured modeling and daily egg production techniques. Monitoring of catches from each region was undertaken monthly to provide age-composition data, from which relative recruitment strengths could be inferred. Estimates from biomass surveys and age-composition data were integrated via an age-structured model to provide a robust estimate of pilchard biomass in each of the three management regions. The model outputs, along with analyses of catches, allowed the annual review of stocks in each major zone.

Following the mortality events in 1995/98, the Fish Health Unit assessed the identification and spread of the herpes virus. Another project examined the recovery of the pilchard stocks using egg production methods to estimate biomass.

Murdoch University and SeaNet examined the interaction between the fishery and protected species, focusing on seabirds. The project examined the extent of interactions with wildlife (pinnipeds, cetaceans and seabirds) and potential mitigation methods to reduce these interactions. This project resulted in reductions in significant interactions via changes in fishery operations.

Current Research Focus

Current catches of all zones are currently well below the TACs and the risk to the stocks are low. As a result, annual age-sampling and assessment of the stocks ceased in 2007 with the fishery monitored by statutory catch and effort data submitted by fishers.

Priority Setting Process

Priorities are reviewed on an annual basis through consultation between Scientists of the Finfish Branch (Research Division) and Fishery Managers.

Review Timeline

This science underpinning this fishery was extensively studied during the 1990s and 2000s. This fishery was last reviewed in 2008 and is considered low risk and will be reviewed within the next four years.

Recent Publications

Barange, M. et al. (2009). Current trends in the assessment and management of stocks. *Climate Change and Small Pelagic Fish*, eds. D. Checkley, J. Alheit, Y Oozeki and C. Roy. Cambridge University Press. p 191-255.

Crockford, M., Jones, J.B., McColl, K., Whittington, R.J. 2008. Comparison of three molecular methods for the detection of Pilchard herpesvirus in archived paraffin-embedded tissue and frozen tissue. *Diseases in Aquatic Organisms* 82: 37-44.

Gaughan D.J., Craine M., Stephenson P., Leary T., Lewis P. (2008). Regrowth of pilchard (*Sardinops sagax*) stocks off southern WA following the mass mortality event of 1989/99. Final FRDC Report - Project 2000/135. Fisheries Research Report No. 176. 82 p.

Whittington R., Crockford M., Jordan D., Jones B. (2008). Herpesvirus that caused epizootic mortality in 1995 and 1998 in pilchard *Sardinops sagax neopilchardus* (Steindachner) in

- Australia is now endemic. Journal of Fish Diseases 31, 97-106.
- Jones, J.B. 2006. Aquatic animal health subprogram: pilchard herpesvirus infection in wild pilchards. *Fisheries Research and Development Corporation Final Report 2002/044*, 55p
- Rogers, P., Gaughan, D. & Ward, T. (2006). Small pelagic fishes. In S. McClatchie, J. Middleton, C. Pattiarchi & G. Kendrick (eds), *The South-west Marine Region: Ecosystems and Key Species Groups*. The National Oceans Office (DEH, Govt. of Australia).

Given the small amount of activity no matrix is provided

South Coast – Trawl Fishery

Description and Scope of Fishery

The South Coast Trawl Fishery (SCTF) is an otter trawl fishery that principally targets scallops (*Amusium balloti*) and associated by-products, although in years of low scallop catches licensees have an option to use other trawl gear to target fish species. Scallop landings for the fishery have varied dramatically over the years, depending primarily on the strength of recruitment. While the fishery has theoretical access to a large section of the coastal waters, it is effectively restricted to small areas of higher scallop abundance.

Relevant Resource Assets and Risks from Fishery

South Coast Shelf Molluscs	Moderate Risk
South Coast Finfish	Low Risk
South Coast Protected Species	Negligible Risk
South Coast Habitats	Low Risk
South Coast Ecosystems	Negligible Risk

Summary of historical research completed

Research into the biological and environmental aspects of WA scallop stocks and commercial exploitation, has been carried out by the Department since the late 1960s.

Current Research Focus

Research monitoring of the scallop stocks in this fishery is via daily logbooks which became mandatory in 2008.

Priority Setting Process

Initial assessments were made through internal departmental meetings in 1998 discussing research undertaken, current research and research and development gaps and a plan was drafted for five years. Additional research needs have also been highlighted through the ESD Assessment process.

Review Timeline

Next review due 2012.

Key to symbols in the summary matrix:

- █ Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

South Coast Trawl Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Scallop biology	Completed						Completed in 1980's
1.2 Other Biology							
Recruitment dynamics	Possible						
1.3 Stock Assessment							
C&E Assessment	Ongoing	█	█	█	█	█	
1.4 Fishery Monitoring							
CAES returns	Possibly	█					
Logbooks	Ongoing	█	█	█	█	█	
2. Habitat & Ecosystem							
2.1 Bycatch							
Bycatch monitoring	Completed						NHT (MF) Funding for 07/08 – limited sampling
2.2 Listed Species							
Ongoing	█	█	█	█	█		Any interactions will be listed in logbooks – Low Risk, MOU with DEWHA being developed
2.3 Habitat							
Establishing historical fishing grounds	Possible						Requires consultation with industry
2.4 Ecosystem/Environment							
2.5 Oceanography							
Leeuwin Current monitoring	Ongoing	█	█	█	█	█	
3. Management Analysis							
4. Industry Development							
5. Priority Review							
6. Science Review							

South Coast – Temperate Demersal Gillnet and Longline Fisheries

Description and Scope of Issues

The temperate demersal gillnet and longline fisheries comprise the state-managed West Coast Demersal Gillnet and Demersal Longline (interim managed) Fishery (WCDGDLF) and the Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JASDGDLF), which is co-managed by the State and Commonwealth governments. Both fisheries are managed via limited entry, unitised input (effort) controls and gear-specification restrictions with most fishing by demersal gillnets.

These fisheries target a variety of shark species but scalefish (teleosts) account for between 15 and 20% of total fishery landings. Target species vary by zone, with the primary targets being dusky sharks (*Carcharhinus obscurus*) in Zone 1 and gummy sharks (*Mustelus antarcticus*) in Zone 2 of the JASDGDLF and sandbar sharks (*Carcharhinus plumbeus*) in the WCDGDLF. The whiskery shark (*Furgaleus macki*) and school shark (*Galeorhinus galeus*) due to declines are no longer actively targeted.

Relevant Resource Assets and Risks from Fishery

Statewide South West Sharks	High Risk
South Coast Demersal Finfish	Moderate Risk
South Coast Protected Species	Moderate Risk
South Coast Habitats	Negligible Risk
South Coast Ecosystems	Low Risk

Summary of historical research completed

Major FRDC-funded studies to assess the biology and status of targeted shark stocks on the south and west coasts of Western Australia were undertaken over the period 1993–2004. These studies have provided a detailed basis for managing the fishery and the extensive biological and fishery information gained from these studies has been reported in three FRDC final reports and numerous international journal articles. These data have been used to develop stock assessment models for the fisheries' key target stocks and to determine their likely responses to current levels of exploitation and to test alternative harvest regimes. A database of DNA profiles from protected and commercially important shark species and forensic sampling protocols have been developed for evidentiary purposes and NHT-funded studies of grey nurse shark movement and ecology have been undertaken.

Current Research Focus

Current research involves monitoring and analyses of fishing returns data and data from previous sampling of commercial catches. To support significant recent changes to fishery management arrangements, improve assessments of key stocks and to facilitate the more detailed reporting requirements of the fisheries' export accreditation under the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act, a new daily/trip catch and effort reporting system was introduced in 2006/07. The transition to this new reporting regime has been problematic for some fishers and discrepancies have been identified in the logbook data reported for 2006/07,

2007/08 and 2008/09. New data validation procedures are therefore being developed but catch and effort statistics for the last three seasons cannot yet be reported with adequate levels of confidence.

Priority Setting Process

Research priorities are generally identified through the annual stock assessment processes and periodic analyses of data from the fisheries.

Review Timeline

The performance of the fisheries was last assessed in 2007 based on fishery data from 2005/06. These assessments will be reviewed when problems with daily logbook catch and effort data have been resolved.

Recent Publications

Chidlow, J., Gaughan, D. & McAuley, R. (2006). Identification of Western Australian Grey Nurse Shark aggregation sites - Final Report to the Australian Government, Department of the Environment and Heritage. Fisheries Research Report 155. 48 p.

McAuley, R. B., Simpfendorfer, C. A., Hyndes, & Lenanton, R. C. J. (2007) Distribution and reproductive biology of the sandbar shark, *Carcharhinus plumbeus* (Nardo 1827) in Western Australia. *Mar.Freshwater Res.* 58: 116 - 126.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

South Coast Temperate Demersal Gillnet and Longline Fisheries Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Gummy shark	Complete						Reproduction complete, age & growth incomplete
Whiskery shark	Complete						
Dusky shark	Complete						
Sandbar shark	Complete						
1.2 Other Biology							
Temporal spatial dynamics	Proposed	○	○	○			FRDC proposal pending
Wobbegongs	Partially complete						Reproduction and diet complete; age & growth uncertain
Pencil shark	Partially complete						Reproduction and diet complete; age & growth incomplete
Other spp. Biology	Ongoing						Further data collected opportunistically
Grey nurse ecology	Partially complete						

South Coast Temperate Demersal Gillnet and Longline Fisheries Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1.3 Stock Assessment							
CPUE analysis	Ongoing	█	█	█	█	█	
Gummy	Proposed						HIGH RISK: fisheries' principal target species; no assessment since 1996; Updated stock assessment will require development of new model and age structure.
Whiskery	Proposed						HIGH RISK: not assessed since 2007. Age structure and CPUE requires updating
Dusky	Proposed						HIGH RISK: Fishing mortality rates last estimated in 1995/96 and requires re-estimation to assess sustainability of current catches.
Sandbar	Proposed						HIGH RISK: Fishing mortality last estimated in 2003/04 and requires re-estimation to assess sustainability of current catches.
1.4 Fishery Monitoring							
Daily logbook development & analysis	Ongoing	█	█	█	█	█	
At sea observers	Proposed	O	O				Observer program is a formal recommendation of fisheries' WTO approval
VMS	Partially complete	█	█	█	█	█	All vessels (>6.5m) are now fitted with ALCs. VMS will be used to monitor and acquit effort units from October 2009
DNA Fingerprinting							Proposal
2. Habitat & Ecosystem							
2.1 Bycatch							
Finfish & Elasmobranchs	Complete for 1994-2003	O	O				Observer program is a formal recommendation of fisheries' WTO approval
2.2 Listed Species							
Pinnipeds	Complete for 1994-2003	O	O				HIGH RISK: Estimation of capture rates and observer program are conditions of fisheries' WTO approval.
Other: Dolphins, Turtles, Grey nurse shark, White shark	Complete for 1994-2003	O	O				Observer program is a formal recommendation of fisheries' WTO approval
2.3 Habitat							
2.4 Ecosystem/Environment							
2.6 Other impacts on fishery							
Targeted catch in Commonwealth Fisheries	Ongoing						Via involvement in Commonwealth Shark Resource Assessment Group.
Bycatch in Commonwealth Fisheries	Proposed (limited data for SWTBF)						HIGH RISK: resumption of fishing in SWTBF has significant potential to further deplete dusky and sandbar shark breeding stocks
Illegal, Unreported and Unregulated (IUU) fishing	Proposed	O	O	O	O		HIGH RISK: Unreported catches in the WANCSF and JANSF have significant potential to further deplete dusky and sandbar shark breeding stocks
Recreational fishing	Proposed						NPOA actions and WTO Recommendation
Indigenous fishing	Proposed						NPOA actions and WTO Recommendation
3. Management Analysis							
3.1 Socio-economic							
Mercury and other contamination	Proposed						

South Coast Temperate Demersal Gillnet and Longline Fisheries Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
3.2 Resource Access (Shares)							
Recreational fishing	Proposed						
Indigenous fishing	Proposed						
3.4 Management Systems							
Catch and effort triggers	Ongoing	█	█	█	█	█	
National Plan of Action (NPOA) for the conservation and management of sharks	Ongoing	O	O	O	O		
Protected species recovery plans	Ongoing	O	O	O	O		
EPBC Act export approval assessments	Ongoing	O	O	O			
4. Industry Development							
5. Priority Review							
EPBC Act export approval assessments	Ongoing	O	O	O			
6. Science Review							

South Coast – South Coast Demersal Fishery

Description and Scope of Issues

Commercial

This fishery includes wetline fishers from small vessels in coastal areas around reefs targeting mainly demersal scalefish species. It also includes the haul net fishery operating in the South Coast Bioregion. It does not include the managed Temperate demersal gillnet and longline fisheries operating in the South Coast Bioregion (see Demersal Gillnet and Longline Fisheries Status Report).

Recreational

Recreational fishers also operate in the area but no data are currently available.

Relevant Resource Assets and Risks from Fishery

South Coast Demersal Finfish	Moderate Risk
South Coast Protected Species	Negligible Risk
South Coast Habitats	Negligible Risk
South Coast Ecosystems	Negligible Risk

Summary of historical research completed

Limited monitoring and assessment and tactical research have been focussed on this fishery and the resources that support it. Several studies of the growth, age composition, reproductive biology, mortality and/or diet of West Coast species been conducted by the Department and Murdoch

University which may be used as basis for designing monitoring and assessment for the South Coast.

Current Research Focus

Monitoring catch and effort data from licensed operators that constitute this fishery.

Priority Setting Process

Priorities are set by the Department at relevant meetings. The priority for this fishery will be discussed both within the Department and with Stakeholders.

Review Timeline

To be determined with fishery managers and stakeholders.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

South Coast Demersal Scalefish Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Identification of Indicator species	Completed	■					Outlined in Finfish resource framework
Biology of Indicator species	Proposed	○					Similar to studies completed on West Coast.
1.2 Other Biology studies							
Stock structure of indicator species (genetics, microchemistry)	Underway	■					Small component of WAMSI 4.4.2
Bight redfish	Proposed	○					
1.3 Stock Assessment							
Annual C & E Assessment	Ongoing	■	■	■	■	■	Commercial fishery
1.4 Fishery Monitoring							
Commercial, charter catch & effort	Ongoing	■	■	■	■	■	Logbooks (DoFWA)
Age Structured monitoring	Proposed	○	○				
2. Habitat & Ecosystem							
2.1 Bycatch							
2.2 Listed Species							
2.3 Habitat							
2.4 Ecosystem/Environment							
2.5 Oceanography							
2.6 Other impacts on fishery							

South Coast Demersal Scalefish Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
3. Management Analysis							
3.1 Socio-economic							
3.2 Resource Access (Shares)							
3.3 Compliance							
3.4 Management Systems							
4. Industry Development							
5 Priority Review	Ongoing	■	■	■	■	■	Meeting with Department and Stakeholders
6. Science Review	Proposed						Not possible until priorities established and additional data collection commences

Northern Inland Bioregion

Northern Inland – Biodiversity Issues

Description and Scope of Issues

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 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 supported by the expanded food chain of native fish, and are thought to have increased significantly from their original billabong-based populations.

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).

Relevant Resource Assets and Risks from all Activities

Finfish- Native	Low Risk
Ecosystem	Low Risk
Introduced Pests & Diseases	Low Risk

Current Research Focus

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. The Department also has 'introduced aquatic organism incursion' and 'fish kill incident response' programs in place

Priority Setting Process

No formal process exists

Note – No Research Activity matrix was generated due to small amount of current and planned work for this region.

Northern Inland – Lake Argyle Silver Cobbler Fishery

Description and Scope of Issues

The only commercial freshwater fishery in Western Australia is contained in the impounded waters of the Ord River at Lake Argyle in the north-eastern Kimberley. This gillnet fishery specifically targets the shovel-nosed catfish or silver cobbler.

Summary of historical research completed

Given the nature and priority of this fishery the Lake Argyle Silver Cobbler Fishery is only assessed by compilation of catch and effort data from the fishery in the form of the statutory monthly catch and effort returns. Little data is available on the biology of the Silver Cobbler.

Relevant Resource Assets and Risks from Fishing

Finfish- Native	Moderate Risk
Protected Species (Crocodiles)	Low Risk

Current Research Focus

Data for assessing the status of the freshwater catfish stock in Lake Argyle are derived from the catch and effort returns provided by industry. These data are compiled annually and used as the basis for assessing this fishery.

The catch and effort data provided by industry are used to develop stock assessment models for the fishery. However the modelling approach used in the assessment of the fishery requires a number of assumptions, which creates a high degree of uncertainty around the results generated from the models. To reduce this uncertainty an understanding of some key characteristics of both the fishery and the biology of the species would be needed.

Priority Setting Process and Review Timeline

Initial assessments were made through internal departmental meetings and forums discussing the history of research in the fishery, research activities that have been completed, current research as well as research and development gaps. Research issues have been discussed at annual industry consultation meetings once a year.

Note – No Research Activity matrix was generated due to the small amount of current and planned work for this region.

Southern Inland Bioregion

Southern Inland – Biodiversity Issues

Description and Scope of Issues

This region contains the state'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.

The southwest region of Western Australia is recognised by Conservation International as one of 34 global biodiversity hotspots. The rivers of the southwest have the largest percentage of native endemic fish species (80%) and crustacean species (100%) in Australia. As result they have been recognised by WWF as one of the Earth's 53 most biologically outstanding freshwater habitats. Significantly, the southwest rivers and streams in Australia are also one of 28 freshwater habitats identified by WWF as a Global Ecoregion that is considered to have a conservation status of critical or endangered.

The conservation of the 13 species of freshwater native fish which exist in Western Australia is a growing issue for the Department of Fisheries. Some of these species are endemic to Western Australia, and therefore their survival depends on proper environmental management. Most of these fish are under pressure because of deteriorating environmental conditions. Therefore the Department of Fisheries is working with other agencies and institutions to undertake research on the distribution and life history of these animals to obtain the information required to protect them. The Department also has a captive breeding program to prevent the extinction of critically endangered and vulnerable species. Further, the Department has an approval process in place for assessing proposals to translocate fish into and within Western Australia, to minimise the risks associated with movement of fish which may impact on endemic species.

Relevant Resource Assets and Risks from all Activities

Finfish- Native	Severe Risk (non fishing)
Protected species	Severe Risk (non fishing)
Ecosystem	High Risk (non fishing)
Introduced Pests & Diseases	Moderate Risk

Summary of historical research completed

The Department of Fisheries has conducted small scale holding of south-west native fish at Pemberton Freshwater Research Centre (PFRC) since the early 1990's. More recently the Department of Fisheries established a captive breeding program at PFRC in 2005 to 1) Breed the critically endangered Margaret River marron for restocking, and 2) Develop production techniques for fish species native to the south-west of WA. These fish species also offer potential for stocking wetlands and lakes for mosquito control and restocking rehabilitated waterbodies.

The department has developed the expertise to remove, produce and maintain native fish and crayfish stocks during refurbishment of water reservoirs to preserve genetic lines for restocking after completion of dam remedial works (Water Corp funded)

Current Research Focus

A captive breeding program to prevent extinction of native species and conserve biodiversity by restocking waterbodies has been established at the Department's Pemberton Freshwater Research Centre and the Aquaculture & Native Fish Breeding Laboratory at Shenton Park. The key species in this program are the critically endangered Western trout minnow (*Galaxias truttaceus hesperius*), Margaret river hairy marron (*Cherax cainii*) and Balston's pygmy perch (*Nannatherina balstoni*) which is listed as vulnerable to extinction. In addition several species such as Mud minnow (*Galaxiella munda*) and Black-stripe minnow (*Galaxiella nigrostriata*) offer potential for restocking waterways as although not yet listed as critically endangered they have severely restricted and fragmented distributions due to widespread habitat degradation.

The identification of the ‘hairy’ marron in the Margaret River catchment as a separate species or sub-species has focused attention on Southern Inland biodiversity issues through the decline of this critically endangered species. Specific management actions that are underway to recover this unique stock involve 1) Removing competing ‘smooth’ marron species from the catchment, 2) Restocking the Margaret river with “hairy” marron produced by the captive breeding program at PFRC, 3) Chairing the Margaret River marron recovery team.

In 2009, the Department commenced the development of an online Native Fish Database. The database currently contains most historical records of native fish distribution in WA. The database is linked to the scientific exemption process administered by the Department that permits university researchers to collect native fish. This will enable the Department to capture all future native fish distribution data collected by universities and other agencies in WA. It will provide a valuable tool for researchers and managers to identify both changes in native fish biodiversity and introductions of feral species.

Priority Setting Process

Research priorities for this program are developed through consultation with freshwater fisheries managers, university research groups and natural resource managers.

Review Timeline

The most recent review of Southern Inland freshwater biodiversity research was around 2008. Next review due around 2013.

Key to symbols in the matrix/summary tables:

- Indicates that the activity is funded and planned to occur.
- Indicates that the activity is part of a proposal but is not yet funded.

Southern Inland Biodiversity Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Broodstock collection, reproduction, larval rearing and nutrition	Ongoing	■	■	■	■	■	Develop broodstock collection, genetic fingerprinting, husbandry practices and breeding protocols to enable the large scale production of endangered species to prevent their extinction by restocking natural and artificial wetlands
Growth	Underway	■	■				Growth/time to achieve minimum size required for tagging prior to restocking
Reproduction	Ongoing	■	■	■	■		Native fish species breeding age, size, fecundity and spawning season
Diet	Possible	O	O				Diet evaluation for native species
1.2 Other Biology							
Restocking artificial wetlands	Ongoing	■	■	■	■	■	Replacement of gambusia with native fish for mosquito control as an alternative to chemical spraying
Restocking natural wetlands	Ongoing	■	■	■	■	■	Restocking critically endangered native fish to prevent extinction
1.3 Stock Assessment							
Native fish distribution	Ongoing	■	■	■	■	■	Identifying species of conservation concern
Native Fish Database	Ongoing	■	■	■	■	■	Management of Native Fish database for monitoring native fish distribution & decline
Tagging & identification techniques	Underway	■	■				Evaluate tags to determine 1) minimum size at which fish can be tagged and 2) Optimum tagging technique prior to restocking waterbodies
Reproduction (Margaret River marron)	Underway	■	■	■	■		Margaret river marron Captive breeding program for restocking
Stock enhancement (Margaret River marron)	Underway		■	■	■	■	Margaret river marron restocking commenced 2010
2. Habitat & Ecosystem							
2.1 Bycatch							
2.2 Listed Species							
Captive breeding program for critically endangered species	Ongoing	■	■	■	■	■	Captive breeding program for critically endangered fish species
Margaret river marron	Underway	■	■	■	■	■	Captive Breeding program for recovery of Margaret river marron
Restocking Critically endangered fish species	Ongoing	■	■	■	■	■	Restocking of species listed as critically endangered to prevent extinction
2.3 Habitat							
Water Corp Dam biological remediation	Ongoing	■	■	■	■		Remove, transport to PFRC, breed and maintain native fish and crayfish during draining & refurbishment of water reservoirs to 1) prevent major fish kills and 2) preserve genetic lines for restocking after completion of dam remedial works (Water Corp funded)
2.4 Ecosystem/Environment							
Environmental monitoring	Ongoing	■	■	■	■	■	Investigation of environmental factors affecting decline in native fish stocks

Southern Inland Biodiversity Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Impacts of introduced species	Proposed	O	O	O			Quantify the impacts of trout & redfin perch on native fish species
Fish Kills	Ongoing	█	█	█	█	█	Respond to reports and investigate cause of fish kills coordinated through Fisheries Research (Fish Health)
3. Management Analysis							
3.1 Socio-economic							
Social assessment	Proposed	O	O	O			Involving community & school groups in native fish conservation and restocking programs
3.2 Resource Access (Shares)							
3.3 Compliance Research							
3.4 Management Systems							
Native Fish Strategy	Underway	█	█	█	█	█	Management of database using research permits to record distribution of native & feral freshwater fish
4. Industry Development							
4.1 Production Technology							
Large scale production techniques	Ongoing	█	█	█	█		Development of large scale production technology for native fish species to enable successful restocking programs to be implemented
5. Priority Review							
6. Science Review							

Southern Inland – Freshwater Aquaculture

Description and Scope of Issues

The Southern Inland Bioregion contains suitable land, water and climate conditions to farm a range of species including marron (*Cherax tenuimanus*), silver perch (*Bidyanus bidyanus*), rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), yabbies (*Cherax albidus*) and a variety of ornamental fish species. Farming occurs in tanks, earthen ponds and farm dams located between Esperance to Hutt River, north of Geraldton, however the bulk of farms are concentrated in the higher-rainfall south-west coastal areas. Potential exists to expand aquaculture production in the Southern Inland Bioregion, particularly on the south-west coastal plain, by using irrigation dam water for aquaculture, prior to reuse on agricultural farms. In addition, some farmers located in salt-affected regions have constructed ponds to trial trout production in saline groundwater.

There are around 180 licensed marron farms in the Southwest bioregion and they currently represent the majority of aquaculture licences in WA. There are around 12 licensed silver perch

farms in WA. Silver perch production has increased rapidly over the past few years, mainly due to improved hatchery supply of juveniles. There are around 10 licensed trout farms in WA. There are around 15 licensed yabby processors in WA, who receive animals harvested from around 4000 farm dams. To protect endemic marron populations in the southwest of the state, yabby farming is restricted to east of the Albany Highway. There are around 25 licensed ornamental fish farms in WA. A wide range of both native and non-native ornamental fish species are produced in WA.

Summary of historical research completed

Marron: The marron farming industry developed from research commenced by the Department of Fisheries in the 1970's that developed techniques to breed, feed and grow marron at PFRC (Pemberton Freshwater Research Centre) and transferred this technology to industry in the late 1980's. More recently, from 2000-05 Department researchers used selective breeding to increase the growth rate of marron and developed improvements in husbandry and farm management strategies.

Silver Perch: Techniques for breeding, feeding and farming silver perch were developed by researchers in New South Wales in the late 1980's. In the early 1990's Department of Fisheries researchers in Western Australia developed extension material to facilitate the adoption of this technology by local farmers.

Trout: Trout farming is well established internationally and as a consequence considerable research on breeding, feeding and rearing these species has been conducted overseas. Since trout were introduced to WA in the late 1800's the Department of Fisheries strain at PFRC have evolved to tolerate warmer water temperatures than those farmed overseas. Selective breeding to increase this temperature tolerance could result in WA becoming a major supplier of fertilised trout eggs to the northern hemisphere.

Yabbies: Research conducted by the Department of Fisheries from 1994-2000 resulted in improved methods for stocking, feeding, harvesting, managing and farming yabbies. It also developed a hybrid yabby that grows twice as fast as the most commonly farmed species.

Ornamental fish: Techniques for farming non-native ornamentals, such as goldfish and koi, are well established overseas. A pilot program was run by UWA to develop improved stocks of koi for export based upon selective breeding of local genetic lines. In addition the department provides technical support to producers of high value ornamental species. The Department, with cooperation from AQIS, has been monitoring the disease status of ornamental fish entering Australia through Perth and which die in quarantine. This is part of the Departments ongoing biosecurity surveillance activity.

Current Research Focus

Marron

- Selective breeding to improve production and transferring these domesticated genetic lines to industry for commercialisation.
- Transfer to industry improved management strategies and farm designs developed by Department researchers.

Silver Perch

- No current research apart from providing technical advice.

Trout

- Selective breeding to increase temperature tolerance and growth of PFRC trout population.
- The cause of a 60% decline in egg viability of brown trout needs to be identified.
- Improved production of triploids by pressure shock.
- Control of inbreeding in PFRC population.
- Production of trout fingerlings for both aquaculture and freshwater angling

Yabbies

- No current research. But should investigate eradication techniques for feral yabby populations within the marron region.

Ornamental Fish

- Provision of technical advice and disease surveillance on imported fish.

Priority Setting Process

Research priorities for this program are developed through consultation with industry associations and key producers and involve a strategic approach to address industry problems as they arise.

Review Timeline

The most recent review of Freshwater Aquaculture research was around 2007/08.

Next review due around 2013.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur.

○ Indicates that the activity is part of a proposal but is not yet funded.

Southern Inland Freshwater Aquaculture Research	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Marron Biology	Completed						Completed in WA in 1980s – 1990s
Yabby Biology	Completed						Completed in WA in 1990s
Silver perch biology	Completed						Completed in NSW
Trout biology	Completed						Completed in WA
Ornamental Fish (native) – growth and reproduction	Underway	■	■	■	■		Growth rates and spawning techniques of native fish species
Genetic improvement of marron	Ongoing	■	■	■	■		Monitoring of a repository stock.
Temperature tolerance & Climate change of trout	Underway	■	■	■	■	■	Trout in WA appear to have a higher temperature tolerance than stocks elsewhere in the world.

Southern Inland Freshwater Aquaculture Research	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1.2 Other Biology							
Disease diagnostic service	Ongoing	█	█	█	█	█	Ongoing surveillance and monitoring.
Brown trout reproduction	Underway	█	█	█			The cause of a decline in egg viability from 70% - 10% is being identified.
Triploid production	Underway	█	█	█	█		Improved production of triploids
2. Habitat & Ecosystem							
Fish Kills	Ongoing	█	█	█	█	█	Respond to reports of fish kills
3. Management Analysis							
3.1 Socio-economic							
Economic evaluation (marron)	Complete						Completed in 2000-05 on commercial farms
4. Industry Development							
4.1 Production Technology							
Production technology marron	Complete						Developed in 1980's, validated in 2000-05
Hatchery production (trout)	Ongoing	█	█	█	█	█	Production of trout fingerlings & yearlings for aquaculture & recreational stocking
Non-Native Ornamental fish	Proposed	O	O	O			Hormonal control of reproduction
Native Ornamental fish	Proposed		O	O			Induced spawning protocols
4.2 Post Harvest							
Post harvest handling marron	Proposed	O	O				Mortality in purging systems requires investigation.
4.3 Marketing							
5. Priority Review							
6. Science Review							

Southern Inland – Recreational Marron Fishery

Description and Scope of Issues

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. This fishery is managed through input controls of licences, closed seasons and gear restrictions, and the output controls of size and bag limits.

The main external factors which affect the marron fishery are illegal fishing activities, degradation of freshwater habitat, winter rainfall, access to dams, and introduced species. Degradation of freshwater habitat (mainly salinisation in the upper reaches of catchments) has significantly reduced the natural range of marron. Winter rainfall plays a major role in marron reproduction, growth and

survival.. Another major issue in this fishery is access to irrigation dams. Introduced species that impact on the marron fishery either through predation or competition for similar resource are redfin perch (*Perca fluviatilis*), trout (*Oncorhynchus mykiss* and *Salmo trutta*) and yabbies (*Cherax albifidus*).

Relevant Resource Assets and Risks

Crustaceans Native (marron)	Severe Risk (non fishing)
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Summary of historical research completed

The marron recreational fishery has historical data from the 1970's.

Additional research on improving habitat in artificial impoundments (water reservoirs) showed that rock wall can provide an important refuge for juvenile marron.

Current Research Focus

- Improved annual stock assessment.
- Develop long-term tagging program.
- Trial large-scale artificial habitat to improve production and fishery in dams.
- Improve logbook survey.
- Remove, produce and maintain marron stocks during refurbishment of water reservoirs to preserve genetic lines for restocking after completion of dam remedial works (Water Corp funded)

Priority Setting Process

Marron research priorities are developed in consultation with the Recreational Freshwater Fisheries Stakeholder sub committee.

Recent Publications

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded

○ Indicates that the activity is part of a proposal but is not yet funded.

Southern Inland Recreational Marron Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Biology	Completed						Data collected as part of FRDC 2003/027

Southern Inland Recreational Marron Fishery Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1.2 Other Biology							
Disease Diagnostic Service	Ongoing						Provided as part of surveillance and monitoring of state disease status
1.3 Stock Assessment							
Annual Assessment	Ongoing	█	█	█	█	█	2006 introduced new sampling program using traps
Methods			█				A more accurate alternative needs to be calibrated against existing box traps, previous techniques and known population size
1.4 Fishery Monitoring							
Phone survey	Ongoing	█	█	█	█		
Logbook survey	Ongoing	█	█				Continuation and/or integration with RAP program currently under review
Field Monitoring			O				A field based recreational angler creel survey could provide more accurate information on the status of the fishery.
2. Habitat & Ecosystem							
2.3 Habitat							
Water Corp Dam biological remediation	Ongoing	█	█	█	█		Remove, transport to PFRC, breed and maintain native fish and crayfish during draining & refurbishment of water reservoirs to 1) prevent major fish kills and 2) preserve genetic lines for restocking after completion of dam remedial works (Water Corp funded)
2.4 Ecosystem/Environment							
3. Management Analysis							
4. Industry Development							See Aquaculture
5. Priority Review							
6. Science Review							

Southern Inland – Recreational Freshwater Angling

Description and Scope of Issues

The south-west recreational freshwater fishery is focused primarily on angling 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 was previously released in the south-west and now occurs as self-breeding populations in most water bodies. Licensed anglers may only use a single rod, reel and line or single handline when targeting

these species. Access to this fishery is controlled by license, seasonal closures, minimum sizes, and bag limits. People under 16 years of age are not required to hold a license to go freshwater angling.

The extent and success of the freshwater angling fishery in the south-west is dependent mainly upon availability of high-quality fresh waters for stocking. The degraded nature (e.g. increased salinity) of many freshwater streams and rivers coupled with the effect of climate change (e.g. reduced flow and water levels) has a strong negative effect on the future of recreational fishing. The availability of water is dependent on rainfall and access to irrigation dams. Thus low rainfall and reduced access to permanent water bodies are having a negative influence on the freshwater angling fishery.

Relevant Resource Assets and Risks from Fishing

Finfish – Exotic (trout)	Moderate Risk
Finfish – Native	

Summary of historical research completed

The Department has records of trout stocking locations and numbers, but there has been limited research into the impacts of stocking on native fish species.

Current Research Focus

Development of logbook program and integration in the RAP program.

Securing external funding to study the interaction between native fish and stocked trout.

Priority Setting Process and Review Timeline

Freshwater Angling research priorities are developed in consultation with the Recreational Freshwater Fisheries Stakeholder sub committee.

A review was completed in the late 1990's.

Key to symbols in the matrix/summary tables:

■ Indicates that the activity is funded and planned to occur if the vacant Freshwater Fisheries Scientist position is filled.

○ Indicates that the activity is part of a proposal but is not yet funded.

Southern Inland Recreational Freshwater Angling Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Trout: Growth, Mortality	Proposed	○	○	○	○	○	Limited information of wild stock growth & survival. A tagging program is required
Trout: Reproduction	Proposed	○	○	○	○	○	Determine location and success of self sustaining populations

Southern Inland Recreational Freshwater Angling Research Projects	Research Status	2010/11	2011/12	2012/13	2013/14	2014/15	Comments
Trout: diet	Complete						data collected as part of FRDC 2003/027; co-operation with Murdoch University
Redfin (growth, diet, mortality)	Complete						Several publications available; additional data collected as part of FRDC 2003/027
Freshwater Cobbler (growth, diet, mortality)	Complete						Several publications available; additional data collected as part of FRDC 2003/027; focus of several research projects by MU
1.3 Stock Assessment							
Annual Assessment	Ongoing	█	█	█	█	█	Catches and catch rates only
1.4 Fishery Monitoring							
Phone survey	Ongoing	█	█	█	█	█	
Logbook survey	Ongoing	█	█	█	█	█	Trial logbook program
2. Habitat & Ecosystem							
2.1 Listed Species							
Impact of trout & redfin on listed species	Proposed	O	O	O	O	O	Urgent need to determine interaction stocked trout and (protected) native fish species
2.2 Habitat							
Potential for trout stocking in artificial impoundments	Proposed	O	O	O	O	O	Evaluation of stocking trout in artificial impoundments as an alternative to streams
2.3 Ecosystem/Environment							
Impact of trout on native species	Proposed	O	O	O	O	O	Urgent need to determine interaction stocked trout and native fish species
Impact of redfin on native species	Proposed	O	O	O	O	O	Urgent need to determine interaction of redfin on native fish species
3. Management Analysis							
3.1 Socio-economic							
Social assessment	Completed						Socioeconomic value of trout angling has been completed
Economic Analysis	Completed						Socioeconomic value of trout angling has been completed
3.2 Resource Access (Shares)							Not needed
3.3 Compliance							
Poaching	Proposed	O	O	O	O	O	Concerns about unlicensed fishing and illegal gear used to target stocked broodstock trout
3.4 Management Systems							
4. Industry Development							
5. Priority Review							
6. Science Review							