Fisheries Occasional Publication No. 75, 2009

Research and Development Plan 2009-10

Western Australian Department of Fisheries

October 2009

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

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Published by Department of Fisheries, Perth, Western Australia.
Fisheries Occasional Publications No. 75, October 2009.

ISSN: 1447 - 2058 ISBN: 1 921258 72 1

Contents

Introduction **1**
Background 1
Potential uses of the plan 2
Outline of the individual R&D reports 3

Departmental priorities for new research, monitoring and development projects 2009-2011 ..... **5**

Collaborative Projects 2009/10 ..... **7**

State-wide **10**
State-wide – Strategic Research and Development Activities 10
State-wide – Ecosystem Based Fisheries Management 15
State-wide – Marine Aquarium Fish 21
State-wide – Specimen Shell Managed Fishery 22
Indian Ocean Territories 24
Artemia Aquaculture 27
Live Rock Aquaculture 28
Octopus Aquaculture 29

West Coast Bioregion **30**
West Coast – Biodiversity & Ecosystem Issues 30
West Coast – Abrolhos Islands FHP Region 34
West Coast – Western Rock Lobster 38
West Coast – Abalone Managed Fishery 43
West Coast – Abrolhos Islands and Midwest Trawl Fisheries 47
West Coast – Blue Swimmer Crab Fishery 50
West Coast – Deep Sea Crab Fishery 54
West Coast – Estuarine and Inshore Fisheries 56
West Coast – Beach Bait Managed Fishery 60
West Coast – Purse Seine Fishery 62
West Coast – West Coast Demersal Scalefish Fishery 65

Gascoyne Bioregion **70**
Gascoyne – Biodiversity Issues 70
Gascoyne – Shark Bay Prawn Fishery 73
Gascoyne – Shark Bay Scallop Fishery 77
Gascoyne – Exmouth Gulf Prawn Fishery 81
Gascoyne – Gascoyne Demersal Scalefish Fishery (Shark Bay Snapper Fishery) 85
Gascoyne – Inner Shark Bay Scalefish Fishery 88
Gascoyne – Blue Swimmer Crab Fishery 91

North Coast Bioregion 94
North Coast – Biodiversity Issues 94
North Coast – Northern Prawn Managed Fisheries 95
North Coast – Nearshore and Estuarine Fishery 99
North Coast – Demersal Fisheries 101
North Coast – Mackerel Fishery 105
North Coast – Northern Shark Fisheries 107
North Coast – Pearl Oyster Managed Fishery and Pearl Production 111
North Coast - Beche-de-mer Managed Fishery 116
South Coast Bioregion 118
South Coast – Biodiversity Issues 118
South Coast – Crustacean Fisheries 119
South Coast - Abalone Managed Fishery 122
South Coast - Trawl Fishery 126
South Coast – Estuarine and Inshore Fisheries 128
South Coast – Purse Seine Fishery 132
South Coast – Temperate Demersal Gillnet and Longline Fisheries 135
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 – Recreational Marron Fishery 145
Southern Inland – Recreational Freshwater Angling 147
Southern Inland – Freshwater Aquaculture Research Plan 149

Introduction

Background

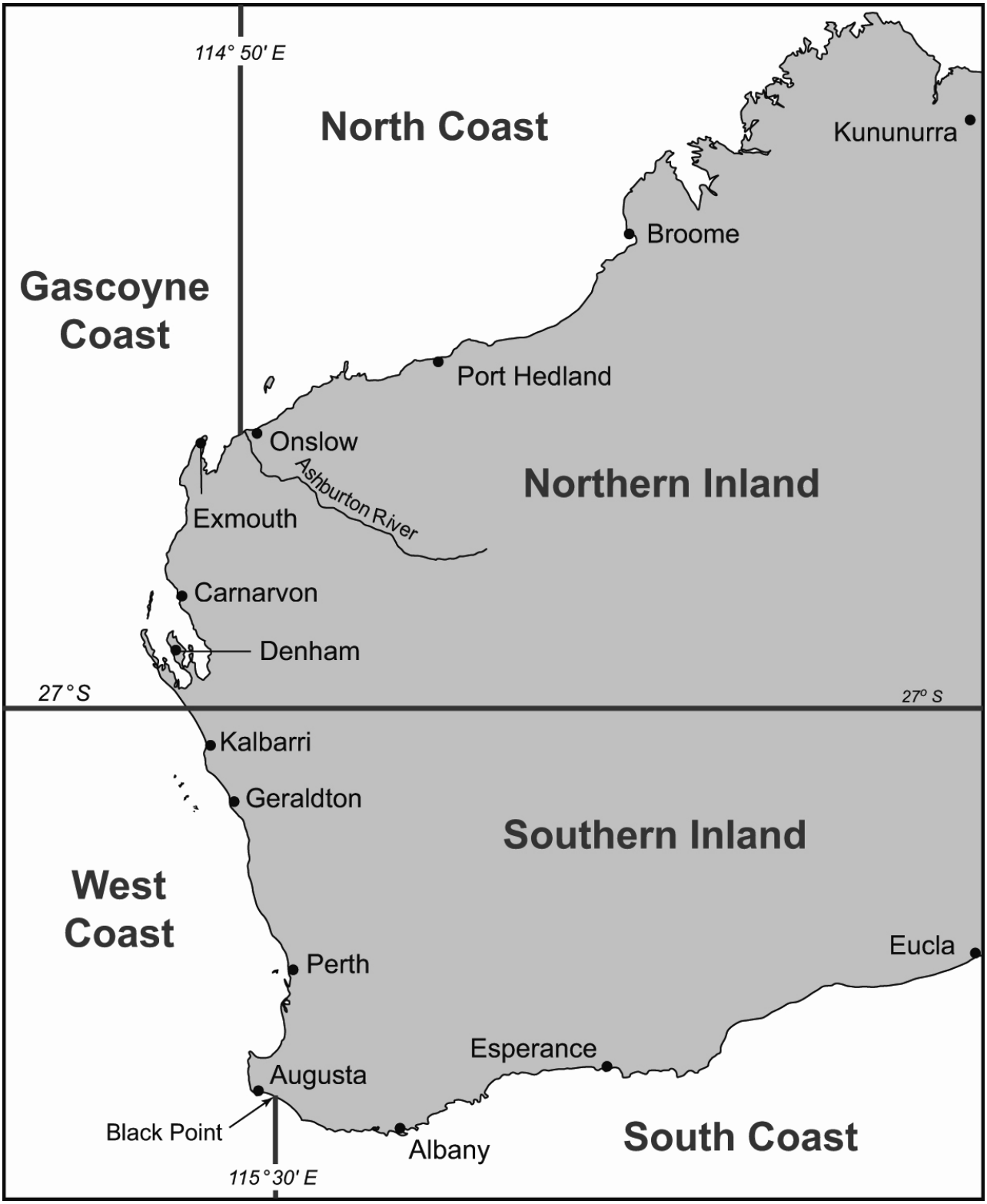
The Department of Fisheries R&D plan for 2009/10 outlines the research, monitoring and assessment activities that are specifically directed towards supporting the collection of information that will assist in achieving the objectives of the *Fish Resources Management Act* (1994) for the coming five year period. This series is updated on an annual basis and should be read in conjunction with the most recent *State of Fisheries* report where comprehensive analyses of the current status of each of the fisheries and fish habitat resources are described.

The plan specifically focuses on those activities that are currently planned or identified which directly relate to the effective management of a specific fishery, ecosystem or aquaculture sector within Western Australia. It therefore not only documents the research, monitoring and assessment activities being done directly by the Department, it also covers the research that is being done by other agencies that has been identified as being directly relevant to the particular fishery/sector issue.

As the plan has been generated from a management perspective it may not cover all the research and development activities that could be undertaken to assist with the commercial operations of a fishery nor does it document all marine related research being undertaken in WA. Thus, industry development elements such as marketing are not covered in a comprehensive fashion. Such priorities are best determined and managed directly by industry.

The objectives and current research focus for each of the sectors documented in this plan are the results of deliberations and discussions with Departmental committees and for most sectors with relevant industry/sector working groups and advisory bodies. Where industry/advisory group research plans exist, this document will have utilised this information.

It will be apparent that there are large difference in the levels of research, monitoring and assessment activities planned among the different fisheries and ecosystems. These differences reflect the diverse levels of risk associated with each of these issues and the ongoing information requirements to enable each of the current management processes to operate effectively. The Department is beginning to apply formal risk assessment techniques to each of the ecological, social and economic assets within each bioregion, using the Ecosystem Based Fisheries Management Framework. The annual update of the R&D plan will therefore be based on the current risk profiles across the range of objectives listed within the FRMA which should ensure that resources are directed to those areas most in need.



INTRODUCTION FIGURE 1

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

Potential uses of the plan

From an internal perspective, it is valuable to have a consolidated document that outlines the research requirements for each aquatic resource sector within WA. The plan provides the mechanism for major gaps in knowledge, resources and expertise to be identified. This should assist with the management of future research initiatives and planning in a broader context.

As each plan not only identifies what needs to be done, but summarises what has been done, it should minimise the development of research proposals for issues that are already adequately covered by previous research or for which no risk issues have been identified. This edition also includes a summary section that outlines, from the Departments perspective, the key new research initiatives and priorities needed for the management of Western Australia's aquatic resources in the coming few years.

Consequently the information should also be of benefit to a number of other groups:

- Each of the commercial industry sectors can use this document to facilitate their own discussions and formulation of their short and long term research priorities;
- Individual fishers can examine and compare the research that is occurring, or is proposed, in their fishery. This knowledge may help increase the level of input received by the sector advisory bodies and therefore result in higher quality 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 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 research which is proposed or underway, in one of their areas of great general interest, fisheries resources.

Outline of the individual R&D reports

There are separate R&D reports for each of the main wild capture fisheries, each of the main aquaculture industries plus, for each bioregion, reports that cover broader ecosystem and biodiversity issues. There are also a number of reports that cover state-wide issues.

Within each of the reports there is a brief overview of the sector/issue plus a short summary description of previous research relevant to the sector. The current major research focus and objectives for next five years are listed along with recent publications/reports. following these background descriptions, most reports have a detailed matrix that is divided into a number of categories (based on ESD principles) to clearly indicate the future focus. 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 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 – Research is complete, no more will be done.

Ongoing – Research continues annually

Underway – Research has commenced and will continue for xx number of years

Proposed – Research is proposed but unfunded

Dr Rick Fletcher

Director, Fisheries Research

December 2009

Departmental priorities for new research, monitoring and development projects 2009-2011

The following list of topics summarises the areas where new research requirements have recently been identified that either require obtaining external funding, or an increase or a significant shift in the allocation of internal funds to complete. This list does not include studies that have been underway for more than a year. It also does not cover relatively small changes to ongoing monitoring projects.

Each of the topics has been annotated to indicate whether the project is * part funded already, ** already fully funded, # funding proposal pending. If no annotation is provided it indicates that the mechanism for funding and project development has not yet been initiated.

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*
- 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*
- Developing cost effective monitoring programs for demersal and nearshore finfish fisheries*

West Coast

- Generating a better understanding of the relationships between rock lobster puerulus settlement, oceanographic conditions and spawning stock levels *#
- Improved robustness in the measurement of rock lobster spawning biomass and recruitment.*
- 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*

Gascoyne

- Stock assessment of developing minor fisheries (Shark Bay crabs)

North Coast

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

South Coast

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

Inland

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

Aquaculture

- Improved fish health support for kingfish/mulloway production #
- Innovative solutions to support octopus production #

Collaborative Projects 2009/10

To improve the utilisation of research expertise and enhance the outcomes generated for management, many projects now involve individuals from more than one agency. The incidence of these collaborative projects to meet Departmental objectives has increased dramatically in the last decade. Their number was greatly enhanced in WA in general 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 multiple inputs.

The following is the current list of collaborative projects listed within this R&D 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. The symbol (W) indicates a WAMSI project.

Project Title	Lead Agency	Collaborators
STATEWIDE		
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
A review of the methods for completing social and economic assessments for use in EBFM (W)	DoF	Murdoch Uni UWA
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
WEST COAST		
Examination of the impacts of the western rock lobster fishery on ecosystems within deep-water water regions. (W)	DoF	Murdoch Uni ECU 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	TAFI	DoF WRLC
Evaluating source-sink relationships of the Western Rock Lobster Fishery using oceanographic modelling.	CSIRO	DoF
Identifying factors affecting the low western rock lobster puerulus settlement in recent years.	CSIRO	DoF UWA
The effect of climate change on the western rock lobster fishery of WA	CSIRO	DoF
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	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
Assessment of stock structure and movement of nearshore finfish species	DoF	Murdoch University
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
Larval advection of scallops	DoF	UWA
NORTH COAST		
Resource Condition Monitoring: Kimberley case study	DoF	DEC UWA
Bioeroding sponges in pearl oyster stocks	DoF	WA Museum
Development of a DNA microarray to identify markers of disease in pearl oysters (Pinctada maxima) and to assess overall oyster health	DoF	Uni Qld Macquarie Uni
Enhancing settlement and survival of Holothuria scabra for fishery enhancement	Tasmanian Seafoods	DoF, NT Fisheries
Developing methods of reducing dolphin bycatch in the Pilbara trawl fishery	Murdoch Univ	DoF
Sustaining productivity of tropical red snappers using new monitoring and reference points	QDPI	DoF NT

Project Title	Lead Agency	Collaborators
Defining the stock structure of northern Australia's threadfin salmon species	JCU	DoF
Relative efficiency of fishing gears and investigation of resource availability in tropical demersal scalefish fisheries (NDSF).	DoF	UWA
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
INLAND		
Developing native fish research and policy strategies	DoF	DoW DEC
Native fish Breeding	DoF	UWA
Development of Native Fish GIS database	DoF	DEC Murdoch UWA
Dam rehabilitation	DoF	DoW
Native fish surveys in south west	DoF	UWA
Exploration of the effectiveness of alternative management responses to variable recruitment of fish	Murdoch	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., Shervington, C., Millington, P. & Hill, A. (2007) Sharing the fish, and other resource access issues: how can this be done at a regional level? In, Proceedings of the Sharing the Fish Conference. Fremantle, W.A. Australia. February 2006 FAO. http://www.fish.wa.gov.au/docs/events/ShareFish/papers/pdf/papers/RickFlecter.pdf.

Landos, M., Dhand, N., Brian Jones, B., Whittington, R. 2007. Aquatic Animal Health Subprogram: Current and future needs for aquatic animal health training and for systems for merit-based accreditation and competency assessments. *Fisheries Research and Development Corporation Final Report 2005/641, 135p.*

Fletcher, W.J. (2006) Frameworks for managing marine resources in Australia through ecosystem approaches: do they fit together and can they be useful? Bulletin of Marine Science 78:691-704

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.*

Keesing J.K. and Heine, J.N. (2006). Strategic Research Fund for the Marine Environment Final Report. Volume 1: the SRFME initiative and collaborative linkages program 260p. Strategic Research Fund for the Marine Environment, CSIRO, Australia

Keesing J.K., Heine, J.N., Babcock, R.C., Craig, P.D. and Koslow, J.A. (2006). Strategic Research Fund for the Marine Environment Final Report. Volume 2: the SRFME core projects 274p. Strategic Research Fund for the Marine Environment, CSIRO, Australia

Key to symbols in the matrix/summary tables:

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

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

Strategic- State-wide Research and Development Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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.
Qualitative modelling	Underway	■	■				This is examining how valuable this approach

Strategic- State-wide Research and Development Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
							can be to assist in management decision making
Project Management Systems	Underway	■	■	■	■	■	
4. Industry Development							
5. Prioritisation							
Research project application prioritisation criteria	Completed						This is located in Fisheries Occasional paper No. 4
Whole of agency prioritisation procedure	Underway	■	■				This links to the Departments risk register and the EBFM outcomes
6. Reviews							
Develop regular review program for each research project	Underway	■	■				

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 that 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

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

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.

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.

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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. Marin 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

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

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. 133 p.

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).

McClatchie, S. & Gaughan, D. (2006). Zooplankton. 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).

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.

Waite, A.M., Thompson, P.A., Twomey, L., Gaughan, D. (2006). Interaction of coastal currents, phytoplankton dynamics and trophic transfer in the coastal waters of Western Australia. pp 92 - 111. In: Keesing J.K. and Heine, J.N. (Eds). Strategic Research Fund for the Marine Environment Final Report. Volume 1: the SRFME initiative and collaborative linkages program 260p. Strategic Research Fund for the Marine Environment, CSIRO, Australia.

Keesing J.K. and Heine, J.N. (2006). Strategic Research Fund for the Marine Environment Final Report. Volume 1: the SRFME initiative and collaborative linkages program 260p. Strategic Research Fund for the Marine Environment, CSIRO, Australia

Keesing J.K., Heine, J.N., Babcock, R.C., Craig, P.D. and Koslow, J.A. (2006). Strategic Research Fund for the Marine Environment Final Report. Volume 2: the SRFME core projects 274p. Strategic Research Fund for the Marine Environment, CSIRO, Australia

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EBFM Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
All Bioregions: Captured species assessments	Ongoing						
West Coast and Gascoyne Bioregions: Developing new, more efficient methods to quantify recreational catches	Underway	O					Work on this project is underway by DoF but funding is yet to be obtained.
1.2 Other Biology							
West Coast and Gascoyne Bioregions: Implications for mobility and stock structure	Underway						
1.3 Stock Assessment							
1.4 Fishery Monitoring							
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.
Gascoyne 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.
2.5 Oceanography							
2.6 Other impacts on fishery							

EBFM Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
3. Management Analysis							
3.1 Socio-economic							
West Coast Bioregion: Improving understanding of recreational fisher behaviour in response to fisheries management	Proposed	O					Recreational fishing paper currently in review at Fisheries Research. 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 construct6ion 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 will be available by 2010.
4. Industry Development							
4.1 Production Technology							
4.2 Post Harvest							
4.3 Marketing							

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.

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.

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 which 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.

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State-wide – Specimen Shell Managed Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
1.2 Other Biology							
1.3 Stock Assessment							
1.4 Fishery Monitoring	Ongoing	■	■	■	■	■	
2. Habitat & Ecosystem							
2.1 Bycatch							
2.2 Listed Species							
2.3 Habitat							
2.5 Oceanography							
2.6 Other impacts on fishery							
3. Management Analysis							
3.1 Socio-economic							
3.2 Resource Access (Shares)							
3.3 Compliance							
3.4 Management Systems							
4. Industry Development							
4.1 Production Technology							
4.2 Post Harvest							
4.3 Marketing							

Indian Ocean Territories

Description and Scope of Issues

In November 2002, the territorial seas (out to 12 nautical miles) of the Cocos (Keeling) Islands and Christmas Island were declared as 'excepted waters' from the *Fisheries Management Act 1991*. Management responsibilities for these waters were transferred from the Australian Fisheries Management Authority (AFMA) to the Department of Transport and Regional Services. The Government of Western Australia's Department of Fisheries (the Department) has now taken on management responsibilities for the marine waters of the Indian Ocean Territories out to 12 nm, under a Service Delivery Arrangement with the Commonwealth Attorney General's Department (AGD), and AFMA continues to manage the waters from 12nm to 40 nm. Under the Service Delivery Arrangement with the AGD, the Department now manages commercial, recreational, charter and aquaculture activities at the Cocos (Keeling) Islands and Christmas Island, in addition to providing fish health diagnostic services, Biosecurity and marine pest monitoring, fish habitat protection advice, fish pathology and licensing services. The Commonwealth Minister for Home Affairs currently holds responsibility for these excepted waters under the *Fish Resources Management Act 1994 (WA) (CI/CKI)* (the 'Applied Act').

The commercial Christmas Island Line Fishery (CILF) primarily targets pelagic species, mainly wahoo (*Acanthocybium solandri*) and yellowfin tuna (*Thunnus albacares*). In addition, limited demersal fishing activities are also undertaken targeting deepwater snappers and groupers.

The Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) primarily targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge joculator*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*).

Large amounts of recreational/artisanal fishing are undertaken around the Cocos (Keeling) Islands and Christmas Island targeting both finfish and invertebrate species. The Cocos (Keeling) Islands consist of a diverse range of fishable habitats that include a sheltered lagoon, fringing reefs and offshore 'blue water' environments that support a range of demersal and pelagic fish species, as well as various crustaceans (e.g. crabs) and molluscs (e.g. gong gong), which are highly sought after by fishers for both individual and community purposes. Christmas Island has a limited amount of habitat available for fishing with no lagoon present, fringing reef surrounding the island and offshore 'blue water' environments that support a limited range of demersal and pelagic fish species, as well as some invertebrates in comparison to the Cocos (Keeling) Islands.

Summary of historical research completed

The projects are only in the development phase, there is little historical research activity completed.

Current Research Focus

Risk assessment workshops have been undertaken since 2006 to identify and refine fisheries research and management priorities at the Indian Ocean Territories. Following these workshops finfish fisheries research has focused on collecting biological material to assess the wahoo stocks and on collecting tissue samples from a suite of species at the Cocos (Keeling) Islands and Christmas Island to examine their connectivity with other sites along the Western Australian coast

and locations to the north. Invertebrate fisheries research has focused on surveys to assess the abundance and biology of gong gong (*Lambis lambis*) and also to understand the abundance and distribution of bêche-de-mer (Holothurians) and clams (*Tridacna* spp.). Biodiversity research has also established a reef-monitoring program to detect changes in reef health due to natural and anthropogenic impacts. Subsequent to the 2006 risk assessment process, the potential for the introduction of marine pest species has been identified and is now the subject of further research and monitoring. An initiative to review and synthesise the ecological and biological data for the marine environments of the Indian Ocean Territories is now underway.

Priority Setting Process

Research priority setting has been undertaken through internal risk assessment workshops which have been conducted since 2006. Research issues are also discussed through consultations with communities on each island group at least once a year and the information generated from these discussions feeds into the internal risk assessment process.

Commercial: Department–industry/community consultation – Christmas Island and Cocos (Keeling) Islands.

Recreational: Community Consultation - Cocos (Keeling) Islands and Christmas Island.

Review Timeline

Risk assessments and research reviews are conduced annually in preparation for annual funding considerations.

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Indian Ocean Territories Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Gong Gong	Proposed	O	O	O	O	O	Project identified – High Risk
Wahoo	Proposed	O	O	O	O	O	Project identified – High Risk
Coronation trout	Proposed	O	O	O	O	O	Project identified – High Risk
1.2 Other Biology							
Stock structure – representative species	Proposed	O	O	O	O	O	Project identified – High Risk
1.3 Stock Assessment							
Annual Catch and Effort Assessment	Ongoing	■	■	■	■	■	Ongoing
Dist. and Abundance - Clams	Ongoing	■	■	■	■	■	Ongoing
Dist. and Abundance – Gong gong	Ongoing	■	■	■	■	■	Ongoing

Indian Ocean Territories Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1.4 Fishery Monitoring							
Commercial catch and effort	Ongoing	■	■	■	■	■	Ongoing
Commercial monitoring (vessel monitoring at sea)	Proposed		O				Proposed
Charter boat catch and effort	Proposed		O				Proposed
Fish Kills	Proposed	O	O	O	O	O	Proposed as part of Commonwealth surveillance and monitoring
2. Habitat & Ecosystem							
2.1 Bycatch	Proposed		O				Low risk
2.2 Listed Species	Proposed		O				High risk
2.3 Habitat	Proposed		O				High risk
2.4 Ecosystem/Environment	Proposed		O				High risk
Fish Kills	Underway	■					Respond to reports and investigate cause of fish kills (funded for at least 1 year)
2.5 Oceanography	Proposed		O				Low risk
2.6 Biosecurity / Marine Pests	Ongoing	■					No risk ranking, monitoring design complete, implementation planned
2.7 Other impacts on fishery							Nothing identified
3. Management Analysis							
3.1 Socio-economic							
Social assessment	Possible						Low risk
Economic analysis	Possible						Low risk
3.2 Resource Access (Shares)							
Detailed determination of access shares	Not needed						Nothing identified
Monitoring of shares	Not needed						Nothing identified
3.3 Compliance							
Validation of Catch Records	Proposed		O				Low risk
3.4 Management Systems							
Management of recreational/artisanal sector	Proposed						High risk
4. Industry Development							
4.1 Production Technology							
4.2 Post Harvest							
4.3 Marketing							

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 being 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 –atural Betacarotene. 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 2008-09

Live Rock Aquaculture

Description and Scope of Issues

Live rock is a 'trade name'or a substrate (generally a rock or dead coral) that has subsequently been colonised by a range of benthic flora and fauna and used as an architectural structure in marine aquaria (both public and private). The rock is not 'live' but the variety of organic matter around or on it is alive.

Summary of historical research completed

Currently, there is no research or commercial project looking at the possibilities of the hatchery production of live rock, being conducted in Australia. However, there is a need to develop coral/live rock aquaculture to provide these products as a viable alternative to natural coral collection. The wild collection of corals and live rock in WA is under scrutiny and it is likely that in the near future will be reduced and/or restricted. DoFWA is currently preparing a policy paper regarding coral and live rock aquaculture. This area of aquaculture is gaining interest locally and around the world since the Australian corals and rocks are fetching high prices in the EU and US markets.

Current Research Focus

An FRDC proposal was submitted together with Kimberley TAFE. The project is aiming directly at the Kimberly indigenous communities. It is believed that, if successful, the project can establish a new source of income through sustainable aquaculture. This project will reduce the need to harvest live rock and corals from the natural environment and will contribute to the sustainable management of our coral reefs.

The objectives of the project are as follow:

- To develop grow-out techniques for live rock, suitable to the conditions in the far north of Western Australia
- To identify suitable indigenous communities in the Kimberley that are keen on developing live rock Aquaculture
- To develop a sustainable (economically, environmentally and socially) industry that is suitable for indigenous communities based on local sites and using local materials

Priority Setting Process and Review Timeline

Live rock has been identified as a priority culture species in recent Kimberley aquaculture planning meetings. Walt Smith International, a US commercial company culturing live rocks in Fiji and has business in Tonga has expressed an interest to be involved in the project. It is envisage that the company can help with fast tracking some of the technology as well as open direct marketing and distribution channels to the final product. New project

Octopus Aquaculture

Description and Scope of Issues

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.

This is the first attempt to culture octopus in Australia and there are still a great deal of unknown factors. The ranching period, from juvenile to market size, is expected to take approximately 10 weeks depending on captured size and grading. Octopuses are seasonal spawners which may restrict wild capture / ranching production to only a period of the year. Therefore, closing the life cycle and shifting the focus towards aquaculture of hatchery-reared octopus, in order to prolong the annual production period is the next logical step.

Summary of historical research completed

New project

Current Research Focus

The hatchery techniques for mass culture of octopus including nutrition, physiology and husbandry are still largely unknown. The proposed project will focus on closing the life cycle and look at different aspects including brood stock nutrition and husbandry, larvae nutrition and systems management. Several proposals (FRDC, ADC) proposals were submitted together with a WA company and the project is planned to start in October 2009.

Priority Setting Process

Initial assessments were made through internal departmental meetings, discussions with the FRAB, ACWA and ADC followed by research application to FRDC. Research issues have been discussed with industry bodies as well as government departments in SA, Victoria and NSW.

Review Timeline

New project

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.

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

Keesing J.K. and Heine, J.N. (2006). Strategic Research Fund for the Marine Environment Final Report. Volume 1: the SRFME initiative and collaborative linkages program 260p. Strategic Research Fund for the Marine Environment, CSIRO, Australia

McClatchie, S. & Gaughan, D. (2006). Zooplankton. *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).

Waite, A.M., Thompson, P.A., Twomey, L., Gaughan, D. (2006). Interaction of coastal currents, phytoplankton dynamics and trophic transfer in the coastal waters of Western Australia. pp 92 - 111. In: Keesing J.K. and Heine, J.N. (Eds). Strategic Research Fund for the Marine Environment Final Report. Volume 1: the SRFME initiative and collaborative linkages program 260p. Strategic Research Fund for the Marine Environment, CSIRO, Australia.

Key to symbols in the matrix/summary tables:

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West Coast Biodiversity Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Western rock lobster diet for use in ecosystem work	Underway	■	■				Diet analysis is being conducted for both inshore and deepwater populations by WAMSI and FRDC projects
Coral Trout (Abrolhos)	Underway	■					Currently being conducted by a PhD at ECU
Finfish populations at Jurien	Underway	■					Research on finfish population is currently being conducted by WAMSI node 1.
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
Habitat Mapping	Completed						Marine Futures mapped the habitat and biodiversity at the Abrolhos, Jurien, Rottnest and the Capes
Coral habitats in Abrolhos	Ongoing	■	■	■			A DOF project is currently underway examining the effects natural and anthropogenic Impacts on sensitive coral

West Coast Biodiversity Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
							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	Ongoing	■	■	■			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	Ongoing	■	■				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	Ongoing	■					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 – 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.

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

Stock assessments of the finfish indicator species from 2007/08 were independently reviewed and the results of the review supported the findings of the Department, that overfishing was occurring in the fishery (O'Neill, 2009). The next stock assessment, which will be reviewed, will occur in 2012.

Key to symbols in the matrix/summary tables:

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West Coast Abrolhos Islands FHP Regions Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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	Underway	■					PhD + ECU
Release Mortality	Completed						
Movement	Underway	■					FRDC + ECU
Coral Trout Biology	Underway	■					PhD + ECU
Spangled Emperor Biology	Underway? Marriot In Gascoyne						
Red Throat Emperor	Underway	■					PhD + ECU - not likely to be completed as part of that PhD - but keen to look at status of this species!
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	O					Periodic
Recreational Indicator	Developing	O					
Charter Boat Catch and Effort	Ongoing	■	■	■	■	■	Compulsory catch returns, annual reporting In SOF In relevant sections
2. Habitat & Ecosystem							
2.1 Bycatch							
2.2 Listed Species							
Foraging ecology of Australian sea lions	Completed	■	■				
2.3 Habitat	Ongoing	■					Study currently underway to examine the effects of anthropogenic and natural Impacts on sensitive habitats includes ROA's
	Completed						Marine futures habitat mapping. Future assessment of indicators will occur through WAMSI 4.2
QuickBird Assessment	WAMSI -	■					
2.4 Ecosystem/Environment WC Bioregion ecosystem study							
WAMSI 4.2 developing indicator sites and		■					

West Coast Abrolhos Islands FHP Regions Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
measures							
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						

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.

Summary of historical research completed

A large amount of research has been completed on this fishery and a comprehensive list of much of 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

Research activities continue to focus on the core business of assessing stock sustainability and forecasting future catch levels. This involves 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.

An environmental management strategy was developed for use in the assessment of the broader ecosystem impacts of rock lobster fishing in the context of ESD and MSC certification. This strategy includes research into the ecosystem effects of rock lobster fishing in deep water. A Fisheries Research and Development Corporation (FRDC) funded project to examine the effects of western rock lobster fishing on the deep-water ecosystem off the west coast of Western Australia 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 Western Australian Marine Research Institution and a new FRDC project starting 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.

A second project examining lobster populations between fished and unfished zones is ongoing at Rottnest Island. This project consists of annual sampling using pots and underwater dive surveys at Armstrong Bay and Parker Point sanctuary zones. Results from the first two 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 and natural mortality.

Further funding will be sought to continue this monitoring into the future.

A low puerulus settlement risk workshop was held in 1 and 2nd of August 2009 at the Western Australian Fisheries and Marine Research Laboratories. 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 was released to stake holders for comment in July 2009.

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.

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 will commence 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: Rock Lobster Industry Advisory Committee (RLIAC) and subcommittees; annual RLIAC coastal tour; meetings between the Department of Fisheries and industry; Western Rock Lobster Council

Recreational: Recreational Fishing Advisory Committee

Review Timeline

Research relevant to the management of the fishery is reviewed annually by Scientific Certification Systems, Inc., on behalf of the MSC. The second annual review was conducted on the 17 November 2008 and then third annual review is planned for the 3 November 2009. The 3rd annual surveillance will review any changes in the management of the fishery, (including regulations, key management or scientific staff or stock evaluation) and evaluate the progress of the fishery against any conditions of certification raised during the reassessment in 2006. Additionally, the SCS Assessment Team will conduct a partial reassessment of the fishery as it pertains to Principle 1 – Stock Status and Harvest Strategy.

A formal stock assessment was also held in July 2007 and was conducted by four internationally respected scientists. The outcomes of this review have been published in Fisheries Occasional Publication No. 50, 2008. A second similar review is planned within five years of this initial review.

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. (2007). Changes in egg production of the western rock lobster (Panulirus cygnus) associated with appendage damage. *Fisheries Bulletin*. 105:418–425.

Melville-Smith, R. & de Lestang, S, Chatfield, B., Nelson, M. and Nichols, P.D. (2007). Neither maternal size nor site of Spawning influences larval competency in western rock lobster *Panulirus cygnus* George. *Journal of Crustacean Biology*. 27: 445-453.

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

Limbourn, A.J., Babcock, R.C., Johnston, D.J., Nichols, P.D., Knott, B. 2009. Spatial and temporal variation in lipid and fatty acid profiles of western rock lobster pueruli at first settlement: Biochemical indicators of diet and nutritional status. *Mar. Freswat. Res*. 60, 810-823.

Limbourn, A.J., Babcock, R.C., Johnston, D.J., Nichols, P.D. and Knott, B. 2008. Post-settlement energy reserves in *Panulirus cygnus*: experimental effects of starvation on survival and nutritional condition. *Marine Biology*. 153, 445-456.

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West Coast Western Rock Lobster Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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	Ongoing	■	■	■	■	■	
Annual Assessment	Ongoing	■	■	■	■	■	
Develop New Model	Underway	■	■	■			Models updated as new data developed
Shallow Water Depletion Assess.	Underway	■	■	■			
Deep Water Depletion Assessment	Underway	■					Initial trials underway
Change in Ratio and Index Removal	Proposed	■	■				Application pending with 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	■	■	■	■	■	Within season trials
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

West Coast Western Rock Lobster Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
2.3 Habitat	Ongoing	■	■	■	■	■	
Seagrass and Limestone reef effects	Completed						Sufficient for management
Coral Reef effects	Underway	■	■				Study at the Abrolhos Islands
2.4 Ecosystem/Environment	Ongoing	■	■	■	■	■	
Deep water ecosystem study	Underway	■	■	■	■		Closed area monitoring
Jurian Bay inshore	Completed						SRFME/WAMSI study
Dongara inshore	Completed						CSIRO studies in the 1980s
Rottnest Sanctuary zones	Underway	■	■	■	■	■	Comparing fished *vs*. unfished
2.5 Oceanography	Underway	■	■	■			
Leeuwin Current monitoring	Ongoing	■	■	■			
Oceanographic Modelling	Underway	■	■	■			FRDC funded
Impacts of ocean conditions on catch rates	Completed						
2.6 Other impacts on fishery							Nothing identified
3. Management Analysis							
3.1 Socio-economic							
Economic Analysis (MEY)	Underway	■	■				Examination of Maximum Economic Yield
3.2 Resource Access (Shares)							
Determination of access shares	Periodic			■			Needed for IFM
Monitoring of shares	Ongoing	■	■	■	■	■	Needed for IFM
3.3 Compliance							
Enforcement efficiency	Underway	■	■	■			
3.4 Management Systems							
Input vs output controls	Completed						Business case developed
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							Completed by Industry
5. Priority Review							
RLIAC R&D		■	■	■			Annual review of R&D plan
6 Science Review							
Stock Assessment				■			Last completed in detail in 2007
MSC audits		■	■	■			Yearly audits

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.

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 (details outlined above) 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.

Recreational

Current annual recreational catch and effort estimates are derived from an annual field survey (West Coast Zone / Perth metropolitan fishery), and an occasional 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. The estimates are based on average catch (weight and numbers), catch rates (derived from 1,200 interviews in 2008), and fisher counts conducted by Fisheries Volunteers and research personnel from shoreline vantage points and aerial surveys. This method provides a comprehensive assessment for this region but is too resource-intensive to be applied outside of the Perth metropolitan area.

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 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. Major assessment reports are peer reviewed every three years.

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	2009/10	2010/11	2011/12	2012/13	2013/14	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
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 complete din 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	2009/10	2010/11	2011/12	2012/13	2013/14	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	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. Review							
5.1 Priority Review		■	■	■	■	■	Annual industry meetings
5.2 Science Review		■			■		Major assessment reports peer reviewed every three years

West Coast – Abrolhos Islands and Midwest Trawl Fisheries

Description and Scope of Fishery

The Abrolhos Islands and Mid West Trawl Managed Fishery (AIMWTMF) is based on the take of saucer scallops *(Amusium balloti)*, with a small component targeting the western king prawn *(Penaeus latisulcatus)* in the Port Gregory area. The Port Gregory area has seen negligible fishing in recent years due to changes in the fishing season dates.

The South West Trawl (SWTMF) Fishery includes two of the state's smaller scallop fishing grounds – Fremantle and Geographe Bay. It 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, 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.

The catches in all these fisheries is taken using otter trawling.

Summary of historical research completed

Monitoring of the scallop stocks in these fisheries is undertaken using daily logbooks which became mandatory in 2008. Prior to this, monthly catch and effort returns were used. 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. This research was initially aimed at determining basic biology of the species to ensure that the scallops were being harvested at ecologically sustainable levels whilst achieving the best economic returns from the available scallop resource.

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

In the AIMWTMF research is primarily aimed at the monitoring of the fishery through the use of daily logbooks and completing pre-season surveys to forecast the following seasons 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 will be undertaken in late 2009 to provide additional growth information. This additional sampling may continue into 2010 focussing on scallop health 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. Some limited sampling of scallop stocks and size composition in the Fremantle area is now planned for late 2009 as part of the square mesh trial extension.

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 AIMWTMF licensees to discuss research priorities and planning. Additional research needs have also been highlighted throught the ESD Assessment processs for which a re-assessement has been completed in 2008.

The most recent Industry, Research Division meeting for the AIMWTMF was held 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 AIMWTMF.

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West Coast Abrolhos Islands and Mid West Trawl Fisheries Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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	■	■	■	■	■	

West Coast Abrolhos Islands and Mid West Trawl Fisheries Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
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	O	O				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	O					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	■	■	■	■	■	
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	■					Tri-monthly sampling in AIMWTF in 2009/10
5. Priority setting							
Industry/Department Meetings	Annual	■	■	■	■	■	
6. Science Review	Periodic				■		Next EPBC review

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 activites. In the West Coast bioregion it is centered 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.

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 he 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.
- 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 is undertaking :

- Comprehensive recreational survey from November 2007 to October 2008.

- Monthly commercial monitoring program to assess the impact of commercial fishing in the West Coast Estuarine, Warnbro Sound and Mandurah-Bunbury fisheries.

Priority Setting Process

Research priorities are set in consultation with management, and feedback obtained during meetings with industry and major stakeholder groups (WAFIC, RecFishWest and RFAC) 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 and for the Peel-Harvey Estuary the stock assessment is due by the end of 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 2009/10.

Recent Publications

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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West Coast Blue Swimmer Crabs Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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.

West Coast Blue Swimmer Crabs Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1.3 Stock Assessment							
Stock Assessment	Ongoing	■	■				For Cockburn Sound (DBIF funded)
	Underway	■	■				For Peel-Harvey Estuary (DBIF funded)
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	Proposed	O	O				Recreational crabbing survey proposed for 2009/10 Cockburn Sound fishing season
– 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 being investigated for Cockburn Sound
2.4 Ecosystem/Environment							
2.5 Oceanography	Ongoing	■	■				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	O				This is a major management issue
3.3 Compliance							
3.4 Management Systems		O	O				Industry proposed study on co- management
4. Industry Development							
5. Priority setting							
Industry/Department Meetings	Annual	■	■	■	■	■	
6. Science Review	Periodic		■				At completion of stock assessment for Peel Harvey

West Coast – Deep Sea Crab Fishery

Description and Scope of Issues

The West Coast Deep Sea Crab (Interim) Managed Fishery targets giant (king) crabs (*Pseudocarcinus gigas*), crystal (snow) crabs (*Chaceon albus*) and champagne (spiny) crabs (*Hypothalassia acerba*) using baited pots operated in a long-line formation in the offshore waters of the west coast. In the late 1990s when this fishery first commenced, it targeted champagne crabs, however, the fishery moved into deeper waters targeting crystal crabs.

Summary of historical research completed

The FRDC has funded research on aspects of both the giant and the champagne crab fisheries. Biological (growth, reproduction, movement patterns etc) and fisheries data are available for crystal crabs. The species is slow growing with estimates that legal sized male crabs to be ~13-15 years old and some may live to ~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. Comprehensive biological information is available for giant crabs but sampling centred off Victoria and South Australia and less so in Western Australia.

Current Research Focus

Research for this fishery currently involves annually assessing the status of the west coast deep sea crab stocks based on commercial catch returns, log book information and at-sea research monitoring of the catch. The performance of this fishery has now been defined as the level of catch remaining within an acceptable range.

Priority Setting Process and Review Timeline

Research and management meetings are held with industry as required.

Key References and Recent Publications

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.

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.

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.

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West Coast Deep Sea Crab Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Giant Crabs	Completed						FRDC project
Crystal and Champagne Crabs	Completed						As above
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							Negligible risk
2.2 Listed Species							Negligible risk
2.3 Habitat							Negligible risk
2.4 Ecosystem/Environment							Negligible risk
2.5 Oceanography							Low Priority
2.6 Other impacts on fishery							Nothing identified
3. Management Analysis							Nothing Identified
4. Industry Development							
5. Priority Review							No planned review

West Coast – Estuarine and Inshore Fisheries

Description and Scope of Issues

The fish resources in West Coast estuaries and inshore 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 macrocephlus*). The commercial catch (excluding baitfish) includes Australian herring (*Arripis georgianus*), Australian salmon (*Arripis truttaceus*), southern sea garfish (*Hyporamphus melanochir*), yellowtail scad (*Trachurus novaezelandiae*), sea mullet (*Mugil cephalus*), yellow-eye mullet (*Aldrichetta forsteri*), western sand whiting (*Sillago schombergki*), King George whiting (*Sillaginoides punctata*), pink snapper (*Pagrus auratus*) and, most recently within Cockburn Sound, the gloomy octopus. The recreational catch also includes these species, plus tailor (*Pomatomus saltatrix*) and silver trevally (Pseudocaranx sp.). Blue swimmer crabs (*Portunus pelagicus*) are also caught in these areas but they are covered elsewhere in their own section of this report.

The status of many stocks are 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.

Summary of historical research completed

The basic biology of many species is adequately understood (black bream, cobbler, whiting species and mullet species) from the extensive set of research projects that have been undertaken mainly by the Department and Murdoch University over the past 30 - 40 years.

The recreational finfish catch share is now estimated to be at least 30% in the Peel/Harvey Estuary, 50% in the Swan/Canning Estuary, 75% 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.

Current Research Focus

The indicator species were selected for these resources using a risk assessment process. Indicators for estuaries include black bream, cobbler (estuary stocks only) and Perth herring. Indicators for inshore regions include tailor, Australian herring, silver trevally, sea garfish, King George whiting, other whiting, mulloway (*Agyrosomus japonicus*) and sea mullet.

- Monitoring of these indicator species is based on fishery-independent surveys of annual recruitment, compulsory monthly returns from commercial fishers and voluntary recreational logbooks.
- An NRM funded research project to develop the program to monitor the age structure and status of Australian herring and tailor and determine sources of recruitment to the West Coast fishery and identify factors associated with annual recruitment variation has recently begun.
- 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 inshore fishery, focusing on various other inshore species.
- An FRDC proposal has been submitted to examine the octopus fishery in Cockburn Sound.
- There are also 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 completed at a Research Review meeting in February 2009 and issues are reviewed at regular internal meetings. Discussions are also held between the Department of Fisheries, industry and peak body members (e.g. the Western Australian Fishing Industry Council, Recfishwest) and the Recreational Fishing Advisory Committees

Review Timeline

An internal risk assessment of inshore and estuarine fish stocks in the West Coast Bioregion was completed in 2009.

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. 133 p.

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West Coast Estuarine and Inshore Fisheries Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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
Mulloway	Complete						Adequate for management
King George & other whiting	Complete						Adequate for management
Australian herring	Complete						Adequate for management
Tailor	Underway	■	O	O	O		Develop age-based monitoring of west coast fishery. Describe local growth rates, spawning periods & recruitment dynamics. Available data mostly from elsewhere, limited data from WA. NRM-funded 1-year project. FRDC funding application with Murdoch Uni. pending.
Southern sea garfish	Underway	■					Need to re-examine age structure, growth & reproduction. Available data mostly from other states, limited data from WA.
Perth herring	Proposed		O	O			Need to re-examine age & growth. Validate otolith annuli. Ages previously determined from scales & are unreliable.
Silver trevally	Proposed	O	O	O	O		Stock structure unclear, maybe several stocks with different biological characteristics. FRDC funding application with Murdoch Uni. pending.
1.2 Other Biology							
Spawning & stock structure of Perth herring.	Underway	■					Declining stock, highly vulnerable, low fishery value but potential indicator species & important prey for higher value species. Studies of Swan R. larvae & genetics of West Coast populations underway.
Whiting (other than KGW)			O	O	O		Review composition of 'whiting' suite of species in recreational catch. FRDC application with Murdoch Uni. pending
King George whiting			O	O	O		FRDC application with Murdoch Uni. pending
Australian herring	Underway	■	O	O	O		Develop age-based monitoring of West Coast fishery. Examine recruitment dynamics and stock structure. NRM-funded 1-year project. FRDC funding application with Murdoch Uni. pending.
1.3 Stock Assessment							
Annual trends in catch and CPUE	Ongoing	■	■	■	■		CAES data & recreational logbooks
Annual trends In juvenile recruitment	Ongoing	■	■	■	■		Beach seining
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 1-year project. FRDC funding application with Murdoch Uni. pending.
Age-based model (Swan River bream)	Underway	■					Murdoch Uni project.

West Coast Estuarine and Inshore Fisheries Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1.4 Fishery Monitoring							
CAES	Ongoing	■	■	■	■		Limited. Minimal Swan R. & Hardy Inlet data, No Leschenault estuary data. No Geographe Bay data after 2009.
Creel survey - boat based	Underway	■	■				West Coast survey underway
Shore Based trial survey	Funded	■	■				A trial survey has now been funded by NHT
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		Herring (W & S Coasts), tailor & garfish (W Coast)
Cobbler	Proposed	O	O	O	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, blowfish)
2. Habitat & Ecosystem							
2.1 Bycatch	Not needed						Low risk
2.2 Listed Species	Not needed						Low risk
2.3 Habitat	Developing	■	■				Swan River fish communities (Murdoch Uni funded by DoF, SRT & DoW)
2.4 Ecosystem/Environment							
Fish community surveys		■	■	■			Faunal surveys In Swan, Peel Harvey & Leschenault. Ecosystem modeling (Murdoch Uni projects).
Fish kills	Occasional	■	■	■	■		Opportunistic sampling, logistically difficult, limited resources available
2.5 Oceanography	Not needed						Nothing identified
2.6 Other impacts on fishery	Underway	■	■				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	Possible						
4. Industry Development							Nothing identified
5. Review							
5.1 Priority Review		■	■				
5.2 Science Review			■			■	

West Coast – Beach Bait Managed Fishery

Description and Scope of Issues

The West Coast Beach Bait Managed Fishery (WCBBF) extends from the mouth of the Moore River, north of Perth, to Tim's Thicket in the south. The south-west fishing activities occur from Tim's Thicket south to Point D'Entrecasteaux, with activity typically concentrated in Geographe Bay (Cape Naturaliste to Preston Beach). The primary target is whitebait (Hyperlophus vittatus) and the main fishing method is beach seine netting, although non-powered purse seining and haul netting from small boats are also utilised.

Summary of historical research completed

A significant research project on the biology and stock assessment of whitebait along the lower west coast of Western Australia was undertaken by the Department between 1991 and 1994. Based on this research, the annual catch of whitebait, obtained from the information supplied by fisher's monthly returns, is used as an indicator of abundance to report on the performance of the fishery.

Current Research Focus

There is an ongoing research sampling program designed to predict recruitment of key inshore species, some of which contribute to this fishery. In addition, ongoing monitoring of catches as a de facto indicator of abundance forms the basis of current research to assess the status of the whitebait stocks.

Priority Setting Process

Priorities are reviewed on an annual basis through consultation between Scientists of the Finfish Branch (Research Division) and Fishery Managers. This fishery is currently considered as low risk.

Review Timeline

The science was reviewed extensively in 1996. This fishery was last reviewed in 2008 and is considered low risk will be reviewed within the next five years.

Key to symbols in the summary matrix:

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

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

West Coast Beach Bait Research Projects	Research Status	2008/09	2009/10	2010/11	2011/12	2012/13	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Whitebait	Completed						Adequate for management
1.2 Other Biology	Not needed						No other issues identified
1.3 Stock Assessment							Not a priority
1.4 Fishery Monitoring							
CAES data	Ongoing	■	■	■	■		
Recruitment index	Underway	■	■	■	■		Whitebait only, may be phased out.
2. Habitat & Ecosystem							
2.1 Bycatch	Nil						Low risk
2.2 Listed Species	Nil						Low risk
2.3 Habitat	Nil						Low risk
2.4 Ecosystem/Environment	Annual	■	■	■	■		Link between Leeuwin Current and recruitment
	Completed						Critical for penguins (Murdoch Uni.)
2.5 Oceanography	Annual	■	■	■	■		As above
2.6 Other impacts on fishery	Not needed						Nothing identified
3. Management Analysis							No Prioirty
4. Industry Development							No Priority
5. Review							
5**.1 Priority Review**						■	Low Risk
5.2 Science Review						■	N/A

West Coast – Purse Seine Fishery

Description and Scope of Issues

The West Coast Purse Seine Fishery operates between 33°S latitude and 31°S latitude (the metropolitan fishery) and 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.

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 five 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).

Key to symbols in the matrix/summary tables:

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West Coast Purse Seine Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Pilchard Biology	Completed						Many studies
Sardinella Biology	Completed						Study Completed in 90s
1.2 Other Biology							
1.3 Stock Assessment	Suspended						No longer a priority
Sardine DEPM Estimates	Completed						No longer of priority.
1.4 Fishery Monitoring							
Commercial Catch & Effort	Ongoing	■	■	■	■	■	
Age samples of pilchard catch	Suspended						No Longer a priority .
2. Habitat & Ecosystem							
2.1 Bycatch (Low Risk)	Nil						Low Risk
2.2 Listed Species	Nil						Low risk
2.3 Habitat (Low Risk)	Nil						Low risk
2.4 Ecosystem/Environment	Completed						Critical prey studies completed by Murdoch Uni.
2.5 Oceanography							Low priority
2.6 Other impacts on fishery	Completed						Work on pilchard virus completed
3. Management Analysis							
3.1 Socio-economic	Not needed						Low value, small scale
4. Industry Development							
4.2 Post Harvest							
Product quality	ongoing						Industry initiatives
Value adding	ongoing						Industry initiatives for human consumption in the 80s and early 90s
5. Review							
5.1 Priority Review						■	Low Risk
5.2 Science Review						■	N/A

West Coast – West Coast Demersal Scalefish Fishery

Description and Scope of Issues

The West Coast Demersal Scalefish Fishery includes a complex of mostly line based fishing operations by commercial, charter and recreational sectors. The fishery operates in the west coast bioregion, between just north of Kalbarri and just east of Augusta. More than 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 Redthroat Emperor *Lethrinus miniatus*, Bight Redfish *Centroberyx gerrardi* and Baldchin Groper *Choerodon rubescens*. A range of species is taken in deeper waters, including Eightbar Grouper *Hyporthodus octofasciatus*, Hapuku *Polyprion oxygeneois*, Blue-eye Trevalla *Hyperoglyphe antarctica* and Ruby Snapper *Etelis carbunculus*.

Indicator species (dhufish, pink snapper and baldchin groper) are used to monitor and assess the health of the suite of species in the fishery. Age-based stock assessments of those three species were conducted for data collected between 2002 and 2006 and during 2007/08. Both assessments were independently reviewed and the reviews agreed with departmental findings that overfishing was occurring in the fishery (O'Neill, 2009).

Summary of historical research completed

Several studies of the growth, age composition, reproductive biology, mortality and/or diet of the indicator species and also of other demersal species, such as Breaksea Cod *Epinephelides armatus* and Western Foxfish *Bodianus frenchii*, have been conducted mostly by the Department and Murdoch University. Recently completed work includes – determining the stock status of the indicator species; geographic variations in biology; post-release mortality; spawning aggregations of targeted species; potential impacts of ongoing development in Cockburn Sound on snapper; and differences in fish communities and size composition of fish species inside and outside closed areas at Rottnest Island, the Jurien Bay Marine Park and the Abrolhos Islands.

Current Research Focus

- 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 will continue until 2011/12.
- A creel survey of the boat-based recreational fishery in the west coast bioregion will be conducted in 2009/10.
- The stock structures of dhufish, pink snapper and baldchin groper using genetic and otolith microchemistry techniques under 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.
- 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 will be conducted to produce estimates of spawning stock biomass.
- Tagging of adult P. auratus in Cockburn Sound, using acoustic transmitters to investigate the fidelity of individuals to Cockburn Sound.
- Biology of coral trout at the Abrolhos Islands and investigation of spawning aggregations.
- The diet of snapper (Murdoch University), as part of a study of food webs

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

The stock assessments of the indicator species from 2007/08 were the subject of a formal independent review completed in 2009 (O'Neill, 2009). The results supported the findings of the Department. The next stock assessment review is scheduled for 2012. The information obtained on the biology, post release mortality and spawning aggregations was reviewed though the relevant FRDC project submission process.

Recent 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.

Lenanton, R., StJohn, J., Keay, I., Wakefield, C., Jackson, G., Wise, B. and Gaughan, D. (Eds) (2009). Spatial scales of exploitation among populations of demersal scalefish: implications for management. Part 2: Stock structure and biology of two indicator species, West Australian dhufish (*Glaucosoma hebraicum*) and pink snapper (*Pagrus auratus*), in the West Coast Bioregion. Fisheries Research Report No 174. Department of Fisheries, Western Australia, Perth, 181 pp.

Lenanton, R., St John, J. (Project PI 2000-2007), Wise, B., Keay, I. and Gaughan, D. (2009) Maximising survival of released undersize west coast reef fish. Final report to Fisheries Research and Development Corporation on Project No. 2000/194. Fisheries Research Report No. 191. Department of Fisheries, Western Australia. 130p.

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, Perth, 32 pp.

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.

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

Wise, B. S., St John, J. & Lenanton, R. C (Editors) 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 on Project No. 2003/052. Fisheries Research Report No. 163, Department of Fisheries, Western Australia, 130p.

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

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.

Rome, B., Newman, S.J., Jackson, G, and Norriss, J (2007) Gascoyne Wetline Fish Identification Field Guide. Fisheries Occasional Publications No 42. Department of Fisheries, Western Australia, Perth, 31 pp.

Key to symbols in the matrix/summary tables:

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West Coast Demersal Scalefish Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
West Australian Dhufish (Adult)	Completed						Several studies completed.
Juvenile	Underway	■	■				Data on juvenile recruitment strength, important locations for spawning and recruitment, mechanisms for larval dispersal. NHT & WAMSI
Pink Snapper Biology	Completed						Several studies completed on west coast.
Diet	Underway	■	■	■			Study of diet (MU, FRDC)
Baldchin Groper Biology	Completed						Studies completed at Abrolhos Islands & mid-west. No data on juvenile recruitment strength.
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)
Bight redfish	Proposed	O					FRDC proposal for study of biology and stock structure (MU/DoFWA).
1.3 Stock Assessment							
Annual C & E Assessment	Ongoing	■	■	■	■	■	Commercial fishery, charter fishery
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	■	O	O	O	O	West coast bioregion
Recruitment strength	Underway	■					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 vulnerable 5, UWA/FWA.
Testing use of different methods for monitoring indicator species	Proposed	O					NRM (DoFWA)
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	Underway	■	■				WAMSI WC Bioregion ecosystem study
2.5 Oceanography	Underway	■					CSIRO (WAMSI) investigating oceanographic influences on dispersal of dhufish larvae.
2.6 Other impacts on fishery	Completed						Cockburn Sound port study just completed.

West Coast Demersal Scalefish Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
3. Management Analysis							
3.1 Socio-economic							
Social assessment	Possible	■					WAMSI
Economic Analysis	Ongoing	■	■				WAMSI
Evaluation of Rec fisher incentives		■					WAMSI
3.2 Resource Access (Shares)							
Determination of access shares	Underway	■	■	■	■	■	IFAAC
Monitoring of shares	Ongoing	■					
3.3 Compliance	Nil						
3.4 Management Systems							
	Underway	■					WAMSI - Applying EBFM
	Underway	■	■				Exploration of the effectiveness of alternative management responses to variable recruitment (MU)
	Underway	■	■				Development of an agent-based model to communicate implications of recruitment variability of finfish to recreational fishers (MU)
4. Industry Development							
4.1 Production Technology	Nil						
4.2 Post Harvest	Nil						
4.3 Marketing	Nil						
5. Reviews							
5.1 Priority Review	Ongoing	■	■	■	■	■	Annual departmental industry meetings
5.2 Science Review	Just Completed				■		Next review due in 2013

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

Gascoyne 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.

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.

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

Gascoyne Biodiversity Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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							
	Underway	■	■				WAMSI 4.4.1 - Captured species assessments & monitoring
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): e.g,
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	Developing						WAMSI 4.1. Applying EBFM framework.
	Developing						DEH/NOO south west regional plan

Gascoyne – Shark Bay Prawn Fishery

Description and Scope of Fishery

The SBP fishery has the highest prawn production Western Australia and is located in the waters in and near Shark Bay. The fishery targets western king prawns, brown tiger prawns and a variety of smaller prawn species including coral prawns and endeavour prawns. 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.

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 2003) 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 new FRDC-funded project focusing on minimising gear conflict and resource sharing issues in the Shark Bay trawl fisheries commenced in 2008. This will include hydrographic modeling of scallop 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 throught the EPBCAssessment processs 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.

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 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.

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

Shark Bay Prawn Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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
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.

Shark Bay Prawn Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
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
2.3 Habitat							
Habitat/effort impacts	Ongoing	■	■	■	■	■	EPBC requirement
Coral/sponge habitat mapping	Required	O					DEC
Closure of sensitive habitats	Possible	O					Consultation required
2.4 Ecosystem/Environment							
Biodiversity of trawled and untrawled areas	Completed		■				Review every 5-10 years
Formal risk assessment	Periodic	■					EPBC requirement
2.5 Oceanography							
Leeuwin Current monitoring	Ongoing	■	■	■	■	■	
Temperature loggers	Ongoing	■	■	■	■	■	
2.6 Other impacts on fishery							
Spatial closures	Possible	O	O				Component of FRDC project
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						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.
World Heritage Areas							
3.3 Compliance							
4. Industry Development							
4.1 Production Technology							
Onboard handling							
OHS	Possible	O					Changes to fishing hours
Product quality certification							
Hoppers	Completed						Industry Lead initiative – all boats now using them
4.2 Post Harvest							
4.3 Marketing							
5. Priority Setting	Periodic		■		■		Industry Departmental Meetings
6. Science Review	Periodic		■			■	Also part of EPBC asessment

Gascoyne – Shark Bay Scallop Fishery

Description and Scope of Fishery

The Shark Bay Scallop fishery (SBS) operates within the waters of Shark Bay off the mid west coast of Western Australia and is usually WA's most significant scallop fishery. This is an otter trawl fishery for southern saucer scallops.

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 of Fisheries since the late 1960s. This research was aimed at determining basic biology of the species to ensure that the scallops are being harvested at ecologically sustainable levels whilst achieving the best economic returns from the available scallop resource.

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). As a result, annual management arrangements can be 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).

The fleet has provided a detailed record of all the scallops taken since the 1980s in research logbooks completed by all vessels. This collection of fisheries dependent data (voluntary logbooks, catch and effort statistics system (CAESS) and processor unload records) for stock assessment and monitoring of the scallops will continue.

Fleet interaction issues have been, and continue to need to be, addressed including snapper bycatch issues (Moran & Kangas 2003) and scallop-prawn interactions. For example, the earlier opening of the scallop fishery since 2004 has proven successful in improving size and market price of the scallop meat and reducing some prawn and scallop fleet conflicts and will be continued on a trial basis for a few years. Other '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.

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).

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

Research for monitoring the status of the scallop stock is based on detailed logbook records and

factory receivals provided by industry. In addition, an annual research survey is carried out in November, which, together with existing detailed biological knowledge, enables an annual catch forecast to be provided. These survey data are also used as the basis for the management arrangements in the following year.

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 ceased at an agreed catch rate level to ensure sufficient spawning stock in left during the key spawning period. Additional sampling for meat quality is scheduled for 2010 to improve the timing of fishing to optimise the value of scallops caught.

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 in Shark Bay and usefulness of area closures in scallop/prawn management commenced in March 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. In 2006 a review of the Shark Bay prawn and scallop fisheries was undertaken which involved workshops with licensees and other stakeholders. At these workshop, current research and research gaps were discussed and prioritised. In subsequent years, research issues were discussed with Shark Bay scallop fishery licensees during their association meetings. Additional research needs have also been highlighted throught the ESD Assessment processs for which a re-assessement has been completed in 2007.

Review Timeline

Apart from the EPBC assessments there has not been any recent, ormal review of the research completed for this fishery. Early research and publications on the biology and reproductive cycle of scallops have been peer reviewed.

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 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	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Scallop Biology	Completed						Competed in the 1970s and 1980
		■	■	■			Additional information on spatial and temporal differences in meat size and quality will be collected on an opportunistic basis
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
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

Shark Bay Scallop Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
2.3 Habitat							
Habitat/effort impacts	Ongoing	■	■	■	■	■	EPBC requirement
Closure of sensitive habitats	Possible	O					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 Masters project
2.6 Other impacts on fishery							
Spatial closures	Possible	O	O				Component of FRDC project
3. Management Analysis							
3.1 Socio-economic							
Social assessment	Possible	O					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
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
4.2 Post Harvest							
4.3 Marketing							
5. Priority Setting	Periodic		■		■		Regular Industry Departmental meetings
6. Science Review	Periodic		■			■	

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.

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 2004) 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 throught the ESD Assessment processs for which a re-assessement has been completed in 2008.

The most recent Industry – Departmental meeting on research was held in 2007, next review due 2011.

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 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	2009/10	2010/11	2011/12	2012/13	2013/14	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	■	■	■	■	■	
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.

Exmouth Gulf Prawn Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
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	Possible						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	O	O				FRDC report due end 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							
5. Priority Setting			■				
6. Science Review		■			■		

Gascoyne – Gascoyne Demersal Scalefish Fishery (Shark Bay Snapper 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 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. Management arrangements for the wetline fishery that will incorporate the SBSF are now being finalised and will start to be implemented in late 2010. In addition, Integrated Fisheries Management (IFM) is scheduled for implementation in the Gascoyne in 2010-2011.

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. An integrated stock assessment model was developed for the first time in 2002 as part of an FRDC-funded project (completed 2003). 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 bioregion was undertaken in 1998/99.

Current Research Focus

The current focus is monitoring the recovery of the pink snapper (oceanic) spawning stock and determination of the status of the other two demersal indicator species within this fishery (goldband and spangled emperor).

Commercial catch and effort information for this fishery is now obtained from daily/trip logbook returns (introduced in the SBSF in February 2008).

Completing the analyses of the survey of recreational boat based catch and effort for the Gascoyne bioregion undertaken in 2007/08.

Information on catches taken by charter vessels is obtained from monthly catch and effort returns.

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 at regular intervals (updated in early 2009). A WAMSI project is currently investigating the relationships between pink snapper populations from Shark Bay to the South Australian border.

Goldband snapper and Spangled emperor: Comprehensive research on these species commenced in 2007. A 'weight of evidence' based assessment has recently been completed and is pending review.

Priority Setting Process

Priorities are reviewed annually by researchers and managers, typically prior to the Shark Bay Snapper Managed Fishery AGM, the most recent of which was held in August 2009 in Carnarvon.

Priorities are set based on the current level of understanding of the key species, stock status and fishery, and potential future pressures and issues identified, using a simple risk assessment approach and expert opinion. The creation of a Gascoyne Demersal Scalefish Fishery and outcomes of Gascoyne IFM process (2010-2011) may see this review process change.

Science Review Timeline

'Weight of evidence' based assessments for spangled emperor and goldband snapper are to be externally reviewed in early 2010. The oceanic pink snapper assessment was externally reviewed in July 2006. Assessments for oceanic pink snapper and goldband snapper will be updated in 2011.

Recent Publications

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, Perth, 32 pp.

Rome, B., Newman, S.J., Jackson, G, and Norriss, J (2007) Gascoyne Wetline Fish Identification Field Guide. Fisheries Occasional Publications No 42. Department of Fisheries, Western Australia, Perth, 31 pp.

Research Issues

Concern in relation to some vulnerable deeper-water species (ruby snapper, grey-banded cod) and the effect of any expansion of fishing operations by Commonwealth Western Deep Water Trawl licensed vessels. There is a need to obtain information on the status of red emperor in the Gascoyne.

Key to symbols in the summary matrix:

■ Activity is funded and planned.

O Activity is proposed but not yet funded

Gascoyne Demersal Scalefish Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
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	O				Project Identified
1.2 Other Biology							
Pink snapper juvenile recruitment	Ongoing	■	O	O	O	O	Shark Bay trawl surveys
Stock structure – pink snapper (oceanic)	Underway	■	■	■			WAMSI 4.4.2-1, genetics (Murdoch PhD), otolith chemistry

Gascoyne Demersal Scalefish Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
Stock structure – spangled emperor	Underway	■					Collaboration with CSIRO/AIMS
1.3 Stock Assessment							
Age-structured modelling for pink snapper	Ongoing	■	O	O	O		Need to monitor stock recovery to 40% target level
Age-based assessments for goldband	Ongoing	■	O	O			Need to re-run assessment In 2011.
Age-based assessments for spangled emperor	Ongoing	■	O	O			
Age-based assessments for red emperor	Proposed	O	O				Project Identified
1.4 Fishery Monitoring							
Pink snapper, age structure of catch	Ongoing	■	O	O	O		Need to monitor stock recovery to 40% target level
Goldband, age structure of catch	Ongoing	■	O	O			Need to re-run assessment In 2011.
Spangled emperor, age structure of catch	Ongoing	■	O	O			IFM species, needs additional resources
Red emperor, age structure of catch	Proposed	O	O				Project Identified
CAES catch and effort data	Ongoing	■	O	O	O	O	Daily logbooks since Feb 2008
Charter boat catch and effort	Ongoing	■	O	O	O	O	
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
Recruitment and environment			O	O			Recruitment to oceanic snapper, potential project with UWA
3. Management Analysis							
3.1 Socio-economic							
3.2 Resource Access (Shares)			O	O			IFM process scheduled for 2011
3.3 Compliance							
3.4 Management Systems							
4. Industry Development	Not needed						Low Priority
5. Priority Setting			O				
6. Science Review			O				

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 [SBBSMNF] and Inner Shark Bay Recreational Fishery). The SBBSMNF 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 black snapper (grass or blue-lined emperor), pink snapper, whiting, tailor, western butterfish, school mackerel and blackspot tuskfish. A limited number of licensed charter vessels operate out of Denham and Monkey Mia.

Summary of historical research completed

Considerable research has been conducted on the main 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 TACs.

The first major survey of recreational fishing across the Gascoyne bioregion, including the inner gulfs, was undertaken in 1998/99 this was repeated in 2008. Recreational fishing surveys just for the gulfs were carried out at the main boat ramps each year from 2000-2008.

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 SBBSMNF.

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.

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.

Analysis of the results from the recent bioregional creel survey is underway. A recreational fishing boat-ramp survey in Inner Shark Bay is scheduled to be undertaken in 2010.

Priority Setting Process

Research and Development priorities are reviewed every 3 years by the Inner Shark Bay Pink Snapper Working Group, most recently in July 2008. At this meeting, the Department committed to updating inner Shark Bay pink snapper stock assessments before the next review.

The creation of a Gascoyne Demersal Scalefish Fishery and Gascoyne Inshore Net Fishery, and the outcomes of the Gascoyne IFM process, may require these research priorities to be re-assessed.

Science Review Timeline

Stock status and management arrangements for pink snapper in the inner gulfs were reviewed by the Inner Shark Bay Pink Snapper Working Group in July 2008. The next assessment and review is scheduled for mid 2011.

Recent Publications

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, Perth, 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

Jackson G. (2007) Fisheries biology and management of pink snapper, Pagrus auratus, in the inner gulfs of Shark Bay, Western Australia. PhD Thesis, Centre for Fish and Fisheries Research, Murdoch University, Western Australia, 254 pp.

Jackson, G., Burton C., Moran M.J., Radford B. (2007) Distribution and abundance of juvenile pink snapper, Pagrus auratus, in the gulfs of Shark Bay, Western Australia, from trap surveys. Fisheries Research Report No 161. Department of Fisheries, Western Australia, Perth, 36 pp.

Norriss J.V. and Jackson G. (2007) A substantial recruitment year for the western yellowfin bream (*Acanthopagrus latus*, Sparidae) sustains years of high catch rates in the inner gulfs of Shark Bay, Western Australia. *Journal of the Royal Society of Western Australia* 90: 157-159

Wakefield C.B., Moran M.J., Tapp N.E., and Jackson G. (2007) Catchability and selectivity of juvenile snapper (Pagrus auratus, Sparidae) and western butterfish (Pentapodus vitta, Nemipteridae) from prawn trawling in a large marine embayment in Western Australia. Fisheries Research 85: 37-48

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.

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

Inner Shark Bay Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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	■	■	■	■		
Model-based assessment for Pink Snapper	Planned		O	O			Next review due mid 2011
1.4 Fishery Monitoring							
CAES data	Ongoing	■	■	■	■		
Recreational fishing survey	Proposed	O	O				Need for estimate of catch in 2010, Scheduled to include cameras at boat ramps
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				O			
6. Science Review				O			

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 embayments of Shark Bay and Exmouth Gulf. The Shark Bay Crab (Interim) Managed Fishery has developed since 1998 into the largest crab fishery in WA, with an annual catch of about 650 t. The Exmouth Gulf Developing Crab Fishery was established in 2001 via the Developing New Fisheries process. Operators in the Shark Bay Crab (Interim) Managed, Exmouth Gulf Developing Crab and Pilbara Developing Crab Fisheries are only permitted to use 'hourglass' traps. A significant number of crabs are caught and retained by the various Prawn Trawl fisheries that operate in these regions

Summary of historical research completed

Data for the ongoing assessment of blue swimmer crab stocks in the Gascoyne Bioregion and along the North Coast has been obtained from fishers' compulsory catch and effort returns, voluntary daily log books and on-board catch monitoring conducted by Fisheries Research staff. A significant amount of 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.

Current Research Focus

The review of the Shark Bay Crab Interim Management Plan, which ceases on 31 August 2010, 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 and RFAC) as required.

Review Timeline

An update of this stock assessment for the Shark Bay Crab (Interim) Managed Fishery is due in 2009/10. Both the Exmouth Gulf and Pilbara Developing Crab Fisheries were formally reviewed in mid-2007 by the Developing Fisheries Assessment Committee (DFAC) as part of the 'Developing New Fisheries' process.

Recent Publications

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.

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

Gascoyne Blue Swimmer Crab Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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						Assessed as part of National rec. fishing program.
Stock & recruitment	Ongoing	■	■	■	■	■	
2. Habitat & Ecosystem							
2.1 Bycatch	Underway	■	■				Qualitative only
2.2 Listed Species							Low Risk
2.3 Habitat							Low 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

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 ags development initiatives. It is also the subject of another Commonwealth Regional Marine Planning exercise.

Summary of historical research completed

A summary of the research information available for this region was complied as part of a WAMSI project – this was 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.

Priority Setting Process

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

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

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) using otter trawl. 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 otter trawls.

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 Delury 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.

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

Northern Prawn Trawl Fisheries Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	20123/14	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		O	O			Low Risk, mainly for BPMF
Banana prawn biology	Minimal						Mainly for KPMF and NBPMF, occasionally caught in higher numbers in OBPMF, opportunistic sampling in NPBMF
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
Delury 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		O	O			Further evaluation/trialling may take place
Bycatch monitoring	Periodic/ Possible	O		■			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 may wish to revisit
2.4 Ecosystem/Environment							
Formal risk assessment	Periodic		■				EPBC requirement

Northern Prawn Trawl Fisheries Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	20123/14	Comments
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 Permanent Closures	Underway						Implemented in ONPMF and 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		■					

North Coast – Nearshore and Estuarine Fishery

Description and Scope of Issues

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) extends from the WA/NT border (129ºE) to the top of Eighty Mile Beach, south of Broome (19ºS). 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 19ºS. 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).

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

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

Key to symbols in the matrix/summary tables:

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

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

North Coast Nearshore and Estuarine Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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	O	O	O	O	O	Project identified – High risk
1.2 Other Biology							
Sawfish	Proposed	O	O	O	O	O	Project identified – High risk
Pig eye shark	Proposed	O	O	O	O	O	Project identified – High risk
Lemon shark	Proposed	O	O	O	O	O	Project identified – High risk
1.3 Stock Assessment							
Annual Catch and Effort Assessment	Ongoing	■	■	■	■	■	Ongoing
Age Structured Models (indicator species)	Proposed	O	O	O	O	O	Project identified to develop a national model
1.4 Fishery Monitoring							
Commercial Catch and Effort	Ongoing	■	■	■	■	■	Ongoing
Age Structure of Indicator Species	Proposed		O		O		Periodic
Commercial monitoring (vessel monitoring at sea)	Proposed	O		O		O	Periodic
Recreational Creel	Proposed		O				Periodic
Charter Boat Catch and Effort	Ongoing	■	■	■	■	■	Ongoing
2. Habitat & Ecosystem							
2.1 Bycatch	Proposed		O				Periodic – Low risk – initial project completed
2.2 Listed Species							
Sawfish	Proposed	O	O	O	O	O	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		O	O			Needed for IFM
3.3 Compliance							
Validation of Catch Records	Proposed		O		O		A requirement for any ESD reporting
3.4 Management Systems							
Management of recreational sector	Proposed		O				May be needed for IFM
4. Industry Development							
5. Priority Setting							
5.1 Priority Review		■	■	■	■	■	Annual industry meetings
5.2 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*), frypan 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.

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 a Murdoch University commenced to look into gear modifications.

An industry funded observer program commenced in 2004 in the trawl fishery to improve estimates of the quantity of bycatch, especially protected species. This observer programme will be reviewed.

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: The monitoring of the Pilbara fishery consists of the collection of spatial data on effort and catch of 10 major target species in the fish trawl and fish trap fisheries from logbooks, VMS data, and weighed catches from unload data. Otoliths are collected each year as part of the observer program for one of the indicator species; red emperor (*Lutjanus sebae*), Rankin cod (*Epinephelus multinotatus*), bluespotted emperor (*Lethrinus punctulatus*), and goldband snapper (*Pristipomoides multidens*).

The status of the Pilbara stocks is determined annually using catch and catch rates of the 10 major species, and every three to four years using an age-structured model and the age-composition data collected in previous years.

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.

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:

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North Coast Demersal Fisheries Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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	O	O	O	O	O	Project identified – current gap – High risk
Rankin cod	Completed						Sufficient for management
Bluespotted emperor	Completed						Sufficient for management
Brownstripe snapper	Completed						Sufficient for management
Rosy threadfin bream	Completed						Sufficient for management
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	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 creel	Proposed			O			Periodic
Charter Boat Catch and Effort	Ongoing	■	■	■	■	■	Ongoing
Catching efficiency of gears (Kimberley)	Underway	O	O				FRDC Project
2. Habitat & Ecosystem							
2.1 Bycatch							
Monitoring and review (Pilbara)	Proposed	O	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	■					Observer programme with 22% coverage to be reviewed

North Coast Demersal Fisheries Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
P: Protected species mitigation - acoustic pingers	Completed						Acoustic pingers were ineffective
P: Selection grids	Underway	■	■	■	■	■	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	O	Project identified
2.6 Other impacts on fishery							
K: Effects of Indonesian impacts	Proposed	O	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	O	Project identified
4.3 Marketing							
5. Review							
5.1 Priority Review		■	■	■	■	■	Annual industry meetings
5.2 Science Review (Pilbara)				■			Major assessment reports peer reviewed every three years
5.2 Science Review (Kimberley)		■			■		An Independent review of the stock assessment for the NDSF was undertaken

North Coast – Mackerel Fishery

Description and Scope of Issues

The commercial mackerel fishery includes the taking of all species of the genera *Scomberomorus*, *Grammatorcynus* 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.

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.

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 on an annual basis through consultation between Scientists of the Finfish Branch (Research Division), Fishery Managers and at the Annual Mackerel Management meeting (February each year). This fishery is currently considered as low risk and therefore low priority for research activities.

Review Timeline

The science underpinning this fishery was extensively reviewed in 2005. This fishery was last reviewed in 2008 and as it is considered low risk it will be reviewed within the next five years.

Key to symbols in the summary matrix:

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

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

North Coast Mackerel Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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 but 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 research project
1.3 Stock Assessment							
Annual Assessment	Completed						No planned update
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							
Effects of IMP	Proposed		O				Assessment of Plan Proposed
3.2 Resource Access (Shares)							
Determination of access shares	Proposed		O				As part of Gascoyne IFM
Monitoring of shares	Proposed		O				As part of Gascoyne IFM
Review of IMP	Underway	■					Current Plan ends 2009 and need review of data requirements and assessment of Plan; may be postponed
3.3 Compliance							
Monitoring of vessel activities	Ongoing	■	■	■	■	■	Using VMS
3.4 Management Systems	**Nil**						
4. Industry Development							Nothing Identified

North Coast – Northern 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, the primary fishing method was demersal longlining in the WANCSF with only a small and intermittent amount of pelagic gillnetting in the JANSF. The proposed management revisions were 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 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; untested 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.

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 industry, NHT and FRDC funded research projects that began in 1999. Results from these 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 contingent 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 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. 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. Therefore new data validation procedures are underway.

Priority Setting Process

Research priorities are identified follwoing the annual stock assessment review. Research priorities are also identified by the Northern Science and Management Working Group, NAFM, fishery managers, the MAC. Plus through external processes, eg. National Shark Recovery Group, EPBC approvals etc. A large number of issues identified through these processes for which no funds are available to undertake the proposed work.

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). Another review of shark management and conservation actions throughout Western Australian 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.

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

North Coast Shark Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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						
1.2 Other Biology							
Other spp. reproduction	Partially complete	O					However, data collected in the 1980s from Taiwanese-operated fishery
Other spp. age and growth	Ongoing	O					
1.3 Stock Assessment							
Sandbar	Complete	O	O	O			HIGH RISK: Biologically vulnerable stock, excessive catches since new management proposed. Fishing mortality rates last assessed in 2003/04: require updating.
Dusky	Complete	O	O	O			HIGH RISK: Biologically highly vulnerable stock, unquantified fishing mortality. Fishing mortality rates last assessed In 1995/96: require updating.
Blacktip age structured	Unreliable	O					HIGH RISK: existing assessment model outputs unreliable; unquantified fishing mortality
Multi-species (Productivity Susceptibility) risk assessment	Complete						
1.4 Fishery Monitoring							
CAES analyses	Complete						Superseded by mandatory logbooks
Daily logbook development & analysis	Underway	■					HIGH RISK: integrity of daily logbook catch return data has compromised stock assessments and research advice on fishery management. Process is underway to recover/correct problematic data, but the focus is on the temperate fisheries.
At sea observers	Proposed	O					Essential for validating spp. composition; target, byproduct, mackerel and protected spp. catch rates; spp. ID training, etc.
Landing inspections	Proposed	O					Essential for validating spp. composition; target, byproduct and mackerel spp.etc.
VMS	Partially complete	O					Implemented for WANCSF no legal basis for implementation in JANSF
DNA fingerprinting	Complete for some spp.	O					FMO training required
2. Habitat & Ecosystem							
2.1 Bycatch							
Elasmobranchs	Proposed	O					HIGH RISK: Recently described for WANCSF demersal longline catches, uncertain for pelagic gillnet catches.

North Coast Shark Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
Teleosts	Proposed	O					HIGH RISK: Recently described for WANCSF demersal longline catches, uncertain for pelagic gillnet catches. Significant concern about pelagic gillnets' mackerel catch rates.
2.2 Listed Species							
Whales	Proposed	O					HIGH RISK: Significant stakeholder concerns about potential increase in pelagic gillnet effort
Dolphins	Proposed	O					HIGH RISK: Stated reason for Commonwealth Govt. restricting pelagic gillnets in the 1970s-1980s.
Other: Sawfish, Grey Nurse Shark, Turtles	Proposed	O					
2.3 Habitat							No issues
2.4 Ecosystem/Environment							
Trophic effects	Proposed	O					
Ghost fishing	Proposed	O					
2.5 Oceanography							
2.6 Other impacts on fishery							
Illegal, Unreported and Unregulated (IUU) fishing	Proposed	O					Estimates of FFV impacts are not available.
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					
3.3 Compliance							
3.4 Management Systems							
Catch and effort triggers	Ongoing						HIGH RISK: preliminary estimates of sandbar shark catches in 2007/08 and 2008/09 suggest catches have been an order of magnitude higher than anticipated under proposed new management arrangements
National Plan of Action (NPOA) for the conservation and management of sharks	Ongoing	O	O	O	O	O	
Protected species recovery plans	Ongoing	O	O	O	O	O	
EPBC Act export approval	Ongoing	O					Serious ecological sustainability concerns and no data on which to base re-applications
4. Industry Development							
4.1 Production Technology							
4.2 Post Harvest & Marketing							
Full utilisation (finning)	Proposed	O					NPOA objective

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 and pearl production techniques

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 pearling industry operates in a manner acceptable to public standards for access to the marine environment;
- Demonstrate that the pearling 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

Pearling Industry Advisory Committee and sub-committees

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 September 2008.

Recent Publications

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.

Bearham, D. Spiers, Z. Raidal, S. Jones, J.B., Nicholls, P.K. 2007. Molecular characterisation of a Haplosporidian parasite infecting rock oysters *Saccostrea cucullata* in north Western Australia. Journal of Invertebrate Pathology 95, 33-40.

Bearham, D., Spiers, Z., Raidal, S., Jones, J.B., Nicholls, P.K. 2007. Detection of *Minchinia* sp., in rock oysters *Saccostrea cucullata* (Born, 1778) using DNA probes. Journal of Invertebrate Pathology 97, 50-60.

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.

Hart AM**,** Friedman KJ (Editors) 2004, *Mother-of-Pearl Shell* (Pinctada maxima): *Stock Evaluation for Management and Future Harvesting in Western Australia*, FRDC Project 1998/153, Fisheries Research Contract Report No. 10, Department of Fisheries, Western Australia, 84p

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Pearl Oyster Fishery and Pearl Production Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							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
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	Underway						On going CSIRO modelling research at a bioregional scale
Kimberley inshore bio-oceanography	Completed New proposal		O				Larval drift studies for *Pinctada maxima* spawning and settlement areas.
2.6 Other impacts on fishery							
3. Management Analysis							
3.1 Socio-economic							
Occupational Health & Safety							WAFIC/PPA issue

Pearl Oyster Fishery and Pearl Production Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
Diver safety/farm profiles	Completed						Studies on pearl diving and decompression protocols
3.2 Resource Access (Shares)	No 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	■	■	■			
Seeding techniques (private)							
Hatchery development project (FRDC)							Major FRDC projects by the Dept. of Fisheries on spawing and hatchery culture
Growth rates/nursery spat (FRDC)							Major FRDC projects by the Dept. of Fisheries on nursery culture
MOP nuclei production (FRDC)							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	O			
Promotion/Branding Mkt Resch			■	■			
4.4 Fish Health							
Fish health and diagnostics	Ongoing	■	■	■	■		general fish health and diagnostic services for the pearling 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 *P. maxima*
5. Review							
5.1 Priority Review		■	■	■	■	■	Annual industry meetings
5.2 Science Review				■			Major assessment reports peer reviewed every three years

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 echinites*).

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.

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

North Coast Beche-de-mer Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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 *H. scabra* 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 Identifed
5. Review -							Will coincide with EPBC – WTO assessment

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.

Summary of historical research completed

The Marine Futures project habitat mapping and biodiversity sampling was undertaken over the previous few years. 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.

Recent Publications

McClatchie, S. & Gaughan, D. (2006). Zooplankton. *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).

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

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.

Whilst this form of fishing has been operating since the late 1960s, for many years, only rock lobsters were targeted. It was not until the early 1990s when landings of crabs (champagne, giant and crystal crabs) began to appear in the commercial catch landing statistics for all four zones.

Compulsory catch and effort data, which are collected for the south coast crustacean fishery, have been used to model the southern rock lobster fishery (Melville-Smith and Wright (2001) in the Esperance Rock Lobster Managed Fishery. The WA southern rock lobster fishery occurs on the western edge of the distribution range and a large amount of published biological research is available on the species in South Australia, Victoria, Tasmania and New Zealand, where it is more common and supports large fisheries. The Windy Harbour/Augusta fishery is situated south of the main western rock lobster fishery, which has been extensively researched.

The FRDC has funded research on aspects of the giant crystal and champagne crab fisheries on the south coast.

Summary of historical research completed

As noted above, a large amount of data on the biology of southern rock lobsters exists for it's distribution in South Australia, Victoria, Tasmania and New Zealand but very 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 champagne crabs on the south coast (Smith *et al.* 2004). An important conclusion relating to the management of this species in south Western Australia is that all indications suggested that conditions on the south coast are not conducive for ovarian development and reproduction and that 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).

The report by Chuwen and Stevens (2006) did show that commercial quantities of crystal crabs

were present in depths of 400 to 900m on the south coast with highest landings in 700-800m in the Albany zone. Catch rates in the Esperance zone to the east were low. 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., Griffen, 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.

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: 369pp.

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: 151pp.

Key to symbols in the matrix/summary tables:

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

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

South Coast Crustacean Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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							

South 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. The fishery targets three species: greenlip abalone, brownlip abalone and Roe's abalone, which are harvested by a single diver working off 'hookah' (surface supplied breathing apparatus) using a diving 'iron' to prise abalone off rocks.

There is an extensive amount of relevant and accurate information on the biology and stock status of these three abalone species. The sophisticated suite of management arrangements, including a number of predictive systems, have resulted in the maintenance of abalone stocks and a profitable fishery.

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, and length-frequency sampling. Commercial abalone divers are required to provide daily catch information on the weight and number of abalone collected, the hours fished, the date and location of harvest and the name of the person(s) harvesting. The divers also supply a random selection of abalone shells from each fishing day, and these are measured and used to estimate fishing mortality.

An annual standardized catch per unit effort (CPUE) model was developed that took into account diver, sub-area and month of fishing as well as technological improvements that aid fishing efficiency. New initiatives include digital video imagery assessment by industry divers, who survey selected sites with an underwater video camera, and fishery-independent survey data collected from 140 sites across the 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 2008, with surveys being undertaken on experimental release sites. Results from this experiment will be used to obtain a robust estimate of the growth and survival of stocked abalone that will inform debate on the effectiveness 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 last reviewed in December 2008.

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:

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

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

South Coast Abalone Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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	O					
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	■	■	■	■	■	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
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	■	■	■	■	■	

South Coast Abalone Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
4. Industry Development							
4.1 Production Technology	Completed						Hatchery and grow out work in 1990s
5. Review							
5.1 Priority Review		■	■	■	■	■	Annual industry meetings
5.2 Science Review				■			Major assessment reports peer reviewed every three years

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.

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 throught the ESD Assessment processs.

Review Timeline

Next review due 2012.

Key to symbols in the summary matrix:

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

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

South Coast Trawl Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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	O					Requires consultation with industry
2.4 Ecosystem/Environment							
2.5 Oceanography							
Leeuwin Current monitoring	Ongoing	■	■	■	■	■	
3. Management Analysis							
4. Industry Development							
5. Priority Setting				■			

South Coast – Estuarine and Inshore Fisheries

Description and Scope of Fishery

Estuaries: The fish 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 and black bream 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. Apart from cobbler, the main commercial targets are sea mullet (Mugil cephalus), black bream, Australian herring (Arripis georgianus), King George whiting (Sillaginoides punctata) and leatherjackets (Monacanthidae). 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) plus silver trevally (Pseudocaranx sp.) and southern blue-spotted flathead (Platycephalus speculator).

Inshore waters: The Australian Herring Fishery and the South Coast Salmon Managed Fishery are the two main commercial fisheries operating in inshore waters on the south coast. These commercial fishers mainly operate on beaches in the western portion of the south coast. 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 inshore waters on the South Coast also target Australian herring and salmon. Other popular species include trevally, King George whiting, southern school whiting (Sillago bassensis), salmon and tarwhine (Rhabdosargus sarba).

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

Inshore: 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, which is now used to predict herring catches.

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

Current Research Focus

Estuarine indicators: Black bream (various estuaries) and cobbler (Wilson Inlet only).

Fishery data is very limited for most south coast estuaries, making annual monitoring and assessments difficult. Annual fishery-independent monitoring of cobbler recruitment in Wilson Inlet commenced in 2007. Sampling of the age structure of the Wilson Inlet cobbler catch will commence in 2009-10. Murdoch University also regularly undertakes ecological projects relating to fish in South Coast estuaries.

Inshore indicators: Australian salmon and Australian herring.

The status of herring and salmon stocks and the status of the fish stocks in South Coast estuaries are currently assessed using CAES data, recreational logbook data and fishery-independent surveys of annual recruitment for some species. A State NRM-funded project focusing on herring commenced in 2009. The project will representatively sample the age structure of catches by all sectors (including the west coast) to provide input for a previously developed age-structured spatial model. It will also examine nursery signatures in otoliths to determine sources of recruitment to West Coast and South Coast regions.

Priority Setting Process

Internal Risk Assessment (presented at the Department's Research Review meeting in February 2009). Thus salmon is currently a low priority (i.e. no concerns regarding stock sustainability) and no additional research is planned in the next 5 years.

Meetings between the Department of Fisheries, industry and peak body members (e.g. the Western Australian Fishing Industry Council, Recfishwest).

Review Timeline

An internal Risk Assessment of inshore and estuarine fish stocks 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.

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

South Coast Estuarine and Inshore Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
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
1.2 Other Biology							
Australian herring	Underway	■	O	O	O		Develop age-based monitoring. Examine recruitment dynamics & stock structure. Identify nursery signatures in otoliths NRM-funded 1-year project. FRDC funding application with Murdoch Uni. pending.
Black bream	Underway	■					Factors relating to growth & recruitment variability (Murdoch Uni. project)
1.3 Stock Assessment							
Annual trends in catch and CPUE	Ongoing	■	■	■	■		CAES data. No recreational data yet.
Annual trends In juvenile recruitment	Ongoing	■	■	■	■		Annual trapping & beach seining programs
Age-based model (herring)	Developing	■	O	O	O		Otoliths being collected (west & south coasts). Develop ongoing monitoring. Update existing model. NRM-funded 1-year project. FRDC funding application with Murdoch Uni. pending.
1.4 Fishery Monitoring							
CAES	Ongoing	■	■	■	■		Data from commercial estuarine fisheries only.
Creel survey	Periodic						Need boat & shore-based data. None proposed in next 5 y.
Voluntary recreational logbook	Ongoing	■	O	O	O		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.
Cobbler (Wilson Inlet)	Ongoing	■	■	■	■		Develop formal recruitment index from fishery-independent trapping CPUE. Develop age-based fishery monitoring.
Age structure monitoring	Underway	■	O	O	O		Herring (W & S coasts) & cobbler (Wilson Inlet).
Commercial daily logbook (estuary)	Proposed	O	O	O	O		Draft trialled in 2006/07, not implemented yet.
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 loss possible cause of cobbler

South Coast Estuarine and Inshore Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
							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.
Fish Kills	Ongoing	■	■	■	■	■	Respond to reports and investigate cause of fish kills
2.5 Oceanography							
Leeuwin current monitoring	Ongoing						Qualitative use of data
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. Reviews							
5.1 Priority Review		■	■				
5.2 Science Review			■			■	

South Coast – Purse Seine Fishery

Description and Scope of Issues

The South Coast Purse Seine Managed Fishery consists of three primary management zones – Albany, Bremer Bay and Esperance based on the capture of pilchards (*Sardinops sagax*) by purse seine nets. The management plan also covers the take of yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus teres*). During the late 80s and early 90s this was the largest tonnage fishery in WA until a pilchard virus hit in 1995 and 1998 which decimated stocks. The fishery has not yet fully recovered.

Summary of historical research completed

An extensive set of studies was completed into the biology and stock assessment of pilchards for this fishery in the 80s-90s. This included growth, ageing, plankton studies, stock assessment by age structured modeling and the 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 the biomass surveys and the 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 so will be reviewed within the next five 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. Pattiaratchi & G. Kendrick (eds), *The South-west Marine Region: Ecosystems and Key Species Groups*. The National Oceans Office (DEH, Govt. of Australia).

Key to symbols in the summary matrix:

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

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

South Coast Purse Seine Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Pilchard Biology	Completed						Many studies - sufficient
1.2 Other Biology							
Egg and larvae distribution	Completed						Several studies - sufficient
Stock identification	Completed						Several studies - sufficient
1.3 Stock Assessment							
Annual Assessment	Halted						No longer a priority
DEPM Estimates	Completed						.
1.4 Fishery Monitoring							
Commercial Catch & Effort	Ongoing	■	■	■	■	■	
Age samples of pilchard catch	Halted						Phased out.
2. Habitat & Ecosystem							
2.1 Bycatch (Low Risk)							
2.2 Listed Species							Low risk
Some interactions with e.g. seabirds	Completed						Study by DOF, Seanet, Murdoch Uni.
2.3 Habitat (Low Risk)							Low risk
2.4 Ecosystem/Environment							
Impact on Seabirds	Completed						Critical prey studies completed by Murdoch Uni.
2.5 Oceanography							
Leeuwin Current monitoring	Ongoing	O	O	O	O	O	Low priority
Productivity cycles	Completed						Assessment completed by UWA, DoF MU (SRFME)
2.6 Other impacts on fishery	Completed						Studies of impacts of the pilchard virus now completed
3. Management Analysis							
4. Industry Development							
5. Review				O			

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. The WCDGDLF extends from 26° 00' S in the north to 33° 00' S latitude in the south, however the use of demersal gillnets, longlines with metal snoods and powered reels was prohibited north of 26° 30' S latitude (Steep Point) in 1993, effectively making this the fishery's northern boundary. The JASDGDLF is essentially divided into 2 zones. Zone 1 extends from 33° 00' S latitude off the west coast to 116° 30' E longitude off the south coast and Zone 2 extends from 116° 30' E to 129° 00' E longitude. Both fisheries are managed via limited entry, unitised input (effort) controls and gear-specification restrictions. The overwhelming majority of fishing (*ca*. 97% of standardised effort) is 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*) were also historically important target species of the fisheries. However, due to declines in their abundance caused by periods of overfishing by the JASDGDLF and the adjacent Commonwealth-managed South Eastern Scalefish and Shark Fishery, respectively, these species are no longer actively targeted.

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.

O 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	2009/10	2010/11	2011/12	2012/13	2013/14	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							
Target stocks' temporal spatial dynamics	Proposed		O	O	O		FRDC pre-proposal
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						
1.3 Stock Assessment							
Gummy	Ongoing	O	O	O	O	O	HIGH RISK: fisheries' principal target species; no assessment since 1996; subsequently increasing catch and CPUE. Updated stock

South Coast Temperate Demersal Gillnet and Longline Fisheries Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
							assessment will require development of new model and age structure.
Whiskery	Ongoing	■	O	O	O	O	HIGH RISK: not assessed since 2007 when biomass was increasing but below minimum reference limit (40% virgin biomass); previous overfishing has been a primary reason for management changes. Age structure and CPUE require updating
Dusky	Ongoing	O	O	O	O	O	HIGH RISK: biologically highly vulnerable stock; unquantified fishing mortality in WANCSF, SWTBF, recreational, foreign IUU, bycatch, etc. Declining CPUE indicates unsustainable cryptic mortality of breeding stock. Fishing mortality rates last estimated in 1995/96 and require re-estimation to assess sustainability of current catches.
Sandbar	Ongoing	O	O	O	O	O	HIGH RISK: biologically vulnerable stock; possible 60% depletion of breeding stock, uncertain catch in WCDGDLF since 2005/06; excessive catches in WANCSF since at least 2000; unquantified fishing mortality in SWTBF, recreational, foreign IUU, bycatch, etc. Fishing mortality last estimated in 2003/04 and require re-estimation to assess sustainability of current catches.
1.4 Fishery Monitoring							
CAES analyses	Complete						Superseded by daily logbooks
Daily logbook development & analysis	Ongoing	■	■	■	■	■	HIGH RISK: Process is underway to recover/correct problematic data, to the extent possible
At sea observers	Proposed	O	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							
2. Habitat & Ecosystem							
2.1 Bycatch							
Finfish & Elasmobranchs	Complete for 1994-2003	O	O	O			Observer program is a formal recommendation of fisheries' WTO approval
2.2 Listed Species							
Pinnipeds	Complete for 1994-2003	O	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	O			Observer program is a formal recommendation of fisheries' WTO approval
2.3 Habitat							Low Risk
2.4 Ecosystem/Environment							Proposed
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)	O					HIGH RISK: resumption of fishing in SWTBF has significant potential to further deplete dusky and sandbar shark breeding stocks

South Coast Temperate Demersal Gillnet and Longline Fisheries Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
Illegal, Unreported and Unregulated (IUU) fishing	Proposed	O	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	O					NPOA actions and WTO Recommendation
Indigenous fishing	Proposed	O					NPOA actions and WTO Recommendation
3. Management Analysis							
3.1 Socio-economic							
Mercury and other contamination	Proposed	O					
3.2 Resource Access (Shares)							
Recreational fishing	Proposed	O					
Indigenous fishing	Proposed	O					
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	O	
Protected species recovery plans	Ongoing	O	O	O	O	O	
EPBC Act export approval assessments	Ongoing	O	O	O	O		
4. Industry Development							
5. Reviews							
EPBC Act export approval assessments	Ongoing	O	O	O	O		

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).

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.

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 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.

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. 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.

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Southern Inland Biodiversity Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	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				Diet evaluation for native species
1.2 Other Biology							
Restocking artificial wetlands	Ongoing	O	■	■	■	■	Replacement of gambusia with native fish for mosquito control as an alternative to chemical spraying
Restocking natural wetlands	Ongoing	O	■	■	■	■	Restocking critically endangered native fish to prevent extinction
1.3 Stock Assessment							
Native fish distribution	Ongoing	■	■	■	■	■	Identifiying species of conservation concern
Native Fish Database	Ongoing	■	■	■	■	■	Development of GIS 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	2009/10	2010/11	2011/12	2012/13	2013/14	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)
2.5 Oceanography							
2.6 Other impacts on fishery							
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							
3.4 Management Systems							
Native Fish Strategy	Underway	■	■	■	■	■	Development 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
4.2 Post Harvest							
4.3 Marketing	None						

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 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 albidus*).

Summary of historical research completed

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

More recently research has focussed on improving habitat in artificial impoundments (water reservoirs). The installation of large scale-artificial habitats were trailed in Drakesbrook Dam in 2008. The trials in Waroona Dam showed that the artificial habitat (rock wall) 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

Molony, B.W., Jones, B., Lawrence, C.S., Gouteff, V.A. 2006. Case 3267: *Cherax tenuimanus* Smith, 1912 and *Cherax cainii* Austin in Austin & Ryan, 2002 (Crustacea, Decapoda, PARASTACIDAE) proposed conservation of usage of the specific names. *Bulletin of Zoological Nomenclature* **63(4)**: 231 – 234.

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Southern Inland Recreational Marron Fishery Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Growth	Ongoing	■	■	■	■	■	Limited data on growth in field, need for long-term tagging program; some data collected as part of FRDC 2003/027
Reproduction	Ongoing	■	■	■	■	■	Size-at-maturity and fecundity data collected as part of FRDC 2003/027; sampling more catchments; size-at-maturity highly variable.
Diet	Partly						Some publications available
Mortality	Ongoing						Data collected as part of FRDC 2003/027; need for long-term tagging program
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 introduction new sampling program using traps
1.4 Fishery Monitoring							
Phone survey	Ongoing	■	■	■	■	■	
Logbook survey	Under review						continuation and/or integration with RAP program currently under review
2. Habitat & Ecosystem							
2.2 Listed Species							
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							
Fish Kills	Ongoing	■	■	■	■	■	Respond to reports and investigate cause of fish kills
3. Management Analysis							
4. Industry Development							See Aquaculture

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.

Summary of historical research completed

The Department has records of trout stocking locations and numbers, but there has been little 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:

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Southern Inland Recreational Freshwater Angling Research Projects	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Trout: Growth, Mortality	Proposed		O	O	O	O	Limited information of wild stock growth & survival. A tagging program is required
Trout: Reproduction	Proposed		O	O	O	O	Determine location and success of self sustaining populations
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 Murdoch University
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		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		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	Urgent need to determine interaction stocked trout and native fish species
Impact of redfin on native species	Proposed		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		Concerns about unlicensed fishing and illegal gear used to target stocked broodstock trout
3.4 Management Systems							
4. Industry Development							

Southern Inland – Freshwater Aquaculture Research Plan

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 (S*almo 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 Western Australia.

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

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

No current research apart from providing technical advice.

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.

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

Marron Aquaculture Research	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Growth	Ongoing	■	■	■	■	■	Monitoring of genetic improvement
Reproduction	Underway	■	■	■			There appears to be variation in reproduction among some river lines
Diet	Proposed	O	O	O	O	O	Basic diet developed, but nutritional requirements are still unknown. Currently supervising post-grad student project on determining optimum pellet size.
Genetic improvement	Ongoing	■	■	■	■	■	Major selective breeding project Complete, low level selection continuing to maintain a repository stock.
1.2 Other Biology							
Disease diagnostic service	Ongoing	O	O	O	O	O	Provided by Fisheries Research as part of surveillance and monitoring of State aquatic disease status.
1.3 Stock Assessment	Not needed						
1.4 Fishery Monitoring	Not needed						
2. Habitat & Ecosystem							
Fish Kills	Ongoing	■	■	■	■	■	Respond to reports and investigate cause of fish kills
3. Management Analysis							
3.1 Socio-economic							
Economic evaluation	Complete						Completed in 2000-05 on commercial farms
3.2 Resource Access (Shares)	Not needed						
3.3 Compliance	Not needed						
3.4 Management Systems	Not needed						
4. Industry Development							
4.1 Production Technology							
Production technology	Complete						Developed in 1980's, validated in 2000-05 FRDC project
4.2 Post Harvest							
Post harvest handling	Proposed	O	O	O			11% mortality in purging systems requires investigation.
4.3 Marketing	Not needed						

Silver Perch Aquaculture Research	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Growth	Complete						Completed in NSW
Reproduction	Complete						Completed in NSW
Diet	Complete						Completed in NSW
1.2 Other Biology							
Reproduction in WA	Ongoing	■	■	■	■	■	Trouble shooting/problem solving for industry hatcheries to prevent spawning failures.
Disease diagnostic service	Ongoing	O	O	O	O	O	Provided by Fisheries Research as part of surveillance and monitoring of State aquatic disease status.
1.3 Stock Assessment	Not needed						
1.4 Fishery Monitoring	Not needed						
2. Habitat & Ecosystem							
3. Management Analysis							
3.1 Socio-economic	Proposed				O		This industry has grown rapidly, but the bioeconomics & socioeconomics are still unknown
3.2 Resource Access (Shares)	Not needed						
3.3 Compliance	Not needed						
3.4 Management Systems	Not needed						
4. Industry Development							
4.1 Production Technology	Complete						Completed in NSW
4.2 Post Harvest	Possible						
4.3 Marketing	Proposed				O		Live transport Code of Practice is required by Industry

Trout Aquaculture Research	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Growth	Complete						
Reproduction	Complete						
Diet	Complete						Nutrition of trout is well understood.
Temperature tolerance & Climate change	Underway	■	■	■	■	■	Trout in WA appear to have a higher temperature tolerance than stocks elsewhere in the world. If correct this could create a large export industry for eggs from WA.
1.2 Other Biology							
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 by pressure shock
Redfin eradication	Proposed		O	O			1) Efficiency of trout for eradicating redfin & 2) Making redfin sterile by chromosome manipulation (triploidy)
Genetic improvement	Underway	■	■	■	■	■	1). Selective breeding for heat tolerance & growth 2). Control of inbreeding in PFRC population
Disease diagnostic service	Ongoing	O	O	O	O	O	Provided by Fisheries Research as part of surveillance and monitoring of State aquatic disease status.
2. Habitat & Ecosystem							
3. Management Analysis							
3.1 Socio-economic	Proposed			O	O		Economics of trout production in WA are unknown.
4. Industry Development							
4.1 Production Technology							
Hatchery production	Ongoing	■	■	■	■	■	Production of trout fingerlings & yearlings for aquaculture & recreational stocking
Pond production	Complete						
Inland saline	Underway	■	■				ADU/TAFE FRDC project
4.2 Post Harvest	Possible						
4.3 Marketing	Possible						

Yabby Aquaculture Research	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Growth	Complete						
Reproduction	Complete						
Diet	Future			O			Basic diet developed, but nutritional requirements are still unknown
Genetic improvement	Complete						
Disease diagnostic service	Ongoing	O	O	O	O	O	Provided by Fisheries Research as part of surveillance and monitoring of State aquatic disease status.
1.2 Other Biology	Not needed						
1.3 Stock Assessment	Not needed						
1.4 Fishery Monitoring	Not needed						
2. Habitat & Ecosystem							
2.3 Habitat	Complete						
2.4 Ecosystem/Environment							
Eradication of feral populations	Proposed	O	O	O	O		The spread of yabbies into the marron zone is of serious concern. An eradication strategy is required
3. Management Analysis							
3.1 Socio-economic	Complete						Completed in 1990's.
4. Industry Development							
4.1 Production Technology							
Production technology	Complete						Developed in 1990's FRDC projects
4.2 Post Harvest							
4.3 Marketing	Not needed						

Ornamental Fish Aquaculture Research	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
1. Retained Species Stock Analysis							
1.1 Basic Biology of indicator species (Growth, Reproduction, Diet, Natural mortality)							
Non-Native Ornamental fish							
Growth	Complete						
Reproduction	Complete						
Diet	Complete						
Native Ornamental fish							
Growth	Underway	■	■	■	■	■	Growth rates of native fish species
Reproduction	Underway	■	■	■	■	■	Spawning techniques for native fish species
Diet	Proposed		O				Diet evaluation for native species
1.2 Other Biology							
Non-Native Ornamental fish							
Improved varieties	Proposed		O	O	O	O	Improved stocks for export based upon local genetic & specific pathogen free lines
Native Ornamental fish							
1.3 Stock Assessment	Not needed						
1.4 Fishery Monitoring	Not needed						
Disease diagnostic service	Ongoing	O	O	O	O	O	Provided by Fisheries Research as part of surveillance and monitoring of State aquatic disease status.
2. Habitat & Ecosystem							
2.1 Bycatch	Not needed						
2.2 Listed Species							
Critically endangered fish species for aquariums & ponds	Underway	■	■	■			Potential for conserving critically endangered fish species by producing them for aquarium & ornamental ponds
3. Management Analysis							
3.1 Socio-economic							
Non-Native Ornamental fish	Proposed			O			Economic value of industry
Native Ornamental fish	Proposed			O			Economic value of industry
3.2 Resource Access (Shares)	Not needed						
3.3 Compliance	Proposed				O		Differentiate between wild caught (poached) and farmed native fish
3.4 Management Systems	Not needed						
4. Industry Development							
4.1 Production Technology							
Non-Native Ornamental fish	Proposed	O	O	O	O		Hormonal control of reproduction
Native Ornamental fish	Proposed			O	O		Induced spawning protocols

Ornamental Fish Aquaculture Research	Research Status	2009/10	2010/11	2011/12	2012/13	2013/14	Comments
4.2 Post Harvest							
Non-Native Ornamental fish	Proposed			O			
Native Ornamental fish	Proposed			O			
4.3 Marketing							
Non-Native Ornamental fish	Proposed			O			
Native Ornamental fish	Proposed		O				Export marketing co-operative (underway for blue marron commenced 2009)