MARINE SCIENCE PROGRAM

REPORT TO THE MARINE PARKS AND RESERVES AUTHORITY

What did we learn?
Who did we tell?
What difference did it make?

SUMMARY OF ACTIVITIES, OUTPUTS AND EXPENDITURE FOR 2010/11

REPORT No. 5

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Cover photo: Coral and fish at the Rowley Shoals Marine Park (Shaun Wilson, DEC)

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SUMMARY

This report summarises the performance of the Marine Science Program (MSP) for the 2010/11 financial year and is part of the Department of Environment and Conservation's (DEC) reporting and accountability obligations, under the CALM Act, to the Marine Parks and Reserves Authority (MPRA). This report is based on the implementation of the *MSP Business Plan: 1 July 2010 – 30 June 2011*.

Expenditure on marine science (i.e. research and monitoring) in DEC occurs in the MSP, and in regional and specialist branch cost centres. This report focuses primarily on MSP expenditure and outputs for 2010/11, although some expenditure on marine science by regions and specialist branches is included. 'In kind' contributions from collaborating external agencies are not included.

The report format includes summaries of 2010/11 progress of individual marine science projects. The project summaries are also reported in the Science Division's 2010/11 Annual Research Activity Report. The same format is used to outline annual progress on marine science projects currently being undertaken by DEC regions. The report also includes MSP collaborations and 2010/11 expenditure. Details of the 2011/12 MSP budget and projects are provided, including a detailed work plan for the Western Australian Marine Monitoring Program (WAMMP). The final section of the report is a bibliography of all publications, reports and presentations made by MSP staff since formation of the group in 2007.

The MSP has continued to grow in capacity during 2010/11, with the appointment of three contract research scientist positions. A particular highlight has been establishment in MSP of a permanent position of Principle Research Scientist (Sea Turtles). Dr Scott Whiting has been appointed to this position. The MSP monitoring and temperate and tropical research groups have continued to develop their programs in accordance with strategic plans. Progressive implementation of WAMMP has seen a significant increase in quantitative asset condition-pressure-response data included in the MPRA audit process for all DEC-managed marine parks and reserves. MSP research contributes to this process through quantitative baseline studies of ecological assets in marine reserves, and the development of monitoring indicators and protocols.

Research and monitoring is continuing into the impacts of dredging and spoil dumping by the Gorgon Gas Project on the biodiversity (focus is primarily on coral and fish communities) of the Barrow/Montebello Islands marine protected areas. The team of three MSP scientists, regional staff and volunteers completed several major survey trips to these islands during 2010/11.

Administration of the WAMSI Node 3 Ningaloo Research Program is drawing to a close with all major projects now completed. Summary and synthesis reporting will be completed by December 2011.

1. INTRODUCTION

Report No. 5 outlines the performance of the Marine Science Program (MSP) for the 2010/11 financial year and is part of the Department of Environment and Conservation's (DEC) reporting and accountability obligations, under the CALM Act, to the Marine Parks and Reserves Authority (MPRA). Copies of this report will also be provided to the Director General, the Deputy Director General Parks and Conservation, Divisional Directors and all Regional, District and Specialist Branch Managers.

Established in 2007 with only four members, MSP now has with ten permanent and five contract staff. MSP now supports integrated teams focussed on tropical and temperate research, state-wide marine monitoring, evaluation and reporting, and marine fauna. Externally funded staff work on research investigating the impacts of dredging and spoil dumping associated with the Gorgon Project on the biodiversity of the Barrow/Montebello Islands marine protected areas, particularly in relation to keystone communities such as corals and fish.

Expenditure on marine science (i.e. research and monitoring) in DEC occurs in the MSP and from regional and specialist branch cost centres. This report focuses primarily on expenditure and outputs for 2010/11 by the MSP, but does include annual progress reports on some marine science projects carried out by regional staff. It does not include 'in kind' contributions from collaborating external agencies.

The report format includes summaries of 2010/11 progress of individual marine science projects. The project summaries are also reported in the Science Division's 2010/11 Annual Research Activity Report. The same format is used to outline annual progress on marine science projects currently being undertaken by DEC regions. The report also includes MSP collaborations and 2010/11 expenditure. Details of the 2011/12 MSP budget and projects are provided, including a detailed work plan for the Western Australian Marine Monitoring Program (WAMMP). The final section of the report is a bibliography of all publications, reports and presentations made by MSP staff since formation of the group in 2007.

2. REPORT ON ACTIVITES AND OUTPUTS FOR 2010/11

Major MSP projects, activities and outputs for 2010/11 are outlined below. The project summaries are based on the MSP component of the Science Division's Annual Research Activity Report which is published annually in August/September and distributed widely each year.

2.1 WAMSI Node 3: Science administration, coordination and integration

Core project.

Team members

K Waples (0.6), C Simpson (0.1).

Context

In 2005 the State Government allocated $5 million to undertake research at Ningaloo Marine Park that would underpin its management. A research plan was developed in consultation with DEC marine resource managers and scientists to address key strategies in the *Ningaloo Marine Park Management Plan*. In 2007 a joint research body, the Western Australian Marine Science Institution (WAMSI) was formed. Research within WAMSI was divided into several themes, each with a lead agency. DEC is the leader of Node 3 of WAMSI which addresses research in marine biodiversity and conservation.

Key ecological and biodiversity elements of the Ningaloo research plan were accepted as the science plan for Node 3 of WAMSI.

At the same time as the development of WAMSI, CSIRO Wealth from Oceans National Research Flagship program established the Ningaloo Collaboration Cluster (the Cluster) to address the integration of knowledge of reef use, biodiversity and socio-economics into a Management Strategy Evaluation (MSE) model for Ningaloo Marine Park and the Gascoyne region in general.

The research program of the Cluster complements that undertaken through WAMSI and collectively these two programs, along with core research undertaken by AIMS at Ningaloo, have become known as the Ningaloo Research Program (NRP). DEC is working together with representatives from the Cluster and AIMS to ensure the research program will meet management needs and be properly integrated and communicated to those who will use it.

The science plan for Node 3 of WAMSI consists of six main projects which include up to 20 subprojects. Each project area is led by a different institution/University. Thus the coordination and administration role entails ensuring that all project plans are in place and are running smoothly according to the agreed outputs and timeframes. A key focus of this project is to ensure the transfer and uptake of knowledge generated through the research into DEC management policies, practices and actions. The latter element will become an increasing focus of this project as the research program progresses to completion in 2010 and the final synthesis report is developed for the wrap up of WAMSI in December 2011. As such, both communication and data management are critical elements in knowledge transfer and uptake and are being addressed through this program.

Integration of research within the NRP is managed through the formation of the Ningaloo Research Coordinating Committee (NRCC) and through the following activities which serve to provide forums for sharing information, increasing collaboration between scientist groups and engaging managers and stakeholders:

- Annual Ningaloo Research Symposium
- WAMSI Operations Group
- WAMSI cross-nodal symposia and meetings
- Directed workshops for specific projects (e.g. Management Strategy Evaluation).

Aims

- Ensure the coordination and administration of the research program conducted under Node 3 of WAMSI.
- Ensure the integration of this research program with other research within WAMSI and with external programs relevant to the Ningaloo Marine Park.
- Ensure the outputs of research undertaken through the NRP reach target audiences.
- Ensure that knowledge transfer and uptake occurs between scientists, resource managers and decision-makers.
- Ensure the long term storage and custodianship of data from research undertaken through Node 3 of WAMSI.

Summary of progress (2010/2011) and main findings

- Discussions were held with Exmouth District staff to discuss WAMSI research findings and how best to achieve knowledge uptake within the region.

- Public presentations on WAMSI and DEC Ningaloo research were made in Exmouth in July 2010 and May 2011. A CSIRO scientist was hosted within the Marine Science Program for 2 months to advance the Management Strategy Evaluation model activities and ensure they incorporate DEC management questions and needs for Ningaloo Marine Park.
- Milestone and final reports have been submitted and approved by WAMSI for a number of the research projects.
- A draft final report for Node 3 research is in preparation that will synthesise research findings and contribute significantly to knowledge transfer within DEC and the science community.
- Joint communication activities have been coordinated with the Ningaloo Collaboration Cluster and AIMS.
- The database on research at Ningaloo between 2005 and 2011 has been updated and complemented by a list of science references published on Ningaloo during that time period.
- Meetings have been held with DEC staff from relevant regional offices and Branches that will have a use for the information produced through this research program to discuss their specific information needs and preferred delivery formats.
- Meetings have been held with WAMSI project leaders to discuss research findings, outputs and their full implications for management.
- A report outlining the WA State Government marine research priorities was developed and provided to the WAMSI Strategic Programs Committee for inclusion in the WAMSI Marine Research Institutes proposal to Government for WAMSI II.

Management implications

A key role of this project is to ensure that outcomes of the research both within the NRP and from external research programs are reviewed and used in refining and updating management of the Ningaloo Marine Park through changes to policy, management activities and planning exercises where relevant. Specific implications for management will come from each of the individual projects in the research program and will be implemented as appropriate over time.

The development of a knowledge transfer and uptake framework will be instrumental in ensuring a similar process is followed for other research projects and programs conducted by DEC.

Future directions (next 12-18 months)

- Complete the Node 3 Final Report and summary of Ningaloo research.
- Coordinate presentation of key findings and an overview of the Ningaloo research at the WAMSI Conference in September 2011.
- Further develop the knowledge transfer and uptake framework and submit a paper for publication in a peer reviewed journal on the framework and process.
- Ensure the findings and information from the Ningaloo research are disseminated to all relevant DEC users.

2.2 Conservation of marine turtles in Western Australia

SPP# 1993-040

Team member

B Prince (0.75).

Context

All marine turtles found in Western Australian waters are listed as threatened species by the Commonwealth of Australia and the State of Western Australia. This long-standing statewide research project aims to provide the critical scientific information for the conservation of marine turtles in Western Australia and the management of human pressures on these animals. Currently turtle research and monitoring in Western Australia is undertaken by DEC Science Division and regional staff, academics and industry consultants with limited standardisation of methods or integration of data. There has also been a significant increase in turtle research in Western Australia by external (to DEC) scientists over the past decade as a result of the potential impacts on these species from industrial development. A comprehensive review of all (internal and external) historical and current turtle research and monitoring is needed to underpin the development of an integrated statewide approach to turtle research and monitoring in Western Australia, as outlined in the recently completed Western Australian turtle recovery plan.

Aims

- Gain an adequate understanding of the distribution and abundance of marine turtle populations utilising WA rookeries and marine habitats, the nature of inter-relationships within species at the regional level between groups using different rookeries, and the linkages between nesting and living areas important for the maintenance of these adult turtle populations.
- Develop an understanding of the processes affecting maintenance and abundance of these marine turtle populations as an aid to addressing management needs.
- Develop appropriate management measures and interpretation packages.

Summary of progress (2010/2011) and main findings

- A paper on olive ridley turtles in WA was accepted by *Marine Turtle Newsletter* (in press).
- A paper on Catch-Mark-Recapture data for Varanus Island nesting hawksbill turtles was submitted to *Marine Biology*. Currently responding to reviewer comments.
- A data report was prepared on historical time-series data from Exmouth Gulf.
- Advice has been provided to the WA resource industry in relation to turtle management programs.
- Assistance and advice has been given to university students undertaking turtle research projects.

Management implications

The provision of knowledge will allow appropriate conservation and management programs of marine turtle stocks in Western Australia to be developed to minimise the impacts of human activities on these animals.

Future directions (next 12-18 months)

The project is to be reviewed in 2011/12 as part of a broader review of turtle research

and monitoring in DEC.

2.3 Strategic marine research plan for the Western Australian Department of Environment and Conservation: 2010-2015

Core Project

Team members

S Wilson (0.1), A Kendrick (0.1), C Simpson (0.1).

Context

Historically, much of the research needed to inform DEC's marine conservation and management programs has been delivered through externally-funded programs such as the Northwest Shelf Joint Environmental Management Study, the Strategic Research Fund for the Marine Environment and the Western Australian Marine Science Institution. Although a small research capacity has recently been established within DEC Marine Science Program, external delivery of research will remain a key mechanism to meet DEC's marine research needs for the foreseeable future.

A strategic marine research plan is being developed to ensure that DEC marine research needs are identified, prioritised and delivered in a timely manner so that appropriate scientific information is available to support DEC's marine protected areas, marine fauna management and marine environmental protection programs.

The document will outline a systematic framework to identify and prioritise DEC's marine research needs, the opportunities and constraints to meeting these needs and the strategies needed to take advantage of the opportunities and overcome the constraints.

Aim

To develop and progressively implement a strategic marine research plan to support WA's marine protected areas, marine fauna management and marine environmental protection programs.

Summary of progress (2010/2011) and main findings

- A report on the strategic marine research priorities for DEC was completed and distributed to CSIRO, AIMS and the UWA Oceans Institute in September 2010 as an input to their research planning for the next three/four years.
- A detailed list of specific research projects is being prepared as an appendix to the strategic plan. This will be a dynamic list, periodically updated to reflect changing research requirements.
- A paper on research and monitoring priorities in marine protected areas has been drafted and will be published in 2011/12. The study collates research priorities identified by managers and scientists around Australia and examines their perceptions of research requirements. This is a collaborative project between DEC, Australian National University (ANU) and the federal Department of the Environment, Water, Heritage and the Arts.
- A State Government Marine Research Priorities report was completed and provided to the WAMSI Strategic Programs Committee as an input to the development of WAMSI II.
- Annual research planning meetings were held with regional marine park staff and feedback from these meetings contributed to the development of the strategic plan.
- A research proposal was submitted to ARC for a collaborative project between DEC, AIMS, UWA and ANU examining the functional role of seaweed meadows in tropical

ecosystems.

Management implications

Development and implementation of the strategic marine research plan will enhance DEC's capacity to identify, prioritise and deliver DEC's marine research needs for departmental marine conservation and management programs.

Future directions (next 12-18 months)

- Progressive implementation of the strategic marine research plan.
- Ongoing consultation with researchers and periodic update of list of research projects.
- Development of an annual 'call' for student projects from a DEC list of priority projects eligible for seed-funding.

2.4 Strategic plan for the development and implementation of the Western Australian Marine Monitoring Program (WAMMP)

SPP # to be allocated

Team members

K Friedman (0.1), C Simpson (0.05).

Context

The successful establishment of a long-term, broadscale, institutional marine monitoring, evaluation and reporting (MER) program requires a strategic approach to be taken. The strategic plan for the Western Australian Marine Monitoring Program (WAMMP) will outline the context, rationale, major tasks, timelines and delivery models that are required in the development and implementation of an integrated long-term, state-wide marine protected area and threatened marine fauna monitoring program in Western Australia's coastal waters.

Aim

To develop a strategic plan to guide the development and implementation of an integrated long-term, state-wide marine protected area and threatened marine fauna MER program in Western Australia.

Summary of progress (2010/2011) and main findings

- The draft strategic plan to guide WAMMP has been further developed and is currently being finalised.
- A draft SPP for WAMMP has been developed.
- An operational framework to summarise the WAMMP Annual Work Plan has been developed and implemented as part of MSP annual business planning process.
- A standard WAMMP Field Operations Plan (FOP) has been developed and implemented.
- An operational framework to support the annual Marine Parks and Reserves Authority (MPRA) review process has been developed and implemented.
- Dr Karl Brennan, an ecologist within the Nature Conservation Division of DEC, was hosted within MSP to assess the WAMMP MER frameworks and look at potential benefits in relation to the establishment of terrestrial MER frameworks in the Kimberley and other areas in WA.

Management implications

The development and implementation of the strategic plan for marine MER within DEC's marine conservation programs in an adaptive management context will guide the development and deployment of DEC's marine monitoring capacity over the next ten years. Ultimately the WAMMP will provide the data to continuously improve the efficiency and effectiveness of DEC's marine operational management programs.

Future directions (next 12-18 months)

- Publish the strategic plan by December 2011.
- Finalise the WAMMP SPP.

2.5 WAMMP Sub-project 1: Asset knowledge review and standard operating protocol documentation

SPP # to be allocated

Team members

K Friedman (0.2), C Simpson (0.1), A Kendrick (0.1), S Wilson (0.1), K Bancroft (0.1), K Onton (0.1), T Holmes (0.1), M Rule (0.1), K Waples (0.05).

Context

Monitoring the status of environmental assets assists DEC to meet its statutory responsibilities for the conservation of the State's biodiversity, as it is recognised that the 'health' of the environment is a powerful surrogate for biodiversity conservation. Long-term systematic integrated marine monitoring, together with evaluation and reporting of change, is a key management strategy for measuring success of Marine Protected Area (MPA) and marine fauna management plans, as early detection of detrimental impacts facilitates responsive active adaptive management for the conservation of marine biodiversity.

In the past, DEC marine monitoring work has largely proceeded opportunistically or in response to particular concerns, whereas the purpose of the Western Australian Marine Monitoring Program (WAMMP) is to develop and implement a more strategic integrated program, initially focusing on WA's MPAs and on threatened marine fauna. The condition (structure and function) or 'health' of assets identified in MPA management plans and threatened marine fauna recovery plans is affected by pressures; natural pressures, anthropogenic pressures/uses and climate change pressures. Pressures can be both biotic (e.g. recruitment, predation etc) and abiotic (e.g. sea temperature, cyclonic storms). The primary purpose of monitoring programs is to identify undesirable changes in asset condition as a result of human pressures (as expressed relative to a management target) and to instigate management response/s to mitigate these effects.

Monitoring programs must, therefore, be designed to detect changes when they occur, and identify whether these changes are caused primarily by natural factors, human use or climate change, so that appropriate management responses can be formulated and implemented. Use of a Condition-Pressure-Response (CPR) monitoring framework, assists managers in assessing management efficiency and effectiveness, which is a critical element of an adaptive management framework. Each Asset Knowledge Review will need to have sufficient breadth and detail to guide the development of this aspect of WAMMP. Implementation of the reviews will permit trials of the methods, an output of which will be the documentation of appropriate standard operating protocols (SOPs).

Aim

Develop Asset Knowledge Reviews that identify what to measure (i.e. CPR indicators); how to measure these indicators (i.e. methods) with due consideration of scientific

'power', cost, relevant historical data and practicality; and why these indicator/s and methods were chosen (i.e. rationale).

Summary of progress (2010/2011) and main findings

- Guidelines on the process of developing Asset Knowledge Reviews were updated and distributed to Asset Knowledge Review authors.
- Asset Knowledge Reviews for coral, seagrass and mangrove, pinnipeds, little penguins and water quality were internally reviewed by senior MSP science staff.
- The Asset Knowledge Reviews for coral and fish communities were reformatted to provide a standard for authors that are suitable for publication in the scientific literature.
- A draft report outlining the design for a Marine Information Management System for MSP has been completed. The report defines hardware, software and staffing requirements that are needed to support MSP's information management and operational needs.

Management implications

Monitoring, evaluation and reporting programs are a key element in the adaptive management cycle and are aimed at continuously improving the efficiency and effectiveness DEC's conservation and management programs.

Future directions (next 12-18 months)

- Continue to document and publish WAMMP strategic documents such as the strategic plan, asset knowledge reviews and WAMMP guidelines.
- Initiate four new reviews from the following asset list: dugong, stromatolites, sharks and rays (including manta rays and whale sharks) and turtles.
- Develop guidelines on the development of SOPs within WAMMP.
- Refine interim SOPs as field procedures are trialled and protocols are standardised.

2.6 WAMMP Sub-project 2: Historical time-series development

SPP # to be allocated

Team members

K Friedman (0.1), K Bancroft (0.3), C Simpson (0.05).

Context

Extensive monitoring of the marine environment of Western Australia has been undertaken over the last three decades or more by State and Commonwealth Government agencies, universities, industry and community groups. Although many of these monitoring programs were often issue specific and constrained in time and space, these data have significant potential to help understand historical trends in the condition of biodiversity assets, the pressures on these assets and, in some cases, the management responses to these pressures. This project will examine historical datasets from marine research and monitoring programs in Western Australia that are relevant to the objectives of the Western Australian Marine Monitoring Program (WAMMP). While the main aim is to reconstruct historical trends in asset condition and pressures to extend our understanding 'backwards in time', this project will also inform the process of selecting indicators and methods and temporal and spatial scales of WAMMP monitoring programs into the future. This will further help to ensure relevant past and future datasets are comparable and will also assist in designing the temporal and spatial scales of

WAMMP monitoring programs. Historical timelines are, potentially, also a key aid in improving our understanding of climate change impacts on marine biodiversity over the past several decades.

Aims

- Develop a framework outlining the decision rules to guide the construction of historical time-series on asset condition, pressure and management response and on accessing data for high priority biodiversity assets identified in Marine Protected Area (MPA) management plans and threatened species recovery plans.
- Incorporate datasets into MPA annual report cards which are part of the Marine Parks and Reserves Authority audit process (see WAMMP sub-project 4).

Summary of progress (2010/2011) and main findings

- The Historical Time-series Development guideline was completed.
- A historical time-series for coral community data from Ningaloo Marine Park was used to trial the guidelines.
- Preliminary assessment of historical condition data for most assets listed as key performance indicators in MPA management plans, with special focus on water quality (Marmion Marine Park), coral (Ningaloo Marine Park and Montebello/Barrow Islands Marine Conservation Reserves), seagrass (Marmion and Jurien Marine Parks) and pinniped communities (NZ fur seal state-wide), was completed and included in the 2010 MPRA annual review of MPA management.

Management implications

The construction of historical data will capture past DEC investment in marine monitoring programs and assist the design of future WAMMP monitoring programs. Knowledge of historical trends in marine biodiversity asset condition, pressure and management response will also facilitate an improved understanding of future trends, thereby improving the efficiency and effectiveness of DEC marine conservation and management programs.

Future directions (next 12-18 months)

- Submit a manuscript on the Historical Time-series Development guidelines with worked examples for external publication by December 2011.
- Develop a database that lists past monitoring/research programs and captures relevant datasets that align with WAMMP objectives for priority marine biodiversity assets.
- Continue to collate historical information on previous marine monitoring/research programs to assist in the temporal and spatial design of future WAMMP monitoring programs.
- Continue the identification, retrieval and assessment of historical time-series (including data from sources external to DEC) of asset Condition-Pressure-Response (CPR) data with marine park coordinators and other DEC staff for progressive inclusion into the Marine Parks and Reserves Authority audit process (see WAMMP sub-project 4) and for the development of standardised time-series. The sub project will concentrate efforts for the next 12-18 months on little penguins, fish communities and seagrass communities in Jurien Marine Park, fish communities and coastal biological communities at Ningaloo Marine Park, fish communities and coral communities at Montebello-Barrow Islands Marine Conservation Reserves as well as various other assets where datasets become available.

2.7 WAMMP Sub-project 3: 'Fit to Park'

SPP # not yet allocated

Team members

K Friedman (0.3), A Kendrick (0.1), S Wilson (0.1), K Bancroft (0.4), T Holmes, (0.4), M Rule (0.4).

Context

The Western Australian Marine Monitoring Program (WAMMP) sub-project 3: 'Fit to Park' is focussed on implementation of monitoring programs in the field using the indicators and methods identified in WAMMP Sub-project 1 with due acknowledgement of historical data identified in Western Australian Marine Monitoring Program (WAMMP) sub-project 2. The initial focus of this project will be to determine the appropriate temporal and spatial scales of WAMMP monitoring programs prior to their implementation. This will ensure that monitoring locations and monitoring timing and frequency allow biodiversity asset monitoring data to be comparable within and between major geographical areas of interest (e.g. Marine Protected Areas (MPAs)). The project will also identify the practical constraints (including costs) in regard to field implementation and assess the capacity and role of regional and other DEC staff and community involvement in WAMMP.

Aims

- Develop guidelines for determining the spatial (WHERE) and temporal (WHEN) scales of asset Condition-Pressure-Response (CPR) monitoring programs.
- Identify the practical constraints to the implementation of WAMMP monitoring programs within geographical areas of interest.
- Progressively implement asset CPR monitoring programs for assets priorities outlined in MPA management plans.
- Progressively implement asset CPR monitoring programs for threatened marine fauna according to established DEC priorities.

Summary of progress (2010/2011) and main findings

- Guidelines for determining the spatial and temporal scale of WAMMP monitoring sites were applied by Asset Leaders responsible for establishing and acquiring on-going monitoring CPR datasets for each asset.
- Coral communities were surveyed at previously established and newly established monitoring sites in Ningaloo Marine Park and the Montebello/Barrow Islands Marine Conservation Reserves. Standard and rapid community monitoring survey techniques were used to get quantitative and semi-quantitative records of coral bleaching at Rowley Shoals, Ningaloo, Shark Bay and Jurien Marine Parks. This included the use of aerial assessments from a small plane at Ningaloo Marine Park and Montebello/Barrow Islands Marine Conservation Reserves. In addition to monitoring condition indicators, pressures from coral predators were also monitored at Ningaloo Marine Park.
- Seagrass community monitoring sites were re-surveyed at Shark Bay, Jurien and Marmion Marine Parks under both historical and new sampling regimes. Macroalgae community monitoring was commenced at Marmion Marine Park.
- Mangrove community monitoring was completed at the Montebello Islands, and significant progress was made in capturing and processing remote imagery of mangrove areas in all parks that support this asset.

- A Caring for Country grant application was submitted for coastal biological community monitoring.
- An international student intern will be based in MSP for 6 months to assist with monitoring of coastal biological communities.
- Invertebrate community monitoring was initiated in the metropolitan marine parks, and monitoring of settlement of rock lobster was completed in collaboration with the Department of Fisheries in Ningaloo Marine Park.
- Fish community monitoring sites were established and surveyed in the Jurien Bay, Shark Bay, Ningaloo, Montebello/Barrow Islands and Rowley Shoals marine protected areas.
- Whale shark monitoring data was obtained from AIMS, Ecocean and the Whale Shark Interaction Management Program run by DEC and Commercial Tour Operators.
- Turtle community monitoring was undertaken in the Shark Bay, Ningaloo and the proposed Dampier Archipelago Marine Parks.
- The trialling of an unmanned aerial vehicle (UAV) was undertaken in Shark Bay Marine Park with the aim of developing a more cost-effective method to monitor dugong populations.
- A survey of New Zealand fur seal (NZFS) populations was undertaken along WA's south and southwest coastlines in early 2011 and followed similar surveys in 1989 and 1999. Preliminary analysis of the data indicates that the population doubling of NZFS seen between the first two surveys has slowed with a 10-20% increase in numbers. The population distribution of NZFS has extended considerably up the southwest coast to the metropolitan area with a small colony now located on the western end of Rottnest Island.
- Coastal sea-bird and shore-bird populations were monitored in the Swan Estuary, Shoalwater Islands and Rowley Shoals Marine Parks.
- A little penguin population survey was completed in late 2010 in the Shoalwater Islands Marine Park and followed similar surveys in 2007 and 2008. A preliminary analysis of the 2010 data suggested that the significant decline in numbers observed between 2008 and 2009 is continuing. A further survey is planned for late 2011. The 'beach camera system' to monitor beach-landing numbers of little penguins was trialled further.
- Water and sediment quality monitoring involved an assessment of boat antifouling pollutants at slipways in Ningaloo Marine Park.
- Water temperature monitoring arrays were established and maintained in all marine parks, either with WAMMP loggers or loggers from associated agencies.
- Software applications for post-processing of imagery (predominantly for the determination of benthic habitat condition, e.g. coral communities) were further developed.

Management implications

The CPR data being collected on the assets (outlined above) will be available for marine park coordinators and senior regional staff to help them assess the efficiency and effectiveness of management actions. The data will also be incorporated into the Marine Parks and Reserves Authority (MPRA) audit process of Western Australia's Marine Protected Area (MPA) system.

Future directions (next 12-18 months)

- Finalise the guidelines for determining the spatial and temporal scales of asset Condition-Pressure-Response (CPR) monitoring programs with a manuscript to be submitted for external publication by December 2011.
- Continue to identify and address the practical constraints to the implementation of WAMMP monitoring programs.
- Progressively implement CPR monitoring programs using asset priorities outlined in MPA management plans.
- Progressively implement CPR monitoring programs for threatened marine fauna according to established DEC priorities.
- Continuing focus on integration of monitoring across assets, improving the efficiency of field data collection and data post-processing.

2.8 WAMMP Sub-project 4: MPRA/DEC audit support and management effectiveness reporting

Core project

Team members

K Friedman (0.1), C Simpson (0.05).

Context

Marine protected areas (MPA) in Western Australia are established under the *Conservation and Land Management Act 1984* (CALM Act) and are vested in the Marine Parks and Reserves Authority (MPRA). One of the statutory roles of the MPRA is to monitor (i.e. audit) the implementation of MPA management plans.

The audit function of the MPRA is expressed in three levels of review:

- an annual review (including an asset Condition-Pressure-Response (CPR) report card) of the progressive implementation of the strategies in the MPA management plans
- audit of management performance for each MPA on a periodic basis, partly based on the preceding three to five annual reviews
- a ten-year audit of the implementation of the management plan.

A comprehensive MPA performance assessment report, including a CPR report card, is presented to the MPRA annually. The Western Australian Marine Monitoring Program (WAMMP) assists DEC regional MPA staff in this regard, by providing asset CPR monitoring data and advise for use in 'populating' the MPRA's MPA performance assessment framework.

Aim

The aim of this project is to assist DEC MPA managers in meeting DEC MPRA audit requirements by advising on and, where appropriate, providing CPR data to 'populate' the MPA performance assessment framework the MPRA use to service their audit function.

Summary of progress (2010/2011) and main findings

- The roles, responsibilities, capacity and processes needed to meet MPRA audit reporting priorities and needs were identified through meetings between MSP and most regional MPA managers (usually marine park coordinators).
- Asset CPR data from WAMMP was provided, as it became available, to all MPA

managers.

- A presentation was made to the MPRA Audit Committee and regional MPA managers on the progress of the WAMMP.
- Additional CPR data (including historical datasets) was provided to MPA managers where data was sourced from external providers.
- A process for the annual delivery of science information to MPA managers has been developed and documented. This process involves the updating of a monitoring reporting framework and annual marine park reports, listing all current asset monitoring information that is used to drive assessments of management effectiveness.

Management implications

The MPRA audit process provides an annual understanding of asset CPR for all Western Australian MPAs and is a statutory requirement of DEC under the CALM Act. The same data are used as part of an emerging adaptive management culture by regional MPA managers to improve the efficiency and effectiveness of their management programs.

Future directions (next 12-18 months)

- Development of a clearer understanding of MPRA audit requirements.
- Finalisation of the process (including roles, responsibilities and capacity between the MSP and regional MPA managers) to meet MPRA audit reporting requirements.
- Roll-out of a process (and related reporting) for the provision of asset CPR monitoring updates through:
    - an annual 'Monitoring Matrix' that identifies monitoring information required and its process of acquisition throughout the financial year;
    - annual Marine Park meetings where WAMMP asset leaders formally present asset CPR information (from DEC and external sources) to Marine Park Coordinators (or equivalent); and
    - annual marine park reports (all assets within an MPA) and a periodic 5-year asset report (single asset across the MPA system).

2.9 WAMMP Sub-project 5: Community participation and liaison

Core project

Team members

K Friedman (0.08), K Waples (0.05).

Context

Community engagement and participation is recognised as a key strategy to develop better links between managers, scientists and the community at large. Community partnerships within the context of the Western Australian Marine Monitoring Program (WAMMP) offer the opportunity of extending the scope of an early warning system for detecting change in the marine environment and opportunities to inform and improve understanding of marine conservation issues and priorities in the general population.

Aims

- Successfully engage with the general community on issues of marine conservation, with special regard to WAMMP activity.
- Provide opportunities for direct involvement in monitoring, related activities and

presentations of information to ensure the community is involved in managing the health of our marine and coastal environment.

- Ensure the data collected by the community will complement the monitoring data collected by Government agencies and scientists so that, together these data will be used by management agencies and local communities to help manage human impacts on their local marine environment.

Summary of progress (2010/2011) and main findings

- The Marine Monitoring Unit of WAMMP gave six presentations to community groups and three internal presentations to DEC groups to highlight the progress of WAMMP and to foster improved external and internal support and engagement.
- A community coral monitoring program was continued in Ningaloo Marine Park with greater focus on commercial tour operators.
- A proposal was submitted to *Caring for Country* to support a statewide community monitoring coordinator to improve community understanding and involvement in Marine Protected Area (MPA) management through increased participation and sharing of the results and outcomes.
- Volunteers were supported and trained in the collection, post-processing and reporting of seagrass CPR monitoring information in the metropolitan, Jurien and Shark Bay Marine Parks. DEC coral and fish monitoring surveys at the Montebello/Barrow Islands Marine Conservation Reserves included community participation.

Management implications

The management of MPAs and threatened marine fauna will benefit from increased community understanding resulting from extensive communication of and direct community participation in WAMMP.

Future directions (next 12-18 months)

- Continue community presentations on the objectives of WAMMP.
- Seek long-term funding/sponsorship for a Community Monitoring Coordinator.
- Continue to foster public participation in WAMMP programs where possible.

2.10 WAMMP Sub-project 6: Marine Information Management System

Core project

Team member

K Friedman (0.05); F. Mayer (0.5)

Context

The research and monitoring capacity within the MSP focuses effort on the ecological and social science needed to inform the adaptive management of Western Australia's marine protected area network, the conservation of threatened marine fauna and the conservation of the State's marine biodiversity generally. These programs will generate enormous volumes of data that must be analysed, presented and stored for future uses. To complete these tasks an information management framework is needed to support research and monitoring requirements. Information management in this context is the development and execution of architectures, policies, practices and procedures that properly manage the full data lifecycle needs of the MSP, particular emphasis on the long-term datasets required for the Western Australian Marine Monitoring Program

(WAMMP).

Aim

To establish and implement a best practice information management system for the MSP, with particular emphasis on the management and presentation of long-term datasets produced by WAMMP.

Summary of progress (2010/2011) and main findings

- A review of the marine information management requirements of MSP (and WAMMP), including implementation costs over three years, has been completed.
- Interim guidelines for MSP data collection and information management have been developed and stored on a development platform of MS Sharepoint.
- A data warehouse architecture has been developed and trialled as a prototype.
- Local storage solutions have been installed since December 2010 to safely manage digital imagery and video.
- A literature management system is currently being implemented across MSP.
- Mobile data collection tools and protocols are being developed to WAMMP requirements.

Management implications

As the primary purpose of the monitoring and research is to acquire, evaluate and make available natural resource information to contribute to adaptive management (including pressure and management response), a well structured data handling and archive system is a critical component for management. Ordered, accessible and secure data derived from long term monitoring studies and research projects offer managers an insight into work that has been completed. Having the raw data from past studies, limits the duplication of work and offers the opportunity for reassessment if new questions arise.

Future directions (next 12-18 months)

Continue development and implementation of a marine information management system for MSP and WAMMP.

2.11 Spatial and temporal patterns in benthic invertebrate communities of the Walpole and Nornalup Inlets Marine Park

SPP# 2009-013

Team members

A Kendrick (0.2), M Rule (0.2).

Context

The Walpole and Nornalup Inlets Marine Park (WNIMP) was created in 2009 to include the entrance channel, both basins and the tidal extent of the Frankland, Deep and Walpole rivers. Invertebrates are recognised as a significant ecological value of the marine park and a Key Performance Indicator of management effectiveness. The benthic invertebrate community of the inlets has been described by Hodgkin & Clark (1999) from surveys conducted in 1984 and 1987. The fauna was found to be relatively diverse compared to most estuaries in the south-west of WA because of the predominantly marine conditions that are sustained in the inlets. Few subsequent studies have examined this fauna, and the current knowledge of benthic invertebrates in the system is considered to be inadequate for marine reserve management. Little is known, for

example, of how the fauna varies in response to the seasonal hydrological cycle.

Aims

- Determine spatial patterns in the WNIMP benthic invertebrate community.
- Determine temporal variation in the WNIMP benthic invertebrate community, particularly in relation to seasonal changes in the hydrological cycle of the inlet system.
- Assist DEC's Marine Monitoring Unit in the development of methods for long-term monitoring of benthic invertebrate communities in the WNIMP and more broadly across temperate estuarine marine protected areas.

Summary of progress (2010/2011) and main findings

- Seasonal invertebrate sampling was completed with Frankland District staff in July 2010, October 2010, February 2011 and April 2011.
- Samples from all field trips were processed in the laboratory and a voucher specimen collection is being used to identify unknown species.
- Preliminary analyses indicate that the benthic invertebrate community differs markedly in the major habitats of the inlet system. The peripheral sand flats of the Nornalup Inlet, for example, support several relatively large bivalve species that do not occur in the deeper basin habitats. The overall abundance of invertebrates is also typically highest on the peripheral sand habitats.
- A concurrent survey of benthic algae was carried out during April 2010. This survey markedly increased the number of algal species recorded from the WNIMP and has been published in the *Journal of the Royal Society of WA*.
- Staff presented a lecture and tutorial in Edith Cowan University's School of Natural Sciences 3rd year *Coastal and Marine Management* course. This was followed by a week-long field-camp at WNIMP where students participated in a survey of sand-flat bivalves. This work is currently being written up.

Management implications

This study will provide knowledge of how and why benthic invertebrate communities in the WNIMP are structured in space and time. Such 'inventory' and/or 'baseline' information is required to determine the composition of these ecological assets in relation to natural processes, and to benchmark their condition with regard to the impact of current and future anthropogenic impacts.

Future directions (next 12-18 months)

- Seasonal invertebrate sampling will continue for one more year. Four sampling trips are planned for 2011/2012.
- Staff will continue to contribute to ECU's 2012 *Coastal and Marine Management* course.
- Several papers will be submitted for publication on this work over the next 1-2 years.

2.12 Spatial and temporal patterns in the structure of intertidal rocky platform communities of the Shoalwater Islands and Marmion marine parks

SPP# 2009-002

Team members

A Kendrick (0.2), M Rule (0.15).

Context

The Marmion Marine Park (MMP) and Shoalwater Islands Marine Park (SIMP) are located on the north and south Perth metropolitan coast, respectively. Both marine parks support a diverse range of marine conservation values ranging from various marine habitats to threatened marine fauna and are dominated by sub-tidal and emergent limestone reefs and shallow sandy embayments. These marine parks are subject to high levels of recreational and commercial human activity due to their proximity to the Perth metropolitan area. Significant areas of intertidal reef platform occur in both mainland and island shores and as isolated offshore patch reefs. While a number of local studies of intertidal communities provide a significant regional knowledge base, the broad spatial patterns of intertidal biodiversity across both the MMP and SIMP are not adequately understood. Particular gaps exist in knowledge of the intertidal communities of the SIMP and offshore platform reefs.

This study will determine relationships between the composition of these communities and the physical structure and location of the reefs.

Aims

- Determine the spatial and temporal patterns in the composition of intertidal reef communities in the MMP, SIMP and the proposed northern extension to the SIMP (comprising Garden Island and Carnac Islands).
- Determine if the intertidal reef communities in management zones protected from extractive activities differ from the intertidal reef communities of otherwise comparable reefs.
- Assist DEC's Marine Monitoring Unit in the development of methods for long-term monitoring of temperate west coast intertidal communities.

Summary of progress (2010/2011) and main findings

- Sixteen mainland and offshore intertidal reef sites were sampled in the MMP and SIMP by MSP and Swan Coastal District staff in the 2010/2011 'summer' sampling period. This completed the 'spatial' component of the sampling.
- A collection of voucher specimens is being progressively developed, and will be maintained, as a taxonomic aid. This collection is being used to identify unknown species.
- Data is being collated and entered into a database for analysis. Preliminary analyses suggest that high levels of variation exist between the community compositions of different platform reefs.

Management implications

- This study will provide a basis for the design and implementation of comparative intertidal research in marine parks and reserves across WA.
- Inventory and baseline information will be used to determine the composition of ecological values in relation to natural processes, and to benchmark their condition with regard to the impact of current and future anthropogenic impacts.

Future directions (next 12-18 months)

- Sampling will occur at a sub-set of sites during the 'summer' season in 2011/2012. These sites will then have been sampled for three consecutive years and will complete the 'temporal' aspect of the study. Sites at Garden Island and Carnac Island will also be sampled if conditions permit, and this will complete fieldwork associated with this project. Emphasis will then shift to analysis and publication of

the results.

2.13 Interactive effects of fishing and climate change on coral reef fish populations

SPP# 2009-003

Team members

S Wilson (0.325), T Holmes (0.35), K Onton (0.1).

Context

Climate change and over-fishing are widely regarded as the major threats facing coral reef communities worldwide. Typically fishing has a 'top-down' affect on communities, through the removal of large predators, whilst climate change causes degradation of habitat which effects fish that recruit, feed and shelter within corals. The independent impact of these threats are well studied, however the interactive effects between fishing and climate change are yet to be examined. This interaction may be particularly important on reefs off the mid-western WA coastline where per-capita boat ownership and recreational fishing pressure is extremely high.

Two critical processes that determine community structure of coral reef fish are recruitment and early post-settlement predation. It is hypothesised that degradation of coral associated habitat due to climate change will cause a decline in recruit numbers. Conversely fishing will reduce abundance of large predators and increase numbers of smaller habitat-associated predators, thereby increasing post-settlement predation. Examining how changes in habitat and predators interact and influence post-settlement survival of fish will be critical to understanding impacts to biodiversity of fish communities and fish populations.

Aims

- Determine how habitat degradation instigated by climate change and changes in predation instigated by fishing pressures effect the composition of the predator community on WA coral reefs.
- Assess diet of predatory species targeted by fishers.
- Identify microhabitats preferentially used by juvenile fish.
- Assess how variation in fishing pressure and habitat complexity/composition influence predation rates on juveniles.

Summary of progress (2010/2011) and main findings

- Field work in November and January provided information on fish communities on patch reefs of differing habitat composition inside and outside of sanctuary zones. Field work in February collected data on abundance and distribution of juvenile fish. During this time we also collected data on coral bleaching along Ningaloo Reef.
- A manuscript assessing diet of finfish targeted by fishers in north-west Australia was published in *Environmental Biology of Fishes*. The study highlights spatial and temporal variation in some species diets and identifies species where more dietary information is required.
- A manuscript identifying habitat associations of juvenile fish was published in PLoS ONE. The study demonstrates corals of high structural complexity are important habitat for ~ half the species investigated. The study also shows algal meadows are important juvenile habitat for some species, including species targeted by fishers. An oral presentation of this paper was delivered to the Australian Coral Reef Society at Coffs Harbour, NSW in September 2010

- A manuscript assessing extinction vulnerability of fish was published in *Ecology Letters*. This paper assesses life history characteristics and habitat associations to compare susceptibility of coral reef fish to climate change and fishing, concluding that most fish are vulnerable to only one of these stressors.
- Predation data collected in 2009/2010 in collaboration with CSIRO is currently being analysed and prepared for publication. Preliminary findings were presented to the public in Exmouth July 2010.
- An article on the relationship between fish and corals was published in *Landscope*
- Fish for the dietary study have been collected from the field and processing of samples is underway
- Assessing seasonal and spatial differences in macroalgal meadows was added as an appendix to this project. Satellite imagery and algal samples have been collected from the Ningaloo lagoon during winter spring and summer.

Management implications

- Knowledge on the combined effects of fishing and on fish recruitment project will inform effective management of recreational fishing that may alleviate pressures placed on coral reef biodiversity.
- The project will identify appropriate indicators for ongoing monitoring programs, particularly those undertaken by MSP and identify finfish species that require protection from recreational or commercial fishing.

Future directions (next 12-18 months)

- Prepare a manuscript for submission to international journal based on 2009/10 data
- Complete dietary assessment of fish species that may be affected by fishing.
- Continue to develop photographic library of juvenile fish.
- Analyse data collected during 2010/2011, determine if more replication required before data prepared for publication.
- Assess the impact of 2011 coral bleaching on fish recruitment.
- Analyse satellite imagery and algal samples collected from Ningaloo lagoon. Prepare manuscript for publication which examines temporal variation in the composition, biomass and size of algal meadows.

2.14 Preliminary assessment of diseases affecting Western Australian corals

SPP# 2009-011

Team members

K Onton (0.3), S Wilson (0.025).

Context

Coral diseases have contributed significantly to coral reef degradation in locations around the world over the last three decades. However there is little information on the prevalence and type of disease on Western Australian coral reefs. Ningaloo Reef is the largest fringing coral reef in Australia, home to highly diverse marine life and is regarded as an icon of Western Australian marine conservation. Research into coral disease at Ningaloo Marine Park (NMP) will create a baseline data set that can be used to measure how climate and anthropogenic drivers threaten coral reef sustainability over time, and across regions with varying levels of anthropogenic influence.

Aim

- Review the current knowledge of coral diseases on Western Australian reefs.
- Document the prevalence of diseases affecting corals and the coral taxa/morphologies susceptible to various diseases within NMP.
- Characterise coral disease legions morphologically and histologically.
- Contribute to the development of coral disease standard monitoring protocols.

Summary of progress (2010/2011) and main findings

- A paper detailing the prevalence of coral disease at NMP has been accepted for publication in *Marine Ecology Progress Series*. This paper indicates occurrence of disease at NMP is similar to other locations in the Indo-Pacific. There is no indication that disease prevalence is related to human activities at Ningaloo, however disease was more prevalent at sites where coral feeding by the snail *Drupella* was high. The paper also provides an overview of disease occurrence in the region
- Results from the study were presented as a poster at the Australian Coral Reef Society at Coffs Harbour, NSW in September 2010. A copy of the poster is currently posted at the visitor centre in Milyering.
- Results of the study were presented at a public forum in Exmouth July 2010.

Management implications

The results of this study will provide an indication of the spatial and temporal distribution of various diseases providing information on the prevalence and identity of diseases affecting Western Australian corals. This will assist in identifying the current threat posed by disease and provide a baseline for assessing any changes in impact. This will enable assessment of current management strategies designed to mitigate the impact of threats on coral communities.

Future directions (next 12-18 months)

- This study is now complete.

2.15 Spatial variation in the functional morphology of mangroves in the Shark Bay World Heritage Area

SPP # 2011-003

Team members.

M Rule (0.15), A Kendrick (0.20)

Context

The Shark Bay Marine Park (SBMP) and the adjacent Hamelin Pool Marine Nature Reserve are World Heritage-listed and support a diverse range of iconic marine conservation values. The ecological diversity of SBMP is high because this area is the southern distributional limit of many typically tropical species and the northern limit of many temperate species. The mangrove communities of SBMP are the most southern, extensive mangroves on the Western Australian mainland and are recognised as a significant marine park conservation asset, and eastern Shark Bay is listed under the Directory of Important Wetlands in Australia. Mangroves in the SBMP display a wide variety of morphologies that are possibly related to the unique oceanographic characteristics of Shark Bay. While mangroves are a key ecological value of the SBMP, the current knowledge of these habitats is inadequate and impedes effective

management in the reserve, and the broader World Heritage Area. No significant areas of mangrove habitat, for example, currently exist within SBMP sanctuary zones. This project will provide the first comprehensive description of the variation among dense *Avicennia marina* stands in SBMP. The outcomes of this one-year study will inform broader studies on mangrove ecology and mangrove-associated organisms in the SBMP. The project will also assist with the development of *in situ* monitoring methods and protocols which will be used to monitor mangroves in SBMP and more broadly across Western Australia.

Aims

- Determine variations in the structure morphology of mangrove stands across the SBMP
- Determine a classification of mangroves within the SBMP based on physical structure and environmental parameters.
- Identify indicators for on-going monitoring of mangrove community condition.

Summary of progress (2010/2011) and main findings

- The Science Concept Plan was completed and approved.
- The Science Project Plan was completed and approved.
- Field work was completed in May 2011, when 12 mangrove sites were surveyed between Carnarvon and South Passage in the Shark Bay Marine Park. These data are now being collated and analysed.

Management implications

This study will identify mangroves of conservation significance in the SBMP and will provide significant information that will assist in future reviews of the SBMP management plan and zoning scheme. The data collected in this study will also identify assist in developing appropriate long-term monitoring indicators and methods for assessing mangrove community condition.

Future directions (next 12-18 months)

- The data from the project will be analysed and published. Additional research projects on SBMP mangrove communities will be considered based on the outcomes of this study.

2.16 Knowledge transfer and uptake of recent temperate marine research in WA

Core project

Team members

A Kendrick (0.05), K Waples (0.05); contract (0.5).

Context

Over the past decade or so significant funding has been allocated for marine research in WA's temperate coastal waters. Over $20 million was invested over 5 years through the Strategic Research Fund for the Marine Environment (SRFME), a joint venture between the WA State Government and CSIRO. Approximately $1M of the SRFME funding was allocated for marine research on the Jurien Bay Marine Park and this attracted significant co-investment from CSIRO and local universities and supported a large program of research in this area. Node 1 and Node 4 of WAMSI also focussed on the temperate coastal waters of WA as did a number of large projects funded by the Commonwealth Government's NHT program (e.g. Marine Futures). The majority of this work was

undertaken by science organisations external to DEC and hence there have been no formal attempts to ensure this research is incorporated into DEC policies and programs.

The Marine Science Program (MSP) of DEC has recently developed a Knowledge Transfer Framework (KTF) for facilitating the transfer of science into policy and/or management actions. The aim of the knowledge transfer and uptake process is to set out clear steps that can be undertaken to ensure that information moves between scientists and managers leading to informed decision-making and management activities based on sound science.

A consultant was engaged to apply the KTF to recent (last decade or so) marine research undertaken in the temperate coastal waters of Western Australia. The detailed implications of this research for DEC marine policy and management programs will be discussed with the relevant users within DEC and made available to them for future use in decision-making processes.

Aims

This project aims to ensure that the key findings of recent temperate marine research programs, such as SRFME, NHT and WAMSI, are assessed for their policy and management implications to DEC marine conservation and management programs and made accessible to DEC managers and decision-makers.

Summary of progress (2010/11) and main findings

- Meetings held with relevant staff from the regions and other Branches who would be likely end-users of temperate marine information to introduce the project and to assess their needs and research priorities;
- Final report submitted to DEC including a temperate marine database and guidelines on how to search it;
- Report and database distributed to relevant Regions and Branches as well as the DEC library.

Management implications

Undertaking the knowledge transfer and uptake process will ensure that the key findings and implications of this research program are made available to relevant DEC marine managers and decision-makers.

Future directions (next 12-18 months)

- Project completed

2.17 South coast pinniped survey

Core project

Team members

R. Campbell (0.5),K Friedman (0.025), A Kendrick (0.1), K Bancroft (0.1).

Context

Pinnipeds are a key higher order predator in Western Australia's temperate marine ecosystems. They are predominantly found in continental shelf environments of the higher latitudes but also inhabit temperate and equatorial regions. Historically, all species of pinniped were commercially harvested for their pelts and oil during the 18-20th centuries resulting in large scale reductions of population size and range. Some species have made recent recoveries, such as the New Zealand fur seal, whereas other species, such as the Australian sea lion, remain vulnerable to extinction.

There are two resident species of pinniped in Western Australia, the New Zealand fur seal (NZFS, *Arctocephalus forsteri)* and the Australian sea lion (ASL, *Neophoca cinerea*). Both species are listed as specially protected under the State *Wildlife Conservation Act* (1953). In contrast to ASLs, NZ fur seals appear to be undergoing a range and population expansion within WA, having doubled their population size between 1989 and 1999. The range expansion appears to be continuing with haulout colonies established along the south-west coast, but the rate of population growth and current abundance is unknown.

Aims

- To determine the current geographical range and population abundance of NZFS in WA and compare these data with surveys undertaken in 1989 and 1999.
- To determine the spatial variation in growth rates and density-dependent growth rates of NZFS colonies.
- To design a more cost-effective survey regime that yields spatially relevant signals of change in NZFS populations at relevant time scales for conservation and management
- To better predict the likely rates of population increase and range expansion for the design of future management programs and population survey
- To determine the breeding activity and schedule of sympatric ASL colonies

Summary of progress (2010/11) and main findings

- A comprehensive survey of all known breeding sites of NZFS was conducted in January-February 2011 which found:
    - Abundance of NZFS had increased by a total of 17% over the past 12 years at an annual rate of approximately 1.2%.
    - Several colonies showed very large reductions in pup production from the levels in 1999, including a group of colonies between Esperance and Albany.
    - Pup mortality rate was uniform across the range (~1.4%) and was similar to that recorded in the 1999 survey.
- Three new NZFS breeding colonies were found at Chatham Is, Stanley Is and Bunker Bay (near Cape Naturaliste). One new breeding colony of ASL was found on Draper Is in the Recherche Archipelago. Some data on the breeding schedule of ASL were collected opportunistically and will contribute to a new research program in 2011/2012.
- Training of DEC regional staff on the south coast in pinniped survey techniques was initiated to facilitate future smaller scale monitoring of pinnipeds as well as other threatened fauna species of the south coast of WA (e.g. Cape Barren geese, Australian sea lions).
- A draft manuscript and a data report have been compiled and are undergoing internal review.

Management implications

The reduced growth rate of NZFS colonies in some parts of the range and the large reductions observed in other areas suggest that this species may be approaching a carrying capacity in some areas. This is most likely due to limited marine food resources and not terrestrial habitat at breeding locations. The development and implementation of a long term monitoring program that is both cost effective and logistically feasible will also allow us to tease apart natural and anthropogenic, including climate change, factors that influence abundance and distribution for these species. These data are important in

helping to understand the ecological effects of an expanding higher-order predator population, especially in the context of the establishment of Commonwealth marine parks throughout the temperate waters of Australia. Trends in abundance and preliminary dietary information on the NZFS also suggest that there may be some competition with the threatened ASL. This information will also allow us to better understand current and future trends in interactions with commercial fishing operations and the general public, and to manage this interaction more effectively.

Future directions (next 12-18 months)

- Implement cost-effective annual surveys of selected sentinel colonies of NZFS to determine inter-annual variation in pup production due to stochastic and environmental effects.
- Continue the training and establishment of a state-wide monitoring program to determine the extent of pressure and response parameters of the two resident seal species in WA.

2.18 Effects of the Gorgon Project (GP) dredging program on the marine biodiversity of the Montebellos/Barrow Islands Marine Protected Areas (MBIMPAs)

Core project

Team members

S Field (0.8), G Shedrawi (0.9), R Evans (0.9), K Friedman (0.05) J Huisman (0.05)

Context

The Gorgon Project (GP) which is based on Barrow Island is one of the world's largest natural gas projects and the largest single resource natural gas project in Australia's history. The plant will include three, 5 million-tonne-per-annum LNG trains, with domestic gas piped to the mainland, and a four kilometre long loading jetty for international shipping. The Gorgon Gas Development Revised and Expanded Proposal: Barrow Island Nature Reserve was approved by the Western Australian Government in September 2009 subject to a number of conditions and a commitment by the Gorgon Joint Venture participants to fund a series of conservation initiatives titled “Additional Gorgon Joint Venture Undertakings”.

The GP includes a dredging program that will involve the removal and dumping of ~ 7.6M tonnes of marine sediment over a period of approximately 18 months and started in May 2010. The conditional approval for the GP included conditions for environmental compliance monitoring programs (including a marine baseline project and a ‘near-field’ marine monitoring program by Chevron) and a number of environmental offsets, one of which was a total of $2.5 M over three years to DEC to assess the potential impacts of the dredging on marine biodiversity over the broader scale of the Montebellos/Barrow Islands Marine Protected Areas (MBIMPAs).

The Gorgon Dredging Offset Monitoring Evaluation and Reporting Project (Gorgon MER) will investigate the potential impacts of the dredging and dumping activities on selected marine communities within the MBIMPAs (i.e. the ‘far-field’). The Gorgon MER project will also help inform future environmental impact assessments (EIA) by improving predictions of the spatial scale and nature of the likely impacts of dredging and dumping activities on sensitive marine communities. Additionally, this project will increase the knowledge base of the MBIMPAs.

Aims

Primary

- To assess the nature and extent of potential impacts of the Gorgon dredging program on the condition[1] of coral, fish and other important ecological (if appropriate[2]) communities of the MBIMPA;
- To determine the cause/s, with a particular focus on dredging, dumping and re-suspension of spoil, of any changes in the condition of the above communities;
- To assess the effects of potential confounding natural (e.g. cyclones, disease, predation, bleaching) and other anthropogenic (e.g. fishing) pressures on the condition of coral communities of the MBIMPA.
- To assess the nature and extent of the impacts from the Gorgon dredging program on the social assets (if appropriate[2]) of the MBIMPA.

Secondary

- To ensure that the Gorgon MER is integrated with the DEC Western Australian Marine Monitoring Program (WAMMP).
- To ensure, where possible, that the Gorgon MER is complementary to industry compliance monitoring programs.
- To contribute data, as appropriate, to the development of a strategic capability for predicting the impact of dredging and dumping on shallow tropical communities.

Summary of progress (2010/11) and main findings

- A program for monitoring the health of coral and fish communities, as well as the key pressures on these communities associated with dredging, has been developed and implemented.
- Pre-impact monitoring surveys were completed at permanently marked sites for coral and fish communities in November 2009 and April 2010 providing an indication of the seasonal variability of the sites prior to the commencement of dredging in May 2010.
- Following the commencement of dredging, qualitative surveys of the coral communities at permanent sites were conducted in November 2010 and January 2011 with quantitative surveys completed in February and May 2011. The February survey quantified the extent of a bleaching event (increased water temperature) which affected coral communities throughout the MBIMPAs while the May survey allowed the quantification of the mortality of previously bleached coral communities.
- Monitoring of the pressure field associated with the dredging has been completed for the duration of the Gorgon MER through the maintenance of sediment taps, to quantify sediment deposition, and the monitoring of the extent and persistence of the dredge plume, through the interpretation of remotely sensed MODIS imagery.
- A number of other potential natural and anthropogenic pressures on the coral and fish communities are also being monitored to quantify any additional impacts to these communities.

Management implications

The program provides a baseline for assessing potential impacts and recovery of coral communities within the MBIMPAs, with a particular focus on potential impacts related to the dredging program for the Gorgon Project. It also provides information that will assist

[1] Asset condition includes structure and functions

[2] Current focus is on corals and fish but other ecological (e.g. macroalgae) and social assets should be considered. This will involve collation and assessment of existing marine habitat data in areas of interest.

DEC to protect and manage the MBIMPAs. The data generated from this monitoring program will also complement Offset 'e' of the Pluto LNG program aimed at improving the capacity of Government and industry to manage the impacts of dredging on tropical coral reef communities in WA.

Future directions (next 12-18 months)

- Additional surveys of the coral and fish communities will be undertaken around the time of completion of the dredging program (i.e. October/November 2011) and in April and October 2012 to provide an indication of the trend in the condition of these communities approximately 6 -12 months post-dredging.
- Monitoring of the pressure field will also be maintained for a similar duration to quantify the extent of impacts of residual dredge material at the dredge sites in addition to the re-suspension of material from the spoil ground.
- Results will be progressively published in international journals over the next two years.

2.19 WA regional-scale coral bleaching study

SPP# to be allocated

Team Members

J Moore (0.275), S Wilson (0.075), K Friedman (0.05), S Field (0.05), H Taylor (0.02), R Middlebrook (0.02), D Holley (0.01)

Context

In Western Australia, coral reefs are key assets and provide critical habitat for a large diversity of flora and fauna. Understanding ecosystem processes that have a key role in structuring asset assemblages in our marine parks is therefore critical if we are to effectively monitor and manage WA reefs in space and time. Here, as is the case worldwide, coral reefs are under increasing threats from climate and anthropogenic stressors that are eroding the resilience of reefs to ecological change. During the 2010-11 summer, a considerable ocean warming event occurred along a significant proportion of WA coastline. Accumulated thermal stress over this period impacted coral reefs from the Dampier archipelago to Rottnest Island and possibly further to both the north and south. The extent and intensity of coral bleached, and the associated recovery and mortality of these communities, form the basis of this research project. The outcomes of this project will increase our understanding of threats to coral reefs in WA and enhance management effectiveness to respond to similar events in future.

Aims

- Determine the dynamics of water temperature fluctuations during the warming event at local to regional scales;
- Quantify the spatial and temporal extent of coral bleaching across WA coral communities;
- Investigate the post-impact response of reef corals to bleaching at local to regional scales; and,
- Inform future management strategies detailing responses to disturbance events including refining of NOAA temperature thresholds for bleaching in WA coral reef MPAs.

Summary of progress (*2010/2011*) *and main findings*

- Satellite sea surface temperature (SST) and *in situ* temperature anomaly data from loggers for June 2010 to present has been compiled for WA waters;
- Preliminary examination of the data suggests that temperature profiles observed during the six months preceding May 2011 are likely to be some of the highest recorded for that period in WA waters;
- Surveys of coral communities have been undertaken at marine protected areas at Rottnest Island, Abrolhos Islands, Shark Bay, Ningaloo and the Montebello/Barrow Islands;
- Preliminary analyses of the data suggest coral bleaching has had low to moderate impact in certain areas, with 20-60% of corals bleached;
- Some areas have been severely affected with up to 100% of coral bleached e.g. Bundegi in Exmouth gulf and reefs around Coral Bay (Ningaloo Marine Park);
- Aerial surveys in the Montebello/Barrow Islands Marine Conservation Reserves and at Ningaloo Marine Park show extensive low level bleaching across both marine parks, with moderate to high levels of bleaching observed in many areas.

Management implications

To date, temperature-induced coral bleaching has not been considered a major threat to coral reefs in WA's marine protected areas south of Northwest Cape. Impact and response trajectories of coral communities across WA marine parks to this bleaching event will better inform management of the importance of temperature stressors to corals. These results will also inform future disturbance response plans and facilitate forward planning so that the DEC are better equipped to assess disturbance events, such as bleaching, in a timely fashion.

Future directions (*next 12-18 months*)

- Resurvey all sites within the next 3-6 months to collect recovery and mortality data;
- Present preliminary findings at national conferences and workshops;
- Publish findings in an international peer-reviewed journal article within the next 12 months;
- Develop management strategies for responding to future disturbance events on WA coral reefs.

2.20 Comparison of underwater visual census and diver operated video methods for assessing fish community condition in tropical and temperate coastal waters of Western Australia

SPP# 2010-010

Team members

T Holmes (0.09), M Rule (0.04), R Evans (0.04), S Wilson (0.03), K Friedman (0.02), G Shedrawi (0.02), Regional Officer (0.11)

Context

Assessing the status and trends in the condition of biodiversity assets assists DEC to fulfill its statutory responsibilities for the conservation of the State's biodiversity. The systematic long-term monitoring, evaluation and reporting (MER) of asset condition-pressure-response (CPR) is a key strategy for assessing the efficiency and effectiveness of management action within Western Australia's system of marine protected areas (MPAs). MER programs also determine whether conservation goals (i.e. outcomes) are

being achieved. Marine management strategies include the use of zoning schemes and regulations to control human activities, compliance monitoring, public participation and community education programs and direct management intervention. The early detection of ecosystem change through strategic MER programs allows for the modification of these management practices to changing ecosystem condition and threats within an adaptive management context.

In shallow, coastal waters, the condition of fish communities has traditionally been monitored, using a technique known as Underwater Visual Census (UVC). More recently, a technique for assessing finfish community condition has been developed that utilises stereo-video to capture imagery of fish communities which is later analysed in the laboratory. Known as Diver Operated Video (DOV), this technique has potential advantages over UVC because sampling theoretically requires less scientific expertise, takes less time in the field and data analysts have access to reference material to help identify fish. In addition, it provides a permanent record of the survey that can be checked or revisited at a later point if required. However, DOV datasets may be more costly to process and it is unclear if video imagery captures the same level of diversity and abundance as skilled divers conducting UVC.

Despite the significant amount of DOV surveys that have been completed on fish communities in WA over recent years, no thorough investigation comparing the overall utility, results and cost-effectiveness of this technique to conventional UVC methods has been conducted. As such, comparable assessments need to be undertaken to assess the relative utility of these techniques in both temperate and tropical waters where the Western Australian Marine Monitoring Program (WAMMP) has monitoring responsibilities. This study will improve our understanding of historical UVC and DOV dataset compatibility and the relative costs of each method.

Aims

- Examine the comparability of the fish community dataset (diversity, abundance and size measures) resulting from collection through UVC and DOV survey techniques.
- Examine the effect of varying levels of diversity and abundance on the resulting fish community datasets when data is collected through the two techniques.
- Examine the effect of habitat complexity related to tropical and temperate marine ecosystems on the resulting fish datasets when data is collected through the two techniques.
- Assess the relative cost and practicality of both UVC and DOV techniques in the context of long-term monitoring programs in both tropical and temperate remote locations.

Summary of progress (2010-2011) and main findings

- Field work was conducted in the Rowley Shoals Marine Park in December of 2010. Video data collected during this trip was analysed in February 2011.
- Field work planned for the Montebello/Barrow Islands Marine Conservation Reserve was attempted in November 2010 and February 2011. However, poor weather and water visibility on both occasions resulted in both trips being cancelled. This work has now been rescheduled and relocated to the Ningaloo Marine Park in July 2011.
- Field work planned for the Jurien Bay Marine Park was attempted in March 2011. However, poor weather and water visibility resulted in inadequate data. This work was rescheduled and undertaken in June 2011.

Management implications

- Information obtained from this study will enable appropriate comparisons between historical datasets on fish communities that have been collected using both UVC and DOV methodologies.
- The project will highlight the pros and cons of each methodology, including cost and time analysis, to provide feedback to monitoring programs on which methodologies are most appropriate.

Future directions (next 12-18 months)

- Complete data collection and video analysis from Ningaloo and Jurien Bay Marine Parks.
- Analyse all data sets.
- Prepare a manuscript for submission to international journal within the next twelve months.

3. REGIONAL MARINE SCIENCE PROJECTS, ACTIVITIES AND OUTPUTS

Below are presented marine science projects, activities and outputs that are being undertaken by DEC's Regional Service Division. These projects are initiated and managed by District/Regional staff, who have provided project updates to the MSP.

3.1 Kimberley Region

No current marine science projects

3.2 Pilbara Region

3.2.1. Monitoring of the Ningaloo Marine Park whale shark industry and whale sharks (*Rhincodon typus*) through industry data

SPP #: (to be allocated)

Core project

Team members

E Wilson, H Taylor

Context

The whale shark (*Rhincodon typus*) is listed as a threatened species under WA State legislation and protected under Australian Commonwealth legislation. Internationally, the conservation status of the whale shark is recognised as "vulnerable" in the World Conservation Union Red List of Threatened Species.

The Department of Environment and Conservation (DEC) is responsible for the management of whale shark tourism interactions in the Ningaloo Marine Park under the *Wildlife Conservation Act 1950*. Whale sharks are seasonally present in this marine park and these animals have become the focal point for a tourism industry that provides in-water experiences with whale sharks. DEC developed a whale shark management program in 1997 to monitor and manage human interaction with whale sharks and the industry that provides these experiences. A primary objective of the management of the whale shark interaction program is ensure that any potential impacts on individuals and the overall Ningaloo 'population' are identified in advance so that an adaptive management regime can be applied.

Every whale shark interaction conducted throughout the season is required by license conditions to be recorded in vessel logbooks by each commercial operator. This data has been recorded since 1995. However, the data required to be recorded by the operators have been changed several times over the past decade to improve the quality of the data collected. In 2008 the logbook data was finally reviewed to coincide with the development and implementation of an electronic monitoring system (EMS) to replace logbooks in 2009. Spotter pilot data has been collected from 2002 onwards.

Aligns with

Corporate Plan: Strategy/s: 1.2, 1.3, 2.3, 7.4, 8.4, 8.5;

Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005-2015: Strategy: 7.1.15

Whaleshark Interaction Management Program No 27.

Aims

This project aims to review the existing whale shark industry logbook data to evaluate the utility of the data to determine industry trends and ecological parameters relating to whale sharks while in Ningaloo Marine Park. The objectives of the project are:

- to ensure ecological data collected through the whale shark interaction industry has scientific applications; and
- to track the trends over time in human pressure on the Ningaloo whale shark population
- to determine sources of error within the existing vessel logbook data set so that data accuracy and interpretation may be improved in the future.

Summary of progress and main findings

- EMS data is included in the MPRA report, see section on whale sharks
- A collaborative project, examining the spotter plane (spatial) data has been initiated

Major activities and outputs

- An annual progress report: Whale Shark Interaction Management Program No 27
- Season updates.

Management Implications

Monitoring industry trends within the whale shark industry at Ningaloo Marine Park has been on-going since 1995. In regards to ecological parameters, the data can now provide an indication of intra- and inter-seasonal variation in relative abundance. Passenger levels will give an indication of when the carrying capacity of the industry has been reached and what, if any, impacts this will have on whale shark interactions. Estimated whale shark size and gender data has been collected in vessel logbooks and some uncertainty in regards to error sources requires further analysis and research for accurate interpretation of this dataset.

DEC cautions any researcher wishing to derive statistically valid results from the log book/EMS data set to familiarise themselves first with the sources of data errors. The log books were not intended to provide stand alone scientifically rigorous population modelling but rather were developed to reflect industry trends. Little effort has been spent in the past to either train recorders or verify that data recording is occurring with accuracy and consistency. Further reviews of the EMS data and collection method are in progress to ensure that information gathered is accurate and useful to scientists and decision-makers involved in the conservation management of the whale shark of Ningaloo.

Future directions

- analysis of 2010 data and finalise 2010 annual report;
- Continue to collect and analyse data during 2011 season;
- Further analysis of aerial data to provide better search effort data that can be correlated with other factors that may have an influence on inter-seasonal variability of relative whale shark abundance; and
- Undertake more detailed size data analysis and accurate length measurements of whale sharks to assist with management actions to address the indicative trend of reduced average size.

3.2.2 Monitoring of Coastal Camping along Ningaloo Coast

SPP #: (to be allocated)

Core project

Team members

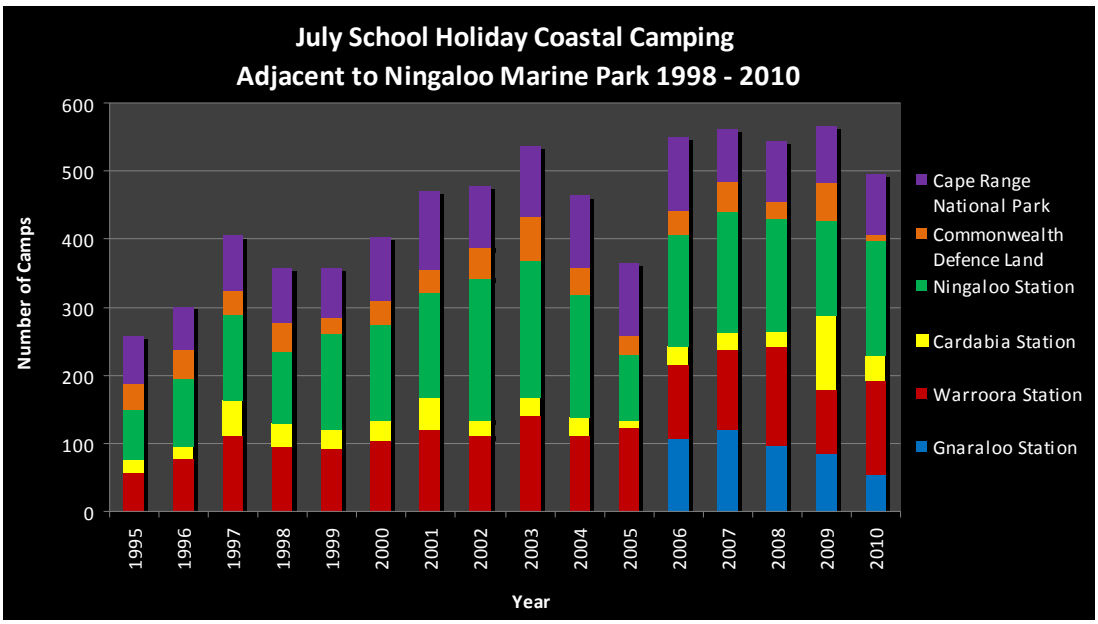
C Smallwood, H. Taylor, R Mau

Context

In order to ascertain the level of visitation in the Ningaloo Marine Park, it is important to understand the level of camping activity on the adjacent pastoral lands to the Park. A systematic monitoring program has been in place for 15 years, collecting counts of coastal camping and identifying trends in recreational activities along a set path within the April, July and October school holidays every year.

Summary of progress and main findings

There has been in increase in the numbers of campers on the Ningaloo coast over the past 15 years, although it seems with the current camping capacity the coast has reached a plateau in recent years. Camping on the Bundera (Commonwealth) defence land has also been reduced. On average, there is almost twice the number of visitors that in 1995 in 2010.



Major activities and outputs

- Coastal flights from the northern boundary of NMP to Red Bluff, on the southern boundary, are conducted on the same days in each school holiday period each year;
- The district patrol log is completed, with counts of camps, vehicles, boats, fishers, passive retreaters, commercial tours etc collection for each delineated section of the NMP.

Management Implications

Increased education and compliance activities will occur in peak periods and locations over time.

3.3 Midwest Region

3.3.1 Monkey Mia Dolphin Monitoring Program

SPP #: (to be allocated)

Core project

Team members

L. Bejder, D. Holley

Context

The reduction in the number of commercially licensed operators in the Red Cliff Bay area off Monkey Mia was undertaken in response to research findings evaluating long term impacts of vessel activity on Dolphins. This management action was based mainly on 2 findings: 1) a statistically significant decline of 15% (equivalent to 1 in 7 individuals) in the use of Red Cliff Bay by individual dolphins during a time period when vessel activity doubled; and 2) female dolphins with high exposure to vessels are less successful at reproducing compared to the lower exposed females.

Follow up research is required to evaluate the effectiveness of management actions taken by DEC to restore dolphin abundance and reproductive success in Red Cliff Bay.

Specifically the objectives of this research are:

- To estimate the relative abundance of bottlenose dolphins in both 'control' and 'tourism' areas off Monkey Mia subsequent to management actions;
- Compare relative dolphin abundance estimates in both 'control' and 'tourism' areas before and after implementation of management actions; and
- To evaluate whether management implementations reverse the documented negative impacts on female reproductive success of cumulative tour and research vessel exposure.

Aligns with

Corporate Plan strategy/s: 1.2, 2.3, 8.4, 8.5; KRA1, KRA2.

Science Division Strategic Plan strategy/s:

Shark Bay Marine Park Management Plan strategy/s: SBMR MP s5.5.7

Summary of progress and main findings

This project is 5 year completed of a 5 year program. Using the same modelling techniques as in the original study, and information from an additional ~2800 dolphin group encounters, analyses indicate a further 7.02% (95% CI=−19.1 to −2.8) decline per km^2 within the tourism site. One year of black box data showed that management intervention reduced slightly the total amount of time tour operators spent within the tourism site.

Major activities and outputs

Currently no reports have been produced. However all analyses are complete. An abstract of the work has been submitted for presentation at the Biennial Marine Mammal Conference, and a poster has been presented at the 2011 AMSA conference in Fremantle.

Management Implications

This project will provide the appropriate post analysis of the reduction of tour operators in the Monkey Mia exclusion zone. The desired response would be a return to or increase in abundance levels to those before the introduction of a second tour vessel within the Red Cliff Bay Area.

Future directions

The 4th annual report from the project is due. This report will include a complete analysis that will allow comparison of relative dolphin abundance within the defined areas. The project is due for completion 31 May 2012.

3.3.2 Shark Bay Loggerhead Turtle Tagging Program

SPP #: (to be allocated)

Core project

Team members

D. Holley (0.1) SB District Staff

Context

In 1994, the Department of Environment and Conservation (DEC) initiated as part of the Western Australian Marine Turtle Program (WAMTP) a tagging program of nesting female loggerhead turtles at Turtle Bay, Dirk Hartog Island. The tagging program utilises a mark and re-capture methodology to estimate the population size based on the ratio of tagged and non-tagged turtles surveyed annually. During each survey female turtles are intercepted as they come up on the beach to nest. Turtles are marked using small uniquely numbered titanium turtle tags attached to the trailing edge of the fore-flipper(s) allowing turtles to be individually identified and monitored over time. The tag number/s, carapace length and condition of each turtle surveyed are entered into the WAMTP database each year. The timing of the program corresponds with a peak in the annual December to April loggerhead turtle nesting season. The WAMTP database currently holds 14 years of tagging data (approximately 6,000 records for turtles tagged at Turtle Bay since 1994) which can be used to monitor the size and health of the loggerhead turtle population nesting at Turtle Bay. The development of a long term data set is essential for undertaking effective management and determining management effectiveness, given that change in turtle population abundance/health is only detectable over long periods, given their reproductive biology and longevity.

Aligns with

Corporate Plan strategy/s: 1.2, 2.3, 8.4, 8.5; KRA1, KRA2.

Science Division Strategic Plan strategy/s:

Business Plan project no:

Shark Bay Marine Reserves Management Plan strategy/s: s5.5.4

Summary of progress and main findings

Since 1994, with the exception of 1995 and 2006, the program has been conducted annually over a two week period in January. The WAMTP dataset has not been analyzed and as such there is not a current reliable estimate of the status of the Turtle Bay loggerhead turtle nesting population. The future analysis of this long-term dataset will need to address issues relating to a change in methodologies between 2004 and 2007 which reduced sampling effort from five beaches to two.

Major activities and outputs

Annual mark recapture program continued during the 2010/2011 nesting season, with all five nesting beaches surveyed and over 1000 migrant and re-migrant turtles marked or recaptured.

Management Implications

The Turtle Bay nesting population of the endangered Loggerhead turtle represents the largest rookery of this species in WA. Monitoring of this population is vital for long term maintenance of the species.

Future directions

- Define peak period for breeding season through use of remote camera monitoring, continue to utilise remote camera for daily track counts of main nesting beaches;
- Continue with the 20011/12 nesting season tagging program; and
- Assess validity of current mark recapture program for long-term monitoring against budget expenditure and personnel requirements. An assessment will be made as part of state-wide turtle monitoring and research program.

3.3.3 Jurien Bay Marine Park Australian Sealion Pup Counts.

SPP #: Unknown

Team members

I Hatch, L Butcher, G Ingliss, K Crane, E Richardson, S Glac, M Dasey, and other DEC Moora district staff.

Context

Through anthropogenic pressures the west coast distribution of Sea Lions (*Neophoca cinerea*) has contracted to a few breeding colonies. Two of these colonies are within Jurien Bay Marine Park (Buller Island and North Fishermans Island) and a third (Beagle Island) is close to the park. The species is known to have a low fecundity and show extreme reproductive site-fidelity. This site fidelity is such that where a localized extinction has occurred recolonisation of that site from other colonies is not thought to be possible. Any decline in reproductive output from an individual colony therefore represents a significant threat to the species as a whole and needs to be identified. The following monitoring has been conducted by JBMP staff: three breeding colonies are visited at least twice through the pupping season and counts are made of live newborn, moulted pups and dead pups.

Aligns with:

Jurien Bay Marine Park Management Plan Number 49: Strategy/s: 7.1.9/3 (Monitor trends in sealion pup production each breeding season); 8.5/1 (Develop and implement a prioritized monitoring program of key values and processes.)

Summary of progress and main findings

- Annual pup production is stable at approximately 140 to 180 pups per season at the three islands in/near JBMP.
- Pup counts have been conducted in 1988, 89,91,97,98,00,03,04,05,07,08 and 2010.
- Data has been provided to external researchers for value-adding.

Major activities and outputs

- Strategy 7.1.9/3 has been achieved by this program (Monitor trends in sealion pup production each breeding season.).

- Video footage of the counts was provided to WinTV and was broadcast as a positive news story on network news (Jan 2010).

Management Implications

The main pressures on Sealion populations are thought to be from fishing. Commercial and recreational Western Rock Lobster (WRL) fishing places pressure on Australian Sealions in two ways: Pups may drown in cray traps; and there may be competition for food - crayfish are thought to be a key component of Sealion diet. Exclusion devices on craypots in the area are now widely accepted by the community and this would've prevented deaths of some sub-adults each season. However, pressure on WRL stocks by over fishing could lead to declines in Sealion fecundity, which would require a management response.

Future directions

This is an ongoing program intended to run every breeding season. The next season is in mid/late 2011.

3.3.4 Jurien Bay Human Use Monitoring Program

SPP #: Unknown

Team members

I Hatch, L Butcher, G Ingliss, K Crane, E Richardson, S Glac, M Dasey

Context

Quantifying the spatial and temporal intensity of usage in and adjacent to Jurien Bay Marine Park has been conducted since 2003/04 using five main methods:

1. Aerial surveys / counts of park visitors, including vehicles, camps, and vessels. There have been 54 flights April 2004 to June 2011 and records are in GIS system. Each aerial survey covers approximately 500 km^2 and records the location activity in the marine park or on adjacent lands.
2. The continuous recording of trailer traffic at Jurien Bay Marina (*MetroCount* data). There is almost continuous data recording from 12th September 2005 to July 2010, with two gaps of 9 weeks in total - in all over 1600 days of data.
3. Land-based patrols and recording of visitors. Sporadic records mainly from 2004;
4. Gathering and collation of park visitor records from sea rescue and nearby camp grounds. Annual stats from Jurien Coastal Patrol and Sandy Cape camping 2004-2006.
5. Face-to-face interviews of park users. One series of interviews Easter 2003.

The data generated from this monitoring program is used to benchmark park visitation and identify areas of high use. Aerial flight records also contain information on illegal/informal camps, cray pot locations, watercraft, vehicles and boat trailers so a variety of management issues can be addressed with the data.

Aligns with:

Management Plan Number 49 (JBMP) strategy/s:

- 8.5/2 (H-KMS: Develop and maintain a database of human usage);
- Activity Code EC1 – Human Use Impacts

Summary of progress and main findings

- All data for the surveys has been loaded onto databases and several GIS layers for

each aerial survey have been created. Analysis has been performed on some of the data and correlations between data recorded in different methods have been used to extrapolate where data gaps exist.

- The surveys have quantified the number of number of visitors to different parts of the marine park in each month of the year. Clear annual patterns of park visitation have been identified and it is possible to extrapolate the date to estimate the total annual number of visitors to the park.
- The number of records of trailer movements are highly correlated (R^2 >0.75) with counts taken on simultaneous aerial surveys of vessels, vehicles, and general visitor numbers.
- Strategy 8.5/2 (H-KMS: Develop and maintain a database of human usage) has been achieved.

Major activities and outputs

No major published outputs have arisen from this work other than in-house analysis for annual reporting. Key periods in the year have been identified as highest use. No significant changes is total annual park visitation are apparent from the existing data for 2006-10.

Management Implications

This data gathering provides a means to plan compliance and educational activities and provides evidence of stable park visitation rates through time. It has identified areas and periods of high/low use, poor compliance and has allowed quantification of the number of park visitors in each area.

Future directions

For 2011-12:

- The MetroCount data gathering is to be continued at the same location near Jurien Marina,
- Six aerial surveys are planned for the year with recording of data as has been done previously,
- Data is to be consolidated and passed on to DEC GIS unit for wider distribution.

3.3.5 Jurien Bay MP Seagrass Monitoring Program.

SPP #: Unknown

Team members

I Hatch, L Butcher, G Ingliss, K Crane, E Richardson, S Glac, R Koch, M Dasey; and researchers from Edith Cowan University under the direction of Kathryn McMahon.

Context

The dominant primary producer in Jurien Bay Marine Park is the extensive beds of macrophytes which encompass several species with a variety of growth forms. These seagrass beds are range in depth from intertidal to over 10 metres in depth and are found throughout the park on sandy substratum. The health of the seagrass is a KPI in the management plan, so monitoring the health of these beds is of high importance. The monitoring program consists of:

- In *Posidonia sinuosa* beds at two locations (near Boullanger Island and near Fishermans Island) four permanent transects have been establish at three separate depths (12 transects at each location). Along each of the permanent transects six

permanent steel quadrats (0.2m x 0.2m) have been placed and the seagrass shoots in each quadrat have been measured on a number of occasions.

- Within each quadrat the following measures are made: The number of shoots in the quadrat; the length of the longest seagrass leaf in the quadrat; an estimate of the percent cover in the quadrat.
- The field sampling has been conducted in 2003, 04, 05, 07, 08, 2010 and 2011.

Aligns with:

Management Plan Number 49 (JBMP) strategy/s:

- 7.1.4/4, (KPI, H-KMS: Monitor Seagrass meadows in areas at most risk from mooring and anchor damage.)
- 7.1.4/2, (KPI, KMS: Educate users of the important ecological role of seagrass communities…)
- 8.5/1 (KPI, H-KMS: Develop and implement a prioritized monitoring program of key values and processes.)

Summary of progress and main findings

- Prior studies independent to this program have been published internally by How and Lavery (2003 and 2004).
- Data compilation and analysis of JBMP data has been performed in 2007 by ECU and is presented in an internal data report.
- There are no clear overall temporal trends apparent from the data between 2003 and 2010 although there are some statistically significant differences between years at some depths.
- Benchmarking of some seagrass meadow parameters has been achieved by this program.

Major activities and outputs

- Strategy 7.1.4/4 has been achieved (Monitor Seagrass meadows in areas at most risk from mooring and anchor damage).
- Strategy 7.1.4/2 has been partially achieved (Educate users of the important ecological role of seagrass communities…) in that relevant information is available for publication, and some has been published.
- Strategy 8.5/1 is being addressed (Develop and implement a prioritized monitoring program of key values and processes.)

Management Implications

Values for some basic parameters of seagrass meadows have been benchmarked so that change in this might be detected.

Future directions

- Data to make a methodological comparison of fixed quadrats and haphazardly-cast quadrats was collected in 2011. The outcome of this analysis may alter future monitoring protocols.
- Depending on the methodological review it is anticipated to continue this program in 2011/12, and reassess the effectiveness of the design to meet the management targets.

3.3.6 Jurien Bay MP Biodiversity Monitoring Program (UTAS)

SPP #: Unknown

Team members

I Hatch, L Butcher, G Ingliss, K Crane, E Richardson, S Glac, M Dasey, K Bancroft (MSP), external researchers from The University of Tasmania – N Barrett, G Edgar *et al*.

Context

The goals of this program were/are to both identify areas of high biodiversity and representation that are worthy of being protected and to monitor change in those places through time, through a BACI-style design. The program has had two main phases: there were approximately 25 sites monitored eight times between 1999 to 2009, and an additional 17 sites that have been monitored from 2004. In summary the program consists of:

- Diver fish surveys. These consist of swum transects of 200m long whereby the diver records the species of each fish seen and the approximate size of each fish.
- Diver macroinvertebrate surveys. Within randomly cast quadrats along 200m transects counts of species sea urchins, gastropods, corals, sponges and other classes of invertebrate were made.
- Diver macroalgae surveys. Percent algal cover for several classes are estimated along transects at a number of points.

The data generated from this program has been analysed in a variety of univariate and multivariate ways to yield a wide range of diversity and temporal change data. At the start of the program it was envisioned to run the project 5 year pre zoning and 5 years post zoning and this will be achieved in 2009.

Aligns with:

Management Plan Number 49 (JBMP) strategy/s:

- 7.1.5/2, (Initiate research programs to quantify the floral and faunal diversity in macroalgal habitat in relation to developing management targets.)
- 7.1.7/2, (H-KMS: Undertake research programs to characterize invertebrate diversity in the marine park)
- 7.1.8/2, (KPI H-KMS: Undertake research programs to characterize finfish diversity in the marine park
- 8.4/3, (KPI H-KMS: Identify and communicate high priority scientific and social research projects to appropriate research organisations.)

Summary of progress and main findings

All data management is undertaken by UTAS and no significant analysis or reporting has been performed by DEC staff. However, data reports have been provided and some published work has been released with the consent of DEC.

A trend of increasing mean size for Breaksea Cod and Silver Trevally through time in protected areas are reported and the lack of representative deeper areas in sanctuary zone are key findings.

- Strategy 7.1.5/2, (H-KMS: Initiate research programs in macroalgal habitats) has been achieved.
- Strategy 7.1.7/2, (H-KMS: Characterize invertebrate diversity in the marine park) has been achieved.

- Strategy 7.1.8/2, (KPI H-KMS: Characterize finfish diversity in the marine park) has been achieved.
- Strategy 8.4/3, (KPI H-KMS: Identify and communicate research project) has been achieved.

Major activities and outputs

Several internal data reports have been compiled and provided to JBMP.

Management Implications

Future rezoning of JBMP could be based on this program.

Future directions

- The before/after program reached its planned end in 2009/10.

3.3.7 Jurien Bay MP Water Quality Benchmarking Program

SPP #: Unknown

Team members

I Hatch, L Butcher, G Ingliss, K Crane, E Richardson, S Glac, M Dasey; K Bancroft (MSP), R Masini (MEB).

Context

The biota of the bioregion in which Jurien Bay Marine Park is situated has evolved in an environment with very little nutrient input having few riverine sources of terrestrial nutrients. The resultant clear water and low water nutrient concentrations have favoured the growth of extensive macrophyte beds in areas that might otherwise be dominated by macroalgae or bare substratum. Changes to water clarity and nutrient concentrations are known threats to macrophyte beds. Two water quality benchmarking programs have been conducted on different spatial and temporal scales:

- 2004/05 Monthly sampling was conducted over a 12 month period at 19 sites with analysis for toxicants, nutrients and physico-chemical WQ. Data includes: TSS, PAR, OC, NH_3, NOx, OP, Chl-a, Conductivity, Temperature, DO for most sites in monthly sampling.
- 2006, 08, 09. Four sites have been sampled over a 2 month period which included sites that had been sampled in the 2004-05 program. Data includes: TSS, PAR, OC, NH_3, NOx, OP, Chl-a, Conductivity, Temperature, DO for most sites in weekly sampling spread over 2 months.

Aligns with:

Management Plan Number 49 (JBMP) strategy/s:

- 7.1.2/3. (KPI, H-KMS: Establish baseline water quality monitoring program in relation to nutrient enrichment.)
- 8.5/1 (KPI, H-KMS: Develop and implement a prioritized monitoring program of key values and processes.)

Summary of progress and main findings

- Data compilation and analysis has been performed in some depth for the 2004-05 data and this showed that the overall the water quality of the area was good. The Jurien Marina was identified as have eutrophication and algae problems. Presented in Data Report: MMS/CWC/JBMP-83/2005

- Analysis of the 2006-09 data found that there were no clear temporal or spatial trends in the study period and that for many nutrient analytes the concentration of nutrients was close to or below analytical detection limits. In particular N as NOx and NH_3 were not present in measurable concentrations in most samples for 2009. Chl-a was low and variable but above detectable limits in the study period. The concentration of Chlorophyll - a was greatest at the site closest to Jurien Bay town (PI3) and this could constitute an impact of nutrient enrichment from the community, though the concentration was below acceptable limits (mean of 0.56 µg/L).

Major activities and outputs

- Strategy 7.1.2/3 has been achieved (Establish baseline water quality monitoring program in relation to nutrient enrichment) and a possible location of nutrient enrichment to the nearshore waters has been identified.
- Future changes in water quality parameters can be identified from established baseline data.

Management Implications

The suspected low ambient nutrient status of the area has been verified and benchmarked for many sites in the marine park. The low rate of nutrient inputs to the system because of low runoff is a characteristic of the ecology is identified as a key process in maintaining the macrophyte beds in these locations.

Future directions

There is no plan to continue with the existing water quality monitoring program until 2012/13 as it is thought that sufficient data has been gathered for benchmarking.

3.3.8 Abandoned, Lost or Discarded Fishing Gear (ALDFG) Monitoring Program

SPP #: Unknown

Team members

M Dasey, S Glac, R Koch, other district staff and Conservation Volunteers Australia

Context

In 2009 the United Nations Environment Program (UNEP) identified Abandoned Lost or otherwise Discarded Fishing Gear (ALDFG) as a common global threat to many aspects of marine ecological processes. This includes entanglement risks to marine mammals and the introduction of plastics to marine food chains. As well, ALDFG from local commercial rock lobster fishers is an unsightly feature of many of Jurien Bay Marine Park's beaches and represents a significant impact to the natural values of the area. This program is designed to both (a) remove plastics and ALDFG that could pose a threat to marine ecosystems, and (b) improve the amenity and natural values of areas of high recreational use. As well using UN protocols some sites have been sampled to classify and quantify waste to monitor future changes in behaviour. The intention is to remove ALDFG from all 90km of the park's beaches by 2011/12:

- October 2009 – with Conservation Volunteers Australia 30km of beach was visited and all ALDFG and litter was removed.
- March 2010 – Conservation Volunteers Australia and DEC removed waste from a further 12km of beach.
- October 2010 - Conservation Volunteers Australia and DEC removed waste from a further 20km of beach.
- April 2011 - Conservation Volunteers Australia and DEC removed waste from a

further 16km of beach.

Aligns with:

Management Plan Number 49 (JBMP) strategy/s:

- 7.1.2. (KPI, H-KMS: Develop an appropriate understanding of the circulation and mixing of the marine park's waters.)
- 8.5/1 (KPI, H-KMS: Develop and implement a prioritized monitoring program of key values and processes.)

Summary of progress and main findings

- Data compilation is currently underway and no reporting has been commenced.
- Significant amounts of floats and ropes from commercial and recreational fishing have been found in the surveys,
- Transport of ALDFG has been found to be sea-breeze driven in a northern direction,
- ALDFG and litter has been found to accumulate on the southern side of shoreline features such as headlands,
- Locations of high-deposition of ALDFG have been identified and can form the focus of ongoing efforts.

Major activities and outputs

- Strategy 7.1.2 has been partially achieved (Develop an appropriate understanding of the circulation and mixing of the marine park's waters.) and a knowledge of where accumulations of ALDFG occur has been established.
- Media releases reporting the program have been produced and positive local media coverage has occurred.
- Future changes in ALDFG deposition can be identified from established baseline data.

Management Implications

The removal of entanglement hazards reduces risks to Australian Sealions in the marine park. By restoring the amenity value of places with high-recreational use social values of the reserve are also enhanced. This program has been used to engage the community and could be used to raise awareness within the fishing industry of the problems associated with rogue fishing gear.

Future directions

- The intention is to visit all beaches of the marine park and remove ALDFG and recreational litter from them by 2011/12.
- The quantitative data is to be analysed at the conclusion of the program.

3.4 Swan Region

No current marine science projects

3.5 South West Region

No current marine science projects

3.6 Warren Region

No current marine science projects

3.7 South Coast Region

No current marine science projects

4. CURRENT COLLABORATION WITH ACADEMIA

DEC Officer	Student	Project title	Degree	Academic
Chris Simpson	A. Hill	Factors influencing the establishment of marine protected areas in Western Australia	PhD (2007-10)	Dr S Shea, Notre Dame University
Alan Kendrick, Mike Rule	various	Marine & Coastal Management Course	3rd yr (2011)	A/Prof G Hyndes, Prof P Lavery, Edith Cowan University
Chris Simpson, Shaun Wilson, Kelly Waples	various	Science Connections: Marine Science Mentoring Program	U/grad (2010)	Dr M van Keulen, Murdoch University
Bob Prince	L. Woolgar	Where are loggerhead turtles produced in WA? Current and future scenarios	Hons (2010-11)	Dr N Mitchell, University of WA

5. EXTERNAL PARTNERSHIPS

Partnership	Project	Cash funding & source	DEC in kind support (fte)
AMSA (WA)	Rottnest Young Scientist Workshop	$500 sponsorship	THO (0.01)
AIMS	Coral reef fish recruitment study	AIMS field support	SWI (0.1), THO (0.1)
AIMS, ANU, UWA	Ningaloo Seasonal Seaweeds	$ 30000	SWI (0.05), JMO (0.3), KMU (0.15), THO (0.05), JHU (0.05)
AIMS, CSIRO, DoF	2010-11 WA regional-scale coral bleaching study	Nil	JMO (0.275), SWI (0.075)
BA	Shark Bay Shorebird Survey	$2000	KON (0.03), Shark Bay District ($6 500)
CSIRO	What is the role of predators at Ningaloo and how are they impacted by human use?	$55000 + $10000 (DEC)	SWI (0.1), THO (0.1).
DoF	Resource Condition Monitoring of Mangroves in Northwest Australia	Nil	KFR (0.02)
ECU	Monitoring movement patterns of marine fauna using Vemco VRAP Acoustic tracking system	Nil	AKE (0.01), SWI (0.01)
ECU	Collaborative marine management teaching in the WNIMP	$2500	AKE (0.05), MRU (0.05)
JCU	Monitoring fish and coral communities at Trunk Reef	$2000	SWI (0.05)
KLC	Movement behaviours and habitat usage of west Kimberley dugongs: A community based approach	$129,990 (AMMC) + $30,000 (Woodside)	SWI (0.05), DHO (0.1), Shark Bay District ($5500)
MU	An ecosystem approach to estimating the viability of dolphin populations exposed to industrial & port activities	$10000 for 3 yrs (DEC)	CSI (0.05)
MU	Little Penguin Study: Development of a monitoring protocol	$27500 for 3 yrs (DEC)	CSI (0.05)
MU	Monitoring management effectiveness: Monkey Mia dolphins	$15-25000 pa for 6 yrs	CSI (0.05)
NCCARF	Network case study: Marine biodiversity and resources network	$900	THO (0.03)
UWA	Establishing genetic guidelines for the effective ecological restoration of seagrass	$5000 for 3 yrs	AKE (0.05)
UWA	Assessing fish communities in Marmion Marine Park	$4000 (DEC)	KFR (0.01)
UWA	Assessing fish communities in Shoalwater Islands Marine Park	$12000 (DEC)	KFR (0.01), AKE (0.01), SWI (0.01), MRU (0.05), KBA (0.01), THO (0.05).

6. SUMMARY OF RESEARCH PROJECTS BY DEC AND NRM REGIONS

DEC Region	NRM Region	Project Title
Pilbara	Rangelands	WAMSI Node 3: Science administration, coordination and integration
Midwest, Pilbara, Kimberley	Rangelands	Conservation of marine turtles in Western Australia
All	All	Strategic marine research plan for the Western Australian Department of Environment and Conservation: 2010-2015
All	All	Strategic plan for the development and implementation of the Western Australian Marine Monitoring Program (WAMMP)
All	All	WAMMP Sub-project 1: Asset knowledge review and standard operating protocol documentation
All	All	WAMMP Sub-project 2: Historical time-series development
All	All	WAMMP Sub-project 3: 'Fit to Park'
All	All	WAMMP Sub-project 4: MPRA/DEC audit support and management effectiveness reporting
All	All	WAMMP Sub-project 5: community participation and liaison
All	All	WAMMP Sub-project 6: Marine information management system
Warren	South Coast	Spatial and temporal patterns in benthic invertebrate communities of the Walpole and Nornalup Inlets Marine Park
Swan	Perth	Spatial and temporal patterns in the structure of intertidal rocky platform communities of the Shoalwater and Marmion marine parks
Pilbara	Rangelands	Interactive effects of fishing and climate change on reef fish populations
Pilbara	Rangelands	Preliminary assessment of diseases affecting Western Australian corals
Midwest	Rangelands	Spatial variation in the functional morphology of mangroves in the Shark Bay World Heritage Area
Midwest, Swan, Southwest	Northern Agricultural, Perth, South Coast	Knowledge transfer and uptake of recent temperate marine research in WA
South coast, Southwest, Warren	South Coast, South West	South coast pinniped survey
Pilbara	Rangelands	Effects of the Gorgon Project dredging program on the marine biodiversity of the Montebellos/Barrow Islands marine protected areas
Midwest, Pilbara		WA regional-scale coral bleaching study
Midwest, Pilbara, Kimberley	Rangelands, Northern Agricultural	Comparison of underwater video census and diver operated video methods for assessing fish community condition in tropical and temperate coastal waters of Western Australia

7. SUMMARY OF SIGNIFICANT ACHIEVEMENTS FOR 2010/11

Achievements
Progressive implementation of the marine research plan, and an increased output of research publications. MSP research scientists have undertaken studies diversely focussed on climate change and fishing impacts on coral reefs, macroalgal community dynamics, coral bleaching, coral disease, fish community structure, mangrove ecology, benthic invertebrate ecology and intertidal reef ecology.
Refined and improved the structure and delivery of WAMMP. Expanded the implementation of systematic State-wide MER of marine reserves and threatened marine fauna. Improved structures for the delivery of asset CPR data to the MPRA audit process.
Four field surveys were undertaken for the Gorgon MER program, which have provided a greater understanding of the impact of dredging operations on coral and fish communities of the Montebello and Barrow Islands.
Completion of major research projects in WAMSI Node 3: Ningaloo Research Program and commencement of synthesis reporting.
Development of the Kimberley Marine Research Strategy as part of the successful MRI bid for WAMSI 2.
Continued implementation of the framework to facilitate the transfer of science knowledge into DEC marine policy, planning and management frameworks.
Appointment of Dr Scott Whiting to the position of Principle Research Scientist (Sea Turtles).

8. PRIORITIES OVER THE NEXT TWO TO THREE YEARS

Priorities
Continue to develop and implement marine research in accordance with strategic priorities.
Continue to expand the implementation of WAMMP in collaboration with DEC regions.
Develop and implement a strategic and prioritised State-wide sea turtle research and monitoring program.
Oversee DEC's involvement in WAMSI 2.
Complete research and monitoring associated with the Gorgon Dredging offsets and implement research and monitoring associated with the Pluto and Wheatstone development offsets.
Complete WAMSI Node 3: Ningaloo Research Program summary and synthesis reporting.
Appoint a senior scientist to coordinate DEC-supported marine mammal research.
Continue to build research and monitoring capacity in the Marine Science Program.
Continue to build strategic alliances with external marine science institutions.
Increase community involvement in DEC marine science programs through community monitoring and NRM groups.

9. MARINE SCIENCE PROGRAM EXPENDITURE FOR 2010/11

Activity/Project title	DEC Region	PI	Expenditure
Marine Science Program administration	All	CSI	$188793
Committees, advice & ministerials etc	All	CSI	$68531
Program Leader contingency	All	CSI	$75537
WAMSI Node 3: Administration	Pilbara	KWA	$14991
WAMSI Node 3: Data management	Pilbara	KWA	$0
WAMSI Node 3: Communication	Pilbara	KWA	$0
WAMSI Node 3: Knowledge transfer	Pilbara	KWA	$44972
Strategic Marine Research plan for DEC: 2010-2015	All	SWI, AKE	$5000
Conservation of marine turtles in WA	Midwest, Pilbara, Kimberley	BPR	$41280
Strategic plan for the development and implementation of WAMMP	All	KFR	$0
WAMMP Sub-project 1: Asset knowledge review and standard operating protocol documentation	All	KFR	$82221
WAMMP Sub-project 2: Historical time-series development	All	KFR	$29761
WAMMP Sub-project 3: Fit to park	All	KFR	$262722
WAMMP Sub-project 4: MPRA/DEC audit support and management effectiveness reporting	All	KFR	$75168
WAMMP Sub-project 5: Community participation and liaison	All	KFR	$28556
WAMMP Sub-project 6: Marine information management system	All	KFR	$12427
Spatial and temporal patterns in benthic invertebrate communities in the WNIMP	Warren	AKE	$60453
Spatial and temporal patterns in the structure of intertidal rocky platform communities of the SIMP and MMP	Swan	AKE	$41987
Spatial variation in the functional morphology of mangroves in the Shark Bay World Heritage Area	Midwest	MRU	$36987
Knowledge transfer and the uptake of recent temperate marine research in WA	Southwest, Swan, Midwest	KWA, AKE	$0
Interactive effects of fishing and climate change on coral reef fish populations	Pilbara	SWI	$88287
Preliminary assessment of diseases affecting WA corals	Pilbara	SWI	$10081
Comparison of UVC and DOV methods for assessing fish community condition in tropical and temperate coastal waters in WA	Midwest, Pilbara	SWI	$19095
Ningaloo macroalgal community study	Pilbara	SWI	$41960
Baseline fish survey of Rowley Shoals/Montebello-Barrow marine reserves	Pilbara, Kimberley	SWI	$12395
Total			**$1257061**

10. MARINE SCIENCE PROGRAM: SUMMARY OF BUDGET ALLOCATION AND EXPENDITURE FOR 2010/11

CF budget allocations for each marine reserve have been adjusted such that allocations to MSP core CF and cross-regional projects, such as WAMMP, have been distributed across all marine reserves. Significant external funding was obtained for research and/or monitoring in the Montebello/Barrow Islands marine reserves (Gorgon project offset funding) and the Ningaloo marine reserves (WAMSI node 3).

Marine reserve(s)	Specific MPA CF allocation	Adjusted CF expenditure	External funding	TOTAL
Rowley Shoals Marine Park	$0	$133216		$133216
Montebello/Barrow Islands marine reserves	$164861	$140611	$546000	$686611
Ningaloo marine reserves	$360640	$341069	$82122	$423191
Shark Bay marine reserves	$82420	$171400		$171400
Jurien Bay Marine Park	$0	$127018		$127018
Metropolitan marine reserves	$82420	$162640		$162640
Walpole & Nornalup Inlets Marine Park	$30905	$181107		$181107
Marine Science Program core CF	$535815	$0		$0
Total	**$1257061**	**$1257061**		**$1885183**

11. MARINE SCIENCE PROGRAM STAFF PRODUCTIVITY FOR 2010/11

Kim Friedman – Principle Research Scientist	
SCIENCE	
SPP	
Data report	
Technical report	Friedman K.J, Kronen M., Vunisea A., Pinca S., Pakoa K., Magron F., Chapman L., Sauni S., Vigliola L., Tardy E., Labrosse P. 2010. Fiji Islands country report: profiles and results from survey work at Dromuna, Muaivuso, Mali and Lakeba (September to November 2002, April to June 2003, June and July 2007, and February 2009). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). xxxv, 467p Pinca S., Kronen M., Friedman K., Magron F., Chapman L., Tardy E., Pakoa K., Awira R., Boblin P., Lasi F. 2010. Regional assessment report: Profiles and results from survey work at 63 sites across 17 Pacific Island Countries and Territories. Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). xxvii, 512 p. Pakoa K., Friedman, K., and Damlamian, H. 2010 The status of trochus (Trochus niloticus) in Tongatapu Lagoon, Kingdom of Tonga. SPC Trochus Information Bulletin 15:3-16. Ropeti, M.E., Friedman, K., Pakoa, K., Tafileichig, A. 2010. Ram, R., Friedman, K., Sobey, M. 2010.
Conference paper	
Journal paper	Friedman, K., Eriksson, H., Tardy, E., Pakoa, K. 2011. Management of sea cucumber stocks: patterns of vulnerability and recovery of sea cucumber stocks impacted by fishing. Fish and Fisheries 12(1): 75-93. Dalleau, M., Andrefouet,S., Wabnitz, CCC., Payri, C., Wantiez, L., Pichon, M., Friedman,K., Vigliola, L., and Benzoni, F. 2010. Use of habitats as surrogates of biodiversity for efficient coral reef conservation planning in Pacific Ocean Islands. Conservation Biology 24(2):541-552.
Book chapter	
Major review	
COMMUNICATION	
Media interviews	Sound Telegraph, Rockingham Newspaper (19 Jan 2011)
Pamphlets/information sheets/newsletters etc	Marine Wildlife of the North-West (input -assistance in formulation of ID Guide, main author C Thompson-Dans)
Briefings/formal discussion etc	Formal DEC marine representative for National State of the Environment Report meetings (1 - 3 March 2011) - and follow up on coral reef fish and mangrove communities information. Advice to MPRA re water quality in Marmion Marine Park at 10 year review Presentation to Aboriginal Heritage and Land and Sea Council Representatives on opporunities for Indigenous Community involvement with WAMMP aims Moore, J., Bellchambers, L., Depczynski, M., Evans, S., Field, S., Friedman, K., Gilmour, J., Holley, D., Holmes, T., Middlebrook, R., Ridgway, T., Taylor, H., Thomson, D., Tinkler, P., Wilson, S. (in press) 'Unprecedented bleaching of Western Australian reef corals' Heatwave Workshop Report.
Web-based communication	
Popular article	
Milestone reports	
Conference abstracts, presentations; seminar/lecture presentations; Poster/formal field day presentations	Presentation to Woodside oil and gas exploration and production company (Nov 2010). Shark Bay presentation to Comparative Ecosystems Studies - Shark Bay and Southern Florida Workshop (UWA March 2011)
KNOWLEDGE TRANSFER	
Advice (e.g. EIA, NRM etc) - (verbal)	Presentations to MPPB, SCUBA2 and Friends of Marmion Marine Park Community Groups, NC, PVS and Penguin Island Staff, Chief Scientist of Western Australia, Prof Lyn Beazely
Advice (e.g. EIA, NRM etc) - (written))	Written input into MPRA Audit asset report cards for all 13 MPAs for various assets including water quality, sediment quality, coral communities, macroalgae communities, seagrass meadows and finfish. Paper reviews Fisheries Research (1), Coral Reefs (1)
Planning/Management guideline - (contributing author)	Mayer,F., Friedman,K., Gioia,P. (in review). Dept. of Environment and Conservation Science Division, Marine Science Program. Information Management Strategic Plan 2011-2014.

Planning/Management guideline - (primary author)	
Species /Protected Area management plans - (contributing author)	
Species /Protected Area management plans - (primary author)	
Policy/Strategy statement (contributing author)	
Policy/Strategy statement (primary author)	

Kelly Waples – WAMSI Node 3 Science Coordinator	
SCIENCE	
SPP	
Data report	Metadata for all WAMSI node 3 projects provided to WAMSI Data Management Officer and available on MEST
Technical report	
Conference paper	
Journal paper	
Book chapter	
Major review	
COMMUNICATION	
Media interviews	
Pamphlets/information sheets/newsletters etc	Project profiles on 13 Node 3 projects completed, posted on the Ningaloo research website and made available to the public and the Regional office Contributed to Northwest Marine Species guide
Briefings/formal discussion etc	Presentation to the WAMSI Board on Node 3 progress, Nov 10 Presentation and discussion with Exmouth District Staff on Ningaloo research and knowledge transfer, July 10 Presentation and discussion with Jurien District staff, MPPB and PVS on temperate research and knowledge transfer within DEC, Aug 10
Web-based communication	Input to the WAMSI Ongoing support and maintenance along with CSIRO of the Ningaloo Research Program website (www.ningaloo.org.au).
Popular article	
Milestone reports	Waples K (2010). WAMSI Project 3.6: Science coordination: administration, communication and data management. Milestone report submitted to WAMSI, July 2010.
Conference abstracts, presentations; seminar/lecture presentations; Poster/formal field day presentations	Update on Ningaloo research and reporting of management strategy implementation, MPRA meeting, Oct 2010 4 other presentations to DEC branches/Divisions on the knowledge transfer and uptake framework and process.
KNOWLEDGE TRANSFER	
Advice (e.g. EIA, NRM etc) - (verbal)	National Marine Mammal Advisory Committee - grant application review for marine mammal research, May 11 Ningaloo Research Coordinating Committee - integration of the Ningaloo Research Program
Advice (e.g. EIA, NRM etc) - (written))	Briefings to DG re research priorities for WAMSI II
Planning/Management guideline - (contributing author)	
Planning/Management guideline - (primary author)	
Species /Protected Area management plans - (contributing author)	

Species /Protected Area management plans - (primary author)	
Policy/Strategy statement (contributing author)	
Policy/Strategy statement (primary author)	

Shaun Wilson – Senior Research Scientist	
SCIENCE	
SPP	Comparison of Underwater Video Census and Diver Operated Video methods for assessing fish community condition in tropical and temperate coastal waters of Western Australia Ningaloo Seasonal Seaweeds
Data report	Effects of Climate Change and Fishing Pressure on Fish Communities (Seychelles, fish and coral community recovery from bleaching) Field operations plan
Technical report	Wilson SK et al. (draft) Fit to park: a generic guide for assisting the determination of "when" and "where" to monitor assets
Conference paper	
Journal paper	Wilson SK, Depczynski M, Fisher R, Holmes TH, O'Leary RA, Tinkler P (2010) The importance of coral in the habitat use of juvenile reef fish. *PLoS ONE* 5, e15185. Cole A, Lawton R, Practhett MS, Wilson SK (2011) Chronic coral consumption by butterflyfish. *Coral Reefs* 30, 85-93. Farmer B, Wilson SK (2011) Diet of targeted finfishes and the implications for trophic cascades *Environmental Biology* 91:71-85 Graham NAJ, Chabanet P, Evans RD, Jennings S, Letourneur Y, MacNeil MA, McClanahan TR, Öhman MC, Polunin NVC, Wilson SK (2011) Extinction risk in coral reef fishes. *Ecology Letters* 14, 341–348 Mora C, Aburto-Oropeza O, Ayala Bocos A, Ayotte PM, Bank S, Bauman AG, Beger M, Bessudo S, Booth DJ, Brokovich E, Brooks A, Chabanet P, Cinner J, Cortés J, Cruz-Motta JJ, Magaña A, DeMartini E, Edgar GJ, Feary DA, Ferse SCA, Friedlander A,Gaston KJ, Gough C, Graham NAJ, Green A, Hardt M, Guzman H, Kulbicki M, Letourneur Y, López Pérez A, Loya Y, Loreau M, Martinez C, Mascareñas-Osorio I,Morove T, Nadon M, Nakamura Y, Paredes G, Polunin N, Pratchett MS, Bonilla HR, Rivera F, Sala E, Sandin S, Soler G, Stuart-Smith R, Tessier E, Tittensor DP, TupperM, Usseglio P, Vigliola L, Wantiez L, Williams I, Wilson SK, Zapata FA (2011) Human footprint on the linkage between biodiversity and ecosystem functioning in reef fishes. *PLoS Biology* 9 e1000606 Onton K, Page CA, Wilson SK, Neale S, Armstrong S. (In press) Distribution and drivers of coral disease at Ningaloo reef, Indian Ocean. Marine Ecology Progress Series Daw TM, Cinner JE, McClanahan TR, Graham NAJ, Wilson SK (In press) Design factors and socioeconomic variables associated with ecological responses to fishery closures in the Western Indian Ocean. Marine Biology McClanahan TR, Graham NAJ, MacNeil MA, Muthiga NA, Cinner JE, Bruggemann JH, Wilson SK (In review) Critical thresholds and tangible targets for ecosystem-based management of coral reefs. PNAS
Book chapter	
Major review	Kendrick A, Wilson SK (Draft) Fish communities: Review of information relevant to the development of a monitoring program for FISH communities in Western Australia
COMMUNICATION	
Media interviews	Senior Research Scientist wins best paper award. Environment and Conservation news Sept 2010 Ningaloo a key fish nursery. Environment and Conservation news Dec 2010 Extinction predictor 'will help protect coral reefs' ARC Centre of Excellence for Coral Reef Studies Media Release Feb 2011
Pamphlets/information sheets/newsletters etc	
Briefings/formal discussion etc	Research planning meeting- Karathra, Exmouth MPRA reporting Sept 2010
Web-based communication	
Popular article	Wilson SK, Holmes T (2011) Reef fish and corals: unlocking the secrets. Landscope 26, 18-22
Milestone reports	
Conference abstracts, presentations; seminar/lecture presentations; Poster/formal field day presentations	Wilson SK, Depczynski M, Fisher R, Holmes TH, O'Leary RA, Tinkler P (2010) Coral reefs and algal meadows as essential habitat for juvenile reef fish Australian Coral Reef Symposium, Coffs Harbour, NSW Wilson SK, Onton K, Page CA, Neale S, Armstrong S. (2010) Coral Disease at Ningaloo. Public lecture Novotel Hotel, Exmouth, Western Australia Wilson SK, Graham NAJ, Chong-Seng K, Nash K, Hicks C (2011) Corals and fish in the Seychelles: Trends through time. Publication presention, Seychelles Fishing Authourity, Mahe, Seychelles. Wilson SK (2011) Ecology of Coral Reef Fish. Lecture to coral Reef Ecology intensive course at Murdoch University June 2010 Onton K, Wilson SK, Page CA, Neale S, Armstrong S. (2010) Coral Disease at Ningaloo. Poster presentation Australian Coral Reef Symposium, Coffs Harbour, NSW

KNOWLEDGE TRANSFER	
Advice (e.g. EIA, NRM etc) - (verbal)	
Advice (e.g. EIA, NRM etc) - (written))	Climate Change Adaptation and Mitigation Strategy 16 x reviews for peer reviewed journals
Planning/Management guideline - (contributing author)	Underwood J, Wilson SK, Ludgerus L (draft) Guidelines for incorporating connectivity science into the conservation management of coral reefs in northwest Australia
Planning/Management guideline - (primary author)	
Species /Protected Area management plans - (contributing author)	
Species /Protected Area management plans - (primary author)	
Policy/Strategy statement (contributing author)	Kendrick A, Wilson SK, Simpson C, Friedman K (2010) Strategic marine research priorities for the Department of Environment and Conservation
Policy/Strategy statement (primary author)	

Alan Kendrick - Senior Research Scientist	
SCIENCE	
SPP	Spatial variation in the functional morphology of mangroves in the Shark Bay World Heritage Area (SPP2011-003)
Data report	Rule, M.J and Kendrick, AJ (2011) Spatial variation in the functional morphology of mangroves in the Shark Bay World Heritage Area. Marine Science Program Metadata Report Rule, MJ and Kendrick, AJ (2011) Spatial and temporal patterns in the structure of intertidal rocky platform communities of the Shoalwater Islands and Marmion Marine Parks (SPP 2009-002): 2010/11. Marine Science Program Metadata report. Rule, MJ and Kendrick, AJ (2011) Spatial and temporal patterns in benthic invertebrate communities of the Walpole and Nornalup Inlets Marine Park (SPP 2009-013): 2010. Marine Science Program Metadata report.
Technical report	
Conference paper	
Journal paper	Huisman JM, Kendrick AJ, Rule MJ (2011) Benthic algae and seagrasses of the Walpole and Nornalup Inlets Marine Park, Western Australia. Journal of the Royal Society of Western Australia 94, 29-44. Rule M, Bancroft K, Kendrick A (Draft) Benchmarking nutrient values for relatively un-impacted warm temperate coastal waters. (In internal review).
Book chapter	
Major review	Kendrick AJ, Wilson SK (Draft) A framework for long-term fish monitoring in WA's marine parks and reserves. (in internal review)
COMMUNICATION	
Media interviews	Contribution to Survey indicates about 50 invertebrate species in inlets (Walpole Weekly, 16 Feb 2011, p 16) Contribution to What lies beneath (Walpole Weekly article, 25 May 2011, p 9)
Pamphlets/information sheets/newsletters etc	
Briefings/formal discussion etc	
Web-based communication	
Popular article	
Milestone reports	
Conference abstracts, presentations; seminar/lecture presentations; Poster/formal field day presentations	Kendrick A. Marine parks and reserves in Western Australia. Lecture in Marine and Coastal Management, SONS, ECU Joondalup (Apr 2011). Kendrick A. Oceanography. Lecture to U3A, Armadale (Jun 2011)
KNOWLEDGE TRANSFER	

Advice (e.g. EIA, NRM etc) - (verbal)	DoW, WNI HCVAE Assessment meeting (Aug 2010) Perth Region NRM, Marine Reference Group (several meetings) WAMSI/UWA/Curtin/CSIRO CFOC Shark Bay Research proposal (meetings) CSIRO Cockburn Sound research planning workshop (Feb 2011) UWA/FIU Shark Bay research workshop (Mar 2011) Contribution to teaching ECU Student field camp at WNIMP (Apr 2011) Advice to ECU students Aldo Turco (PhD) & Federico Vitelli (MSc) regarding temperate herbivory (meetings)
Advice (e.g. EIA, NRM etc) - (written))	Advice to NPB/SCB (DEC) on marine research permit applications (various) Advice to DEWHA for MACC R&D Working Group pilot study (SW Bioregion) Facilitated temperate research knowledge transfer contract with Range to Reef consulting (Nov 2010) Facilitated contract between Murdoch University and SCD for provision of research on Little penguins (Jun 2011) Advice to DoF on draft mangrove fact sheet (Jun 2011) MS reviews for Journal of Fish Biology, Marine & Freshwater Research
Planning/Management guideline - (contributing author)	
Planning/Management guideline - (primary author)	
Species /Protected Area management plans - (contributing author)	
Species /Protected Area management plans - (primary author)	
Policy/Strategy statement (contributing author)	
Policy/Strategy statement (primary author)	Kendrick A, Wilson S, Simpson C, Friedman K (2010) Strategic marine research priorities for the Department of Environment & Conservation. Marine science Program.

Stuart Field - Senior Research Scientist	
SCIENCE	
SPP	Effects of the Gorgon Dredging Program on the Marine Biodiversity of the Montebellos/Barrow Islands MPAs
Data report	Metadata report for The Gorgon Dredging Offset Monitoring Evaluation and Reporting Project (Gorgon MER) - November 2010 Metadata report for The Gorgon Dredging Offset Monitoring Evaluation and Reporting Project (Gorgon MER) - January 2010 Metadata report for The Gorgon Dredging Offset Monitoring Evaluation and Reporting Project (Gorgon MER) - February 2010 Metadata report for The Gorgon Dredging Offset Monitoring Evaluation and Reporting Project (Gorgon MER) - May 2010
Technical report	Annual Research Activity report Annual Report for the Gorgon dredging offset monitoring, evaluation and reporting project.
Conference paper	
Journal paper	
Book chapter	
Major review	
COMMUNICATION	
Media interviews	
Pamphlets/information sheets/newsletters etc	Content has been provided to DEC's Barrow Island Environment team to assist with the production of presentations, newsletters, pamphlets, posters on Barrow to educate Chevron staff on island about the marine environment surrounding Barrow Island and the greater MPAs.
Briefings/formal discussion etc	Presentation to the WAMSI dredge node. Participation in the 'Construction Dredging Environment Expert Panel'. Presentations to the Regional office of DEC. Briefings to the Montebello Barrow Islands Resource Group supporting the Gorgon offset projects.
Web-based communication	

Popular article	
Milestone reports	Monthly reporting through the project management framework on the progress of the project, assessed against the acheivement established milestones.
Conference abstracts, presentations; seminar/lecture presentations; Poster/formal field day presentations	Submission of Abstract to AMSA conference for an oral presentation *'Effects of the Gorgon dredging program on selected aspects of the marine biodiversity of the Montebello/Barrow Islands MPAs.* Support for the submissions of abstract for a poster presentation *'Digitise this! A quick and easy remote sensing method to monitor the daily extent of dredge plumes'.* Submission of Abstract to ACRS conference for an oral presentation *'The initial results of the combined impacts of dredging and high wter temperature bleaching on coral communities within the Montebello/Barrow Islands MPAs*
KNOWLEDGE TRANSFER	
Advice (e.g. EIA, NRM etc) - (verbal)	
Advice (e.g. EIA, NRM etc) - (written))	
Planning/Management guideline - (contributing author)	
Planning/Management guideline - (primary author)	
Species /Protected Area management plans - (contributing author)	
Species /Protected Area management plans - (primary author)	
Policy/Strategy statement (contributing author)	
Policy/Strategy statement (primary author)	

Tom Holmes - Research Scientist	
SCIENCE	
SPP	Holmes T H (2011) Comparison of Underwater Visual Census and Diver Operated Video methods for assessing fish community condition in tropical and temperate coastal waters of Western Australia. SPP 2010-010
Data report	Holmes T H and Wilson S K (2011) Effects of climate change and fishing pressure on fish communities - January 2011 Fieldwork. *Marine Science Program Metadata Report* Holmes TH, Moore J and Wilson S K (2010) Effects of climate change and fishing pressure on fish communities; Ningaloo seasonal seaweeds project; WAMMP mangrove community monitoring program - November 2010 Fieldwork. *Marine Science Program Metadata Report* Holmes T H (2010) Establishment and survey of fish community Long Term Monitoring sites for high intensity sampling along the Ningaloo Marine Park - September 2010 Fieldwork. *Marine Science Program Metadata Report* Holmes T H (2010) Comparison of Underwater Visual Census and Diver Operated Video methods for assessing fish community condition in tropical and temperate coastal waters of Western Australia - Rowley Shoals component. *Marine Science Program Metadata Report* Holmes T H (2011) WAMMP mangrove community monitoring - Montebello/Barrow Islands Marine Park - May 2011 Fieldwork. *Marine Science Program Metadata Report*
Technical report	
Conference paper	
Journal paper	Holmes T H and McCormick M I (2011). Response across a gradient: behavioural reactions of newly settled reef fish to predation cues. *Animal Behaviour.* Holmes T H, Wilson S K, Vanderklift M, Babcock R and Fraser M (in prep) Identity of key predaors of juvenile coral reef fish. *Coral Reefs* Wilson S K, Depczynski M, Fisher R, Holmes T H, O'Leary R A and Tinkler P (2010). The importance of coral in the habitat use of juvenile reef fish. *PlosOne* 5(12): e15185 Madin E M P, Ban N C, Doubleday Z A, Holmes T H, Pecl G T and Smith F (in review) Ecological, socio-economic and management implications of range-shifting species in marine systems. *Global Environmental Change* Cvitanovic C, Wilson SK, Fulton CJ, Almany GR, Anderson P, Babcock RC, Ban NC, Beedon R, Beger M, Cinner J, Dobbs K, Evans LS, Farnham A, Friedman K, Gale K, Gladstone W, Grafton Q, Graham NAJ, Gudge S, Harrison P, Holmes TH, Johnstone N, Jones GP, Jordan A, Kendrick A, Kerr I, Klein CJ, Little LR, Malcolm H, Morris D, Possingham HP, Prescott J, Pressey RL, Skilleter GA, Simpson C, Waples K, Wilson D, Williamson DH (in prep) Protecting coral reefs through the alignment of management and research: the importance of effective knowledge transfer. *Conservation Biology*

Book chapter	
Major review	
COMMUNICATION	
Media interviews	
Pamphlets/information sheets/newsletters etc	
Briefings/formal discussion etc	
Web-based communication	
Popular article	Wilson S and Holmes T (2011) Reef fish and corals: unlocking the secrets. *Landscope* 26 (3): 18-22.
Milestone reports	
Conference abstracts, presentations; seminar/lecture presentations; Poster/formal field day presentations	Holmes T H and McCormick M I (2010) Response across a gradiemt: behavioural reactions of newly settled reef fish to predation cues. International Society for Behavioural Ecology Conference, Perth. Holmes T H (2010) Coral reef fish recruitment. Exmouth public lecture Holmes T H (2011) Fish Monitoring Methods: Underwater Visual Census. Murdoch University Lecture for Mike van Keulen
KNOWLEDGE TRANSFER	
Advice (e.g. EIA, NRM etc) - (verbal)	Advice to Environmental Management Branch on mangrove monitoring component of development proposal on Burrup Peninsula
Advice (e.g. EIA, NRM etc) - (written))	12 x reviews for Peer Reviewed Journals (3 x Animal Behaviour, Coral Reefs, 2 x Environmental Biology of Fishes, Journal of Experimental Marine Biology and Ecology, Journal of Animal Ecology, Journal of Ethology, PLoS One, Behavioural Ecology, Caribbean Journal of Science). 1 x review honours thesis (UWA) 1 x review masters thesis (JCU) Advice to Marine Park Coordinators in Karratha, Exmouth and Denham on the status and trends in mangrove community condition within their associated marine parks Advice to Marine Park Coordinator for Ningaloo Marine Park on the current status of fish community condition at sites in northern sector of park
Planning/Management guideline - (contributing author)	
Planning/Management guideline - (primary author)	
Species /Protected Area management plans - (contributing author)	
Species /Protected Area management plans - (primary author)	
Policy/Strategy statement (contributing author)	
Policy/Strategy statement (primary author)	

Michael Rule - Research Scientist	
SCIENCE	
SPP	Rule, MJ and Kendrick, A. J. (2011) Spatial variation in the functional morphology of mangroves in the Shark Bay World Heritage Area. Marine Science Program Science Project Proposal 2011-003.

Data report	Rule, MJ (2011) Comparison of Underwater Video Census and Diver Operated Video methods for assessing fish community condition in tropical and temperate coastal waters of Western Australia: Jurien Bay. Marine Science Program, Metadata Report Rule, MJ (2011) Jurien Bay Marine Park Seagrass Long-Term Monitoring– March 2011 field program. Marine Science Program Metadata Report Rule, MJ (2011) Establishment of Long Term Monitoring Sites for Macroalgae Monitoring in the Marmion Marine Park. Marine Science Program Metadata Rpt. Rule, MJ (2011) Establishment of Long Term Monitoring Sites for Seagrass Monitoring in the Marmion Marine Park. Marine Science Program Metadata Rpt. Rule, M.J and Kendrick, AJ (2011) Spatial variation in the functional morphology of mangroves in the Shark Bay World Heritage Area. Marine Science Program Metadata Report Rule, MJ, Friedman, K, Moore, J and Debruyne, J (2011) Long-term monitoring of fish communities in the Shark Bay Marine Park: 2010/11. Marine Science Program Metadata Rpt.. Rule, MJ and Kendrick, AJ (2011) Spatial and temporal patterns in the structure of intertidal rocky platform communities of the Shoalwater Islands and Marmion Marine Parks (SPP 2009-002): 2010/11. Marine Science Program Metadata report. Rule, MJ and Kendrick, AJ (2011) Spatial and temporal patterns in benthic invertebrate communities of the Walpole and Nornalup Inlets Marine Park (SPP 2009-013): 2010. Marine Science Program Metadata report.
Technical report	
Conference paper	
Journal paper	Huisman, J. M., Kendrick, A. J. and Rule, M. J. (2011) Benthic algae and seagrasses of the Walpole and Nornalup Inlets Marine Park. Journal of the Royal Society of Western Australia, 94: 29-44 McIlgorm, A., Campbell, H. and Rule, M. J. (in Press) The economic cost and control of marine debris damage in the Asia-Pacific region. Ocean and Coastal Management
Book chapter	
Major review	
COMMUNICATION	
Media interviews	
Pamphlets/information sheets/newsletters etc	
Briefings/formal discussion etc	Rule, M. J. and Kendrick, A. J. (2010) Temperate Marine Research. Progress report to the MPRA
Web-based communication	
Popular article	
Milestone reports	
Conference abstracts, presentations; seminar/lecture presentations; Poster/formal field day presentations	MMP metro rocky shore training workshop August 2010 ECU Walpole student field trip (April 2011) Dish pan hands-AMSA WA conference Rottnest Island July 2010 Training workshop for the Rockingham Bay Seagrass Monitoring Group
KNOWLEDGE TRANSFER	
Advice (e.g. EIA, NRM etc) - (verbal)	Licensing on various permit applications Rockingham Bay Seagrass Monitoring Group Advice/supervision to UWA MSc student, Hong Nam Lo on seasonal patterns of invertebrate assemblages at Ningaloo
Advice (e.g. EIA, NRM etc) - (written))	MS reviews for the journals *Environmental Management* and *Biological Invasions* Honours thesis review for ECU Honours proposal for UWA Landscope review
Planning/Management guideline - (contributing author)	
Planning/Management guideline - (primary author)	
Species /Protected Area management plans - (contributing author)	
Species /Protected Area management plans - (primary author)	
Policy/Strategy statement (contributing author)	

Policy/Strategy statement (primary author)	

Kevin Bancroft - Research Scientist	
SCIENCE	
SPP	
Data report	Bancroft KP (2011) Long-term coral community monitoring in the Montebello/Barrow islands marine protected areas: Site descriptions and preliminary analysis of baseline data collected in December 2006. Marine Science Program, Department of Environment and Conservation, Perth, Western Australia, Marine Science Data Report Series MSPDR9. 91 p.
Technical report	
Conference paper	
Journal paper	
Book chapter	
Major review	Bancroft K, Friedman K (DRAFT) Review of water quality in Marmion Marine Park. Marine Science Program, Department of Environment and Conservation, Perth, Western Australia, Western Australian Marine Monitoring Program Report June 2011. 15 p.
COMMUNICATION	
Media interviews	
Pamphlets/information sheets/newsletters etc	
Briefings/formal discussion etc	Summary of findings of a preliminary review regarding the impacts of the Ocean Reef outfall on the water quality and biodiversity of Marmion Marine Park; Briefing paper to the MPRA
Web-based communication	
Popular article	
Milestone reports	
Conference abstracts, presentations; seminar/lecture presentations; Poster/formal field day presentations	
KNOWLEDGE TRANSFER	
Advice (e.g. EIA, NRM etc) - (verbal)	
Advice (e.g. EIA, NRM etc) - (written))	
Planning/Management guideline - (contributing author)	Bancroft KP, Friedman K, Kendrick A (2011). A guideline for monitoring and communicating progress of WAMMP activity and related management effectiveness reporting. Western Australian Marine Monitoring Program Guideline. May 2011. Marine Science Program, Department of Environment and Conservation, Perth, Western Australia. 7p. Bancroft KP, Friedman KJ (DRAFT) A guideline for the development of historical time series. Marine Science Program, Department of Environment and Conservation, Perth, Western Australia, Western Australian Marine Monitoring Program Guideline. June 2011. 13 p.
Planning/Management guideline - (primary author)	
Species /Protected Area management plans - (contributing author)	
Species /Protected Area management plans - (primary author)	
Policy/Strategy statement (contributing author)	
Policy/Strategy statement (primary author)	

James Moore - Research Scientist	
SCIENCE	
SPP	Moore JAY (2011) Ningaloo seasonal seaweeds project. Appended to SPP 2009-003
Data report	Holmes TH, Moore J and Wilson S K (2010) Effects of climate change and fishing pressure on fish communities; Ningaloo seasonal seaweeds project; WAMMP mangrove community monitoring program - November 2010 Fieldwork. *Marine Science Program Metadata Report*
Technical report	
Conference paper	
Journal paper	
Book chapter	
Major review	
COMMUNICATION	
Media interviews	Moore JAY (2011) Interview with ScienceNetwork WA about implications of marine heatwave event. 5 May 2011
Pamphlets/information sheets/newsletters etc	Moore JAY (2011) Finding corals: a novel approach to coral identification. Environment and Conservation News Issue 7/11
Briefings/formal discussion etc	
Web-based communication	
Popular article	
Milestone reports	
Conference abstracts, presentations; seminar/lecture presentations; Poster/formal field day presentations	Moore JAY et al (2011) Unprecedented large-scale bleaching of Western Australian reef corals. *Marine 'Heatwave' Workshop*, Department of Fisheries, Hillary's, WA, 5 May 2011 Moore JAY (2011) Corals! *Presentation to Year 10 class*, South Fremantle High School, 30 June 2011 Moore (2011) Coral Identification and Capacity Building Workshop convenor, DEC, April 2011
KNOWLEDGE TRANSFER	
Advice (e.g. EIA, NRM etc) - (verbal)	
Advice (e.g. EIA, NRM etc) - (written))	Advice to Marine Park Coordinators in Karratha, Exmouth and Denham on the response plan for coral bleaching summer 2010-11. Advice to Marine Park Coordinator for Ningaloo Marine Park on the current status of coral community condition across the Marine Park.
Planning/Management guideline - (contributing author)	
Planning/Management guideline - (primary author)	
Species /Protected Area management plans - (contributing author)	
Species /Protected Area management plans - (primary author)	
Policy/Strategy statement (contributing author)	
Policy/Strategy statement (primary author)	

12. MARINE SCIENCE PROGRAM EXPENDITURE FOR 2011/12

Activity/Project title	DEC Region	PI	Expenditure
Marine Science Program administration	All	CSI	$198450
Committees, advice & ministerials etc	All	CSI	$48253
Program Leader contingency	All	CSI	$54598
WAMSI Node 3	Pilbara	KWA	$54290
Conservation of marine turtles in WA	Midwest, Pilbara, Kimberley	BPR	$109834
Spatial and temporal patterns in benthic invertebrate communities in the WNIMP	Warren	AKE	$72097
Spatial and temporal patterns in the structure of intertidal rocky platform communities of the SIMP and MMP	Swan	AKE	$49393
Spatial variation in the functional morphology of mangroves in the Shark Bay World Heritage Area	Midwest	MRU	$39932
Interactive effects of fishing and climate change on coral reef fish populations	Pilbara	SWI	$79340
WA regional-scale coral bleaching study		SWI	$12204
Comparison of UVC and DOV methods for assessing fish community condition in tropical and temperate coastal waters in WA	Midwest, Pilbara	SWI	$35689
Functional role of macroalgal communities	Pilbara	SWI	$26447
Fish community survey of the RSMP	Kimberley	SWI	$0
Strategic Marine Research plan for DEC: 2010-2015	All	SWI, AKE	$59162
WAMMP: Strategic planning and coordination	All	KRF	$151649
WAMMP: Asset CPR MER	All	KRF	$294864
WAMMP: Marine information system	All	KRF	$8757
WAMMP: Public participation (incl Community MER)	All	KRF	$16042
Total			**$1311000**

13. SUMMARY OF WAMMP WORKS PROGRAM FOR 2011/12

1. Sub-program: Strategic Planning and Coordination

PROJECTS	WHO LEADS	Strategic Support	WHERE	BY	MSP PI (fte)	MSP Support (fte)	External (fte)	Operational Funds ($)	Broad Objectives	Comments
1. Works planning and implementation of WAMMP	KFR	CSI, AKE, SWI, THO	na	Jun-12	0.3			1,500	Sets out a clear program of work and on-going monitoring of work program	
2. Establish and administer MSP Science Advisory Committee (SAC)	KFR	CSI, AKE, SWI,	na	TBD	0.023	0.03	0.014	250	To provide high level external advice/support for WAMMP. Build understanding and foster collaboration.	For further discussion before proceeding
3. Represent DEC on National MACC R&D WG	CSI	KFR	na	Jun-12	0.1	0.01		1,000	To ensure WAMMP coherence with national marine MER initiatives	
4. Finalise and publish the WAMMP Strategic Plan	KFR	CSI	na	Dec-11	0.018	0.01		2,000	To clearly express the WAMMP 'big picture' for internal and external collaborators	$3000 extra requested for Ops $.
5. Finalise and submit the WAMMP SPP for approval	KFR	CSI	na	Dec-11					To formalise WAMMP as a DEC science program.	
6. Oversee the on-going acquisition and upgrade of marine habitat mapping (imagery purchases, ground-truthing and mapping) for WAMMP	KMU	Asset Leaders	All MPAs	Jun-12	0.12	0.01		3,000	Generic information need.	
7. On-going remote sensing support relevant to WAMMP MER (survey and reporting)	KMU	Asset Leaders	All MPAs	Jun-12	0.050				?	
8. Finalize and publish generic guidelines to determine appropriate temporal and spatial scales for asset C-P-R MER projects.	SWI	KFR, CSI, AKE	na	Dec-11	0.064	0.025		0	To ensure WAMMP practices and procedures are QA/QC'd via the peer review process.	
9. Finalize and publish guidelines to assess the validity of historical ecological and social C-P-R data relevant to WAMMP.	KBA	KFR, CSI, SWI, AKE	na	Dec-01	0.05			0	To ensure WAMMP practices and procedures are QA/QC'd via the peer review process.	
10. Finalize documentation of generic methodologies (e.g. via CPs and SPPs?) for asset CPR MER (listed below), including asset classification systems and SOPs (If appropriate).	KFR	Asset Leaders	na	Dec-11	0.05			0	To ensure WAMMP practices and procedures are QA/QC'd via the peer review process.	For further discussion re format.
11. MSP co-ordination of Annual State of MPA reports: Asset and Issue CPR trends	KBA	KFR, Asset Leaders and MPCs	na	Jun-12	0.1	0.05		1,500	To support Regions in reporting to MPRA.	

12. Communication Strategy	KFR	CSI, SWI, AKE	na	TBD	0.05	0.03		0	To inform internal and external participants in WAMMP of current activities and directions	For further discussion.
13. WAMMP Contingency	KFR	na	na	NA	0.08			3,000	Self- explanatory.	Extra $2000 requested for Ops $.
14. Continue to coordinate the finalisation and publication of outstanding Asset Knowledge Reviews (AKR).	AKE	All AKR authors	na	Dec-11	0.12			2,000	To ensure WAMMP practices and procedures are QA/QC'd via the peer review process.	
15. Complete Asset Knowledge Reviews: Old and New (Dugong, SeaShoreBirds, Turtles)	KFR	Asset Leaders		Jun-12	0.05	0.4	?		Self- explanatory.	$4500 requested for Ops $.
16. Shark Bay Research and Monitoring into Management Manuscript	AKE	KFR	na	Dec-11	?	0.045				$2500 requested for Ops $

2. Sub-program: Strategic Asset CPR and MER (incl Planning - annual work program; Historical time-series - CPR dataset construction; 'Fit to Park' - CPR Field Monitoring; Evaluation and Reporting - re MPRA audit process

PROJECTS	WHO LEADS	Strategic Support	WHERE	BY	MSP PI (fte)	MSP Support (fte)	External (fte)	Operational Funds ($)	Broad Objectives	Comments
1. MICROBIAL COMMUNITY Condition Pressure Response (C-P-R): co-ordination of annual Monitoring, Evaluation and Reporting (MER)				TBD					To plan, undertake, analyse, evaluate and report on historical and current trends in asset CPR against management plan targets and objectives.	Focus of WAMMP MER programs is on assessing the effectiveness and efficiency of operational management to support active adaptive management by RS marine managers.
2. CORAL COMMUNITY C-P-R: co-ordination of annual MER	JMO	CSI	RSMP, NMP, SBMP (pp)	see W-Plan	0.456	0.14	0.05 (SAR)	10,000	As Above	Incl. Coral Bay Recovery; Ningaloo Drupella Survey; MBIMPA (gmer) done by SFI et al; Extra $2500 requested for Ops $.
3. SOFT BOTTOM COMMUNITY C-P-R: co-ordination of annual MER				TBD					As above	
4. DEEP REEF /SUBTIDAL COMMUNITY C-P-R: co-ordination of annual MER				TBD					As Above	?
5. SEAGRASS COMMUNITY C-P-R: coordination of annual MER	MRU		SBMP, JBMP, MMP, SIMP	see W-Plan	0.15	0.1		5,500	As Above	0.05 fte for MRU to complete asset KR included in strategic section (see above)
6. MACROALGAE C-P-R: co-ordination of annual MER	MRU		MMP, JBMP	see W-Plan	0.05	0.166		3,000	As above	Extra $2000 requested.
7. MANGROVE COMMUNITY C-P-R: coordination of annual MER	KBA		MBIMPAs, NMP, SBMP	see W-Plan	0.1	0.166		2,500	As Above	

8. COASTAL COMMUNITY C-P-R: coordination of annual MER	KBA	KMU, THO	NMP	see W-Plan	0.2	0.166	?	3,500	As Above	Halina Kobrin
9. INVERTEBRATE (mobile) COMMUNITY C-P-R: coordination of annual MER	JMO	KFR	MMP, SIMP, JBMP?	see W-Plan	0.14	0.05		2,750	As above	
10. INTERTIDAL COMMUNITY C-P-R: coordination of annual MER	AKE		MMP; SIMP	see W-Plan	0.03				As Above	Use data from Metro MP Inter-tidal Study
11. FINFISH COMMUNITY C-P-R: coordination of annual MER	THO	SWI, GSH?, MRU?	RSMP, NMP, SBMP (pp only?), JBMP (pp only?)	see W-Plan	0.15	0.16		15,000	As Above	Ensure site selection allows SZ and non-SZ comparisons; MBIMPAs finfish done by SF et al; Extra $3000 requested for Ops $.
12. WHALE SHARKS C-P-R: coordination of annual MER			NMP	see W-Plan			0.43		As above	Done by District staff; Condition indices (e.g. scars) will relate directly to local -scale pressures (e.g. boat strikes) rather than population estimates.
13. SHARKS RAYS C-P-R: coordination of annual MER				TBD					As Above	
14. TURTLES C-P-R: coordination of annual MER	SWH		RSMP, MBIMPAs, NMP, SBMP	see W-Plan	0.15		0.455	TBD	As Above	
15. REPTILES (non-turtle) C-P-R: coordination of annual MER				TBD					As above	
16. DUGONG C-P-R: coordination of annual MER				TBD					As Above	Dave Holley to do?
17. PINNIPEDS (ASL and NZFS) C-P-R: coordination of annual MER	RCA	KFR	South/West Coast	see W-Plan	0.35	0.04		2,000	As Above	
18. SEA and SHORE BIRDS C-P-R: coordination of annual MER				TBD					As above	
19. LITTLE PENGUIN C-P-R: coordination of annual MER	JMO	Regions, BCA, AKE	SIMP	see W-Plan	0.1			1,500	As Above	
20. CETACEAN (dolphin) C-P-R: coordination of annual MER				see W-Plan					As Above	Dave Holley to do?
21. CETACEAN (whales) C-P-R: coordination of annual MER				see W-Plan					As Above	Condition indices (e.g. scars) will relate directly to local -scale pressures (e.g. boat strikes) rather than population estimates.

22. WATER/SEDIMENT QUALITY C-P-R coordination of annual MER	KBA	CSI	MMP, WNIMP, MBIMPA	see W-Plan	0.3		Jala	2,500	Review WQ CPR current status and trends in priority MPAs first and recommend on-going work if appropriate. Complete temperature SOP.	WQ reviews should be in report form. Incl. the development of a WAMMP SOP that outlines how temperature data will be collected in WAMMP: incl. objectives, establishment and maintenance requirements/procedures, data capture, analysis, reporting responsibilities and costs.
23. WILDERNESS and SEASCAPES C-P-R: coordination of annual MER				TBD					As Above	
24. HUMAN USAGE coordination of annual aerial survey MER	MTU		All MPAs	see W-Plan		0.045	0.1	4,000	To plan, undertake, analyse, evaluate and report on historical and current trends in human use.	
25. Developing a standard collection and reporting remote camera MER system	KBA	Regions	SIMP (2), SBMP, WNIMP	see W-Plan	0.1		Stu Bright	1,000	Develop an SOP that outlines how remote video camera will be use in WAMMP: incl. objectives, establishment and maintenance requirements/procedures, data capture, analysis, reporting responsibilities and costs.	Outputs in WAMMP SOP format.

3. Sub-programs: Marine information management and WAMMP public participation

PROJECTS	WHO LEADS	Strategic Support	WHERE	BY	MSP PI (fte)	MSP Support (fte)	External (fte)	Operational Funds ($)	Broad Objectives	Comments
1. Implement a Marine Information Management System relevant to MSP needs, with a particular focus on WAMMP, that is consistent with corporate data management policies.	FMA	KFR, CSI, AKE, SWI	na	Jun-12	0.4	0.15		TBD	Self-explanatory	
2. Standardise and streamline data acquisition and databasing of information collected in the Regions	FMA		All MPAs	TBD	0.1	0.05		2,500	Self-explanatory	
1. Community MER engagement program	TBD	KFR		Jun-12		0.05		TBD		To use marine community monitoring to promote public participation and increase marine stewardship as well an 'early warning' system for WAMMP.

TOTAL					**3.951**	**1.893**		**70,000**		

14. MARINE SCIENCE PROGRAM STAFF PUBLICATIONS 2007 – 30 JUNE 2011

Peer reviewed journal articles

2007

Stamation KA, Croft DB, Shaughnessy PD, **Waples**, **KA** (2007). Observations of Humpback Whales (*Megaptera novaeangliae*) Feeding During Their Southwards Migration Past the Coast of Southern NSW, Australia: Identification of a Possible Supplemental Feeding Ground. Aquatic Mammals 33(2), 165-174.

Stamation KA, Croft DB, Shaughnessy PD, **Waples KA**, Briggs SV (2007). Educational and conservation value of whale watching. Tourism in Marine Environments. 4(1), 1-15.

2008

Armstrong SJ, Bancroft KP, Davidson JA. (2008) Bibliography of marine scientific research relevant to the Ningaloo Marine Park and adjacent waters. *Conservation Science Western Australia* 7(1), 179-205.

Allen S, Smith H, **Waples K,** Harcourt R. (2008). The voluntary code of conduct for dolphin watching in Port Stephens, Australia: Is self-regulation an effective management tool? *Journal of Cetacean Research & Management* 9(2), 159-166.

Smith SDA, **Rule MJ**, Harrison M, Dalton SD (2008) Monitoring the seachange: preliminary assessment of the conservation value of nearshore reefs, and existing impacts, in a high-growth coastal region of subtropical Australia. *Marine Pollution Bulletin* 56*,* 525-534.

2009

Andréfouët S, **Friedman K,** Gilbert A, Remoissenet G (2009). A comparison of two surveys of invertebrates at Pacific Ocean islands: the giant clam at Raivavae Island, Australes Archipelago, French Polynesia. *ICES Journal of Marine Science* 66, 1825-1836.

Graham N, **Wilson SK**, Pratchett MP, Polunin NVC, Spalding M (2009) Coral mortality versus structural collapse as drivers of corallivorous butterflyfish decline. *Biodiversity and Conservation* 18, 3325–3336.

Holmes TH, McCormick M (2009) Influence of prey body characteristics and performance on predator selection. *Oecologia* 159, 401-413.

Neaves LE, Zenger KR, Eldridge MBD, **Prince RIT,** Cooper DW (2009). Landscape Discontinuities Influence Gene Flow and Genetic Structure in a large, vagile Australian mammal, *Macropus fuliginosus*. *Molecular Ecology* 18, 3363-3378.

McClanahan TR, Graham NAJ, **Wilson SK**, Letourneur Y (2009) Effects of fisheries closure size, age, and history of compliance on coral reef fish communities in the western Indian Ocean. *Marine Ecology Progress Series* 396, 99-109.

2010

Almany GR, Hamilton RJ, Williamson DH, **Evans RD**, Jones GP, Matawai M, Potuku T, Rhodes KL, Russ GR, Sawynok B (2010) Research partnerships with local communities: two case studies from Papua New Guinea and Australia. *Coral Reefs*. 29, 567-576.

Dalleau M, Andrefouet S, Wabnitz CCC, Payri C, Wantiez L, Pichon M, **Friedman K**, Vigliola L, Benzoni F (2010). Use of habitats as surrogates of biodiversity for efficient coral reef conservation planning in Pacific Ocean Islands. *Conservation Biology* 24(2), 541-552.

Holmes TH, McCormick MI (2010). Smell, learn and live: the role of chemical alarm cues in predator learning during early life history in a marine fish. *Behavioural Processes* 83, 299-305.

Holmes TH, McCormick MI (2010). Size-selectivity of predatory reef fish on juvenile prey. *Marine Ecology Progress Series* 399, 273-283.

Wilson SK, Fisher R, Pratchett MS, Graham NAJ, Dulvy NK, Turner RA, Cakacaka A, Polunin NVC (2010) Habitat degradation compounds effects of fishing on the size structure of coral reef fish communities. *Ecological Applications* 20: 442-451.

Wilson SK et al. (2010) Critical knowledge gaps in current understanding of climate change impacts on coral reef fishes. *Journal of Experimental Biology* 213: 894-900.

Wilson SK, Depczynski M, Fisher R, Holmes TH, O'Leary RA, Tinkler P (2010) The importance of coral in the habitat use of juvenile reef fish. *PLoS ONE* 5, e15185.

2011

Cole A, Lawton R, Practhett MS, **Wilson SK** (2011) Chronic coral consumption by butterflyfish. *Coral Reefs* 30, 85-93.

Daw TM, Cinner JE, McClanahan TR, Graham NAJ, **Wilson SK** (2011) Design factors and socioeconomic variables associated with ecological responses to fishery closures in the Western Indian Ocean. *Coastal Management* 39, 412-424.

Farmer B, **Wilson SK** (2011) Diet of targeted finfishes and the implications for trophic cascades *Environmental Biology of Fishes* 91, 71-85.

Friedman K, Eriksson H, Tardy E, Pakoa K (2011) Management of sea cucumber stocks: patterns of vulnerability and recovery of sea cucumber stocks impacted by fishing. *Fish and Fisheries* 12(1), 75-93.

Graham NAJ, Chabanet P, **Evans RD**, Jennings S, Letourneur Y, MacNeil MA, McClanahan TR, Öhman MC, Polunin NVC, **Wilson SK** (2011) Extinction risk in coral reef fishes. *Ecology Letters* 14, 341–348.

Holmes TH, McCormick MI (2011) Response across a gradient: behavioural reactions of newly settled reef fish to predation cues. *Animal Behaviour* 81, 543-550.

Huisman JM, **Kendrick AJ, Rule MJ** (2011) Benthic algae and seagrasses of the Walpole and Nornalup Inlets Marine Park, Western Australia. *Journal of the Royal Society of Western Australia* 94, 29-44.

McIlgorm A, Campbell H, **Rule MJ** (In Press) The economic cost and control of marine debris damage in the Asia-Pacific region. *Ocean and Coastal Management.*

Mora C, Aburto-Oropeza O, Ayala Bocos A, Ayotte PM, Bank S, Bauman AG, Beger M, Bessudo S, Booth DJ, Brokovich E, Brooks A, Chabanet P, Cinner J, Cortés J, Cruz-Motta JJ, Magaña A, DeMartini E, Edgar GJ, Feary DA, Ferse SCA, Friedlander A,Gaston KJ, Gough C, Graham NAJ, Green A, Hardt M, Guzman H, Kulbicki M, Letourneur Y, López Pérez A, Loya Y, Loreau M, Martinez C, Mascareñas-Osorio I,Morove T, Nadon M, Nakamura Y, Paredes G, Polunin N, Pratchett MS, Bonilla HR, Rivera F, Sala E, Sandin S, Soler G, Stuart-Smith R, Tessier E, Tittensor DP, TupperM, Usseglio P, Vigliola L, Wantiez L, Williams I, **Wilson SK**, Zapata FA (2011) Human footprint on the linkage between biodiversity and ecosystem functioning in reef fishes. *PLoS Biology* 9 e1000606.

Onton K, Page CA, **Wilson SK**, Neale S, Armstrong S (2011) Distribution and drivers of coral disease at Ningaloo reef, Indian Ocean. *Marine Ecology Progress Series* 433, 75-84.

Prince RIT, Jensen MP, Oades D, Bardi Jawi Rangers (2011). Olive Ridley Turtle Presence and Nesting Records for Western Australia. *Marine Turtle Newsletter*. 129, 9-11.

Stamation KA, Croft DB, Shaughnessy P, **Waples K**, Briggs S. (In press). Behavioural responses of humpback whales (*Megaptera novaeangliae*) to whale watching vessels on the south-eastern coast of Australia. *Marine Mammal Science*.

Whiting SD. Whiting AU. (In Press). Predation by the saltwater crocodile (*Crocodylus porosus*) on sea turtle adults, eggs and hatchlings. *Chelonian Conservation Biology.*

Whiting SD (In Press) Shallow water foraging using a shoreline boundary by the Indo-Pacific Humpback Dolphin *Sousa chinensis* in northern Australia. *NT Naturalist*.

Veilleux HD, van Herwerden L, **Evans RD**, Travers MJ, Newman SJ (2011). Strong genetic subdivision generates high genetic variability among eastern and western Australian populations of Lutjanus carponotatus (Richardson). *Fisheries Research.* 108, 74-80.

Technical reports

2007

Armstrong S (2007). Summary of all DEC related current and planned marine research, monitoring and communication projects in Western Australia. Perth, Western Australia, Department of Environment and Conservation.

Armstrong S, Webster F, **Kendrick AJ**, Mau R, Onton K (2007). Summary of the winter coral bleaching event at Ningaloo Marine Park, July 2006. Perth, Western Australia, Marine Science Program, Department of Environment and Conservation: 27.

Armstrong SJ (2007). Ningaloo Marine Park Drupella Long-term Monitoring Program: Results of the 2006 survey. Perth, Western Australia, Marine Science Program, Department of Environment and Conservation: 51.

Armstrong SJ (2007). Establishment of a long-term monitoring program for the proposed Dampier Archipelago Marine Park: Marine Science Project Plan.

Long S. (2007). Disturbance and recovery of coral communities in Bill's Bay, Ningaloo Marine Park: Field survey 16-23 October 2006. Perth, Western Australia, Marine Science Program, Department of Environment and Conservation: 69.

Waples K (2007) Kimberley biodiversity review. Report prepared for the Environmental Management Branch, Department of Environment and Conservation, Perth WA.

Waples K (2007) Current research in the Ningaloo Marine Park, 2007. Department of Environment and Conservation. Perth, WA.

van Schoubroeck P, **Long S** (2007). Disturbance history of coral communities in Bill's Bay, Ningaloo Marine Park, 1975-2007. Perth, Western Australia, Marine Science Program, Department of Environment and Conservation: 43.

2008

Awira R, **Friedman KJ**, Sauni S, Kronen M, Pinca S. Chapman LB, Magron F (2008) Kiribati country report : profiles and results from survey work at Abaiang, Abemama, Kuria and Kiritimati (May to November 2004). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). 343 p.

Bancroft KP, Long S (2008). Modelling suggests connectivity between the Ningaloo Reef and coral reefs of the Pilbara. Discovering Ningaloo: Latest findings and their implications for management. Ningaloo Research Program Progress Report. K. Waples. Perth, Western Australia, Western Australian Marine Science Institute**:** 61-64.

Davidson JA, Lawrie R, **Bancroft KP** (2008) Biological classification of marine benthic habitats in waters of proposed marine parks and reserves in the Pilbara region (including Great Sandy Island Nature Reserve, Cowrie Beach and Spit Point to Cape Keraudren including Bedout, North Turtle and Little Turtle islands). Marine Policy and Planning Branch, Department of Environment and Conservation, Perth, Western Australia, Field Program Report. 46 p.

Foale S, **Friedman K,** Gomez E, Nash W, Tanzer J (2008). Existing and potential non-spatial management options in the Coral Triangle. Briefing paper for Coral Triangle Initiative Workshop, Townsville 10-14 November 2008. 4p.

Friedman K (2008) Pacific sea cucumber dataset from the Secretariat of the Pacific Community, Reef Fisheries Observatory. SPC Beche-de-mer Information Bulletin 27:38-39.

Friedman KJ, Pakoa K, Kronen M, Chapman LB, Sauni S, Vigliola L, Boblin P, Magron F (2008) Vanuatu country report : profiles and results from survey work at Paunangisu village, Moso Island, Uri and Uripiv Islands and the Maskelyne archipelago (July to December 2003). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community. 391 p.

Friedman K, Purcell S, Bell J, Hair C (2008) Sea cucumber fisheries: a manager's toolbox. ACIAR Monograph No. 135, 32 pp.

Friedman K, Ropeti E, Tafileichig A (2008) Development of a management plan for Yap's sea cucumber fishery. Beche-De-Mer Information Bulletin 28:7-13.

Friedman K, Teitelbaum A (2008) Reintroduction of giant clams in the Indo-Pacific. Pg 4-10. In Soorae, P. S. (ed.) (2008) GLOBAL Reintroduction perspectives: re-introduction case-studies from around the globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, UAE. viii + 284 pp.

Kinch J, Purcell S, Uthicke S, **Friedman K** (2008). Population Status, Fisheries and Trade of Sea Cucumbers in the Western Pacific. In: Toral-Granda, V.; Lovatelli, A. and Vasconcellos, M. (eds.). Sea Cucumbers: A Global Review of Fisheries and Trade. FAO Fisheries Technical Paper, No.: 516. pp: 7-55. Rome: Food and Agriculture Organisation. http://www.fao.org/docrep/011/i0375e/i0375e00.htm.

Kinch J, Purcell S, Uthicke S, **Friedman K** (2008) Papua New Guinea: A Hot spot of Sea cucumber Fisheries in the Western Pacific. In: Toral-Granda, V.; Lovatelli, A. and Vasconcellos, M. (eds.). Sea Cucumbers: A Global Review of Fisheries and Trade. FAO Fisheries Technical Paper, No.: 516. pp: 57-77. Rome: Food and Agriculture Organisation. http://www.fao.org/docrep/011/i0375e/i0375e00.htm.

Kronen M, Fisk D, Pinca S, Magron F, **Friedman KJ**, Boblin P, Awira R, Chapman LB (2008). Niue country report : profile and results from in-country survey work (May to June 2005). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). 189 p.

Kronen M, Tardy E, Boblin P, Chapman LB, Lasi F, Pakoa K, Vigliola L, **Friedman KJ**, Magron F, Pinca S (2008). Wallis and Futuna country report : profiles and results from survey work at Vailala, Halalo, Leava and Vele (August-December 2005 and March 2006). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). 333 p.

Pakoa K, **Friedman K,** Damlamian H, Tardy E (2008) The status of the trochus (*Trochus niloticus*) resource in Tongatapu lagoon and recommendations for management.

PROCFish/C Project, Reef Fisheries Observatory, Coastal Fisheries Programme Report, SPC, New Caledonia. 61p.

Purcell SW, Tardy E, Desurmont A, **Friedman KJ** (2008) Commercial Holothurians of the tropical Pacific [Poster]. Noumea, New Caledonia: Secretariat of the Pacific Community.

Ram R, **Friedman K**, Sobey MN (2008). Impacts of harvest and post harvest processing methods for quality and value of bêche-de-mer in Fiji Islands. The 11th Pacific Science Inter–Congress in conjunction with 2nd symposium of French research in the Pacific. Tahiti. 129 p.

Sauni S, Kronen M, Pinca S, Sauni L, **Friedman KJ**, Chapman LB, Magron F (2008). Tuvalu country report: profiles and results from survey work at Funafuti, Nukufetau, Vaitupu and Niutao (October - November 2004 and March - April 2005). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community. 343 p.

Simpson CJ, Waples KA, Kendrick AJ (2008). Science and Management: a framework for knowledge transfer. Pp 88-90. In: Waples K and Hollander E (eds). Ningaloo Research Progress Report: Discovering Ningaloo - latest findings and their implications for management. Ningaloo Research Coordinating Committee. Department of Environment and Conservation, WA. 114 pp.

Teitelbaum A, **Friedman K.** 2008. Successes and failures in reintroducing giant clams in the Indo-Pacific region. SPC Trochus Information Bulletin 14:19-26.

Vunisea A, Pinca S, **Friedman KJ**, Chapman LB, Magron F, Sauni S, Pakoa K, Awira R, Lasi F (2008) Nauru country report: profile and results from in-country survey work (October and November 2005). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community. 151 p.

Vunisea A, **Friedman KJ**, Awira R, Kronen M, Pinca S, Chapman LB, Magron F, Sauni S, Pakoa K, Lasi F (2008). Samoa country report: profiles and results from survey work at Manono-Uta, Salelavalu, Vailoa and Vaisala (june 2005 and August/September 2005). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). 383 p.

Waples K, Hollander E (editors) (2008). Ningaloo Research Progress Report: Discovering Ningaloo - latest findings and their implications for management. Ningaloo Research Coordinating Committee. Department of Environment and Conservation, WA. 114 pp.

Waples K (2008). WAMSI Project 3.6: Science coordination: administration, communication and data management. Milestone report submitted to WAMSI, July 2008.

Waples K, Mckenna S, Steele W. (2008). Ningaloo research communications plan. Draft for CSIRO, WAMSI and Department of Environment and Conservation. Ningaloo Research Coordinating Committee, Perth WA.

2009

Depczynski M, Heyward A, Birrell C, Colquhoun J, Radford B, O'Leary R, **Wilson S**, **Holmes T**, Tinkler P (2009) Methods for monitoring the health of benthic communities. WAMSI 3.1.2 Progress Report.

Friedman KJ., Kronen M., Pinca S, Lasi F, Pakoa K, Awira R, Boblin P, Tardy E, Chapman LB, Magron F (2009). Palau country report : profiles and results from survey work at Ngarchelong, Ngatpang, Airai and Koror (April to June 2007) . Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). 411 p.

Friedman K, Kronen M, Pinca S, Magron F, Boblin P, Pakoa K, Awira R, Chapman L (2009). Papua New Guinea country report : profiles and results from survey work at Andra, Tsoilaunung, Sideia, and Panapompom (June to November 2006). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). 471 p.

Friedman KJ, Pinca S, Boblin P, Magron F, Vunisea A, Labrosse P, Chapman LB, Kronen M (2009) Tonga country report: profiles and results from survey work at Ha'atafu, Manuka, Koulo and Lofanga (November and December 2001; March to June 2002; April to June, September and October 2008). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). xxxii, 369 p.

Kronen M, Boblin P, **Friedman K.**, Pinca ., Magron ., Awira ., Pakoa ., Lasi F, Tardy E, Chapman LB, Vunisea A (2009). Federated States of Micronesia country report: profiles and results from survey work at Yyin and Riiken (Yap) and Piis-Panewu and Romanum (Chuuk) (April-May 2006). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). xxxiv, 367 p.

Kronen M, **Friedman KJ**, Pinca S, Chapman LB, Awira R, Awira R, Pakoa K, Vigliola L, Boblin P, Magron F (2009). French Polynesia country report : profiles and results from survey work at Fakarava, Maatea, Mataiea, Raivavae and Tikehau. Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). 383 p.

Kronen M, Boblin P, **Friedman KJ**, Pinca S, Magron F, Awira R, Pakoa K, Lasi F, Tardy E, Vigliola L, Chapman LB (2009). New Caledonia country report: Profile and results from survey work at Ouassé, Thio, Luengoni, Oundjo and Moindou (March, April and November 2003; January, February, April, June, August and November 2004 ; April and May 2005, January to March 2006, and January and February 2007). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea: Secretariat of the Pacific Community. XXXVIII, 409 p.

Masini RJ, Sim CB, **Simpson CJ**, McKenzie NL, Start AN, Burbidge AA, Kenneally KF and Burrows ND (2009. Protecting the Kimberley: A synthesis of scientific knowledge to support conservation management in the Kimberley region of Western Australia. Department of Conservation and Environment. 46p.

McIlgorm A, Campbell HF, **Rule MJ** (2009) Understanding the economic benefits and costs of controlling marine debris in the APEC region. Report prepared for the Asia-Pacific Economic Cooperation Marine Resources Conservation Working Group. 81 pp (refereed report)

Pakoa K **Friedman K**, Tardy E, Lasi F (2009). Epi Island trochus and sea cucumber resource status and recommendations for management. PROCFish/C and CoFish report to the Vanuatu Department of Fisheries. Secretariat of the Pacific Community, Noumea, New Caledonia.

Pakoa K, Lasi F, Tardy E **Friedman K** (2009). The status of sea cucumbers exploited by Palau's subsistence fishery. PROCFish/C and CoFish report to the Palau Bureau of Marine Resources. Secretariat of the Pacific Community, Noumea, New Caledonia.

Pinca S, Tardy E, Awira R, Pakoa K, Boblin P, **Friedman KJ**, Vunisea A, Lasi F, Magron F, Chapman LB, Kronen M (2009). Marshall Islands country report: profiles and results from survey work at Likiep, Ailuk, Arno and Laura (August and September 2007). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). xxxii, 337 p.

Pinca S, Boblin P, **Friedman KJ**, Kronen M, Magron F, Awira R, Pakoa K, Lasi F, Tardy E, Chapman LB (2009). Cook Islands country report: profiles and results from survey work at Aitutaki, Palmerston, Mangaia and Rarotonga (February and October 2007). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). xxxiv, 339 p.

Pinca S, Vunisea A, Lasi F, **Friedman KJ**, Kronen M, Awira R, Boblin P, Tardy E, Chapman LB, Magron F (2009). Solomon Islands country report : profiles and results from survey work at Nggela, Marau, Rarumana and Chubikopi (June to September 2006 and December 2006). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). 409 p.

Tardy E, Pakoa K **Friedman F** (2009). Assessment of the trochus resources of Kosrae in June 2008 and recommendations for management. PROCFish/C and CoFish report to the FSM Department of Resources and Development and the Kosrae Department of Resource and Economics. Secretariat of the Pacific Community, Noumea, New Caledonia.

Tardy E, Pakoa K **Friedman F** (2009). Assessment of the trochus resources of Pohnpei Island in June 2008 and recommendations for management. PROCFish/C and CoFish report to the FSM Department of Resources and Development and the Pohnpei Office of Economic Affairs. Secretariat of the Pacific Community, Noumea, New Caledonia.

Waples K (2009). WAMSI Project 3.6: Science coordination: administration, communication and data management. Milestone report submitted to WAMSI, July 2009.

Waples K, Simpson C. (2009). Enhancing knowledge transfer and uptake: process for the Ningaloo Research Program. Technical paper. Department of Environment and Conservation, Perth WA

2010

Evans RD, Molony BW (2010). Ranked Risk Assessment for Bycatch in Multiple Fisheries: a Bioregional Risk Assessment Method. Fisheries Research Report No. 212.

Friedman KJ, Kronen M, Vunisea A, Pinca S, Pakoa K, Magron F, Chapman L, Sauni S, Vigliola L, Tardy E, Labrosse P (2010). Fiji Islands country report: profiles and results from survey work at Dromuna, Muaivuso, Mali and Lakeba (September to November 2002, April to June 2003, June and July 2007, and February 2009). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). xxxv, 467 p.

Pakoa K, **Friedman K**, Damlamian H (2010) The status of trochus (Trochus niloticus) in Tongatapu Lagoon, Kingdom of Tonga. SPC Trochus Information Bulletin 15:3-16.

Pinca S, Kronen M, **Friedman K**, Magron F, Chapman L, Tardy E, Pakoa K, Awira R, Boblin P, Lasi F (2010). Regional assessment report: Profiles and results from survey work at 63 sites across 17 Pacific Island Countries and Territories. Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community (SPC). xxvii, 512 p.

Purcell S. (2010). Managing sea cucumber fisheries with an ecosystem approach. Ed/compiled by Lovatelli, A.; M. Vasconcellos and Y. Yimin. *FAO Fisheries and Aquaculture Technical Paper*. No. 520. Rome, FAO. (2010). 157p. ISBN 9789251064894 **Friedman K** (Contributing expert).

Ram R, **Friedman K**, Sobey M (2010). Impacts of harvesting and post-harvesting processing methods on the quality and value of beche-de-mer in Fiji Islands. SPC Beche-de-mer Information Bulletin 30:21-24.

Ropeti ME, **Friedman K**, Pakoa K, Tafileichig A (2010). Management plan for the sea cucumber fishery of Yap State. Secretariat of the Pacific Community Noumea, New Caledonia. ISBN: 978-982-00-0408-5. 32p.

Waples K (2010). WAMSI Project 3.6: Science coordination: administration, communication and data management. Milestone report submitted to WAMSI, August 2010.

Waples K, Simpson C (2010). Focus of the MSP knowledge transfer and uptake process for the Ningaloo Research Program 2010-2011. Internal report. Department of Environment and Conservation.

Wood S, Steele W, **Waples K** (2010). Ningaloo research communication and engagement plan. Internal report for CSIRO, Hobart Tas and Department of Environment and Conservation, Perth WA.

2011

Evans RD, Molony BW (2011) Pilot evaluation of the efficacy of electronic monitoring on a demersal gillnet vessel as an alternative to human observers. Technical report to WAMSI 4.4.1.

Waples K (2011). WAMSI Project 3.6: Science coordination: administration, communication and data management. Final report submitted to WAMSI, July 2011.

Campbell R, Holley D, Bardi-Jawi Ranger Group. (2011) Movement behaviours and habitat usage of West Kimberley dugongs: A community based approach. Report to the Australian Marine Mammal Centre, Dept. of Environment and Conservation Research Report Series, 2011.

Popular articles

Bancroft KP (2008) Discovering the coral life in Shark Bay Marine Park. Landscope. 24(1), 50-55.

Friedman KJ, Gisawa L (2008) Sea Cucumbers: Early retirement or renewal? Island Business Magazine. Pg48-49.

Huisman J, Long S (2008). On the edge: Exploring the Rowley Shoals. Landscope 24(1), 16-21.

Kendrick A, Huisman J, Rule M (2009) Marvellous mangroves. Landscope. 25, 50-56.

Rule, M J*,* Holley D (2010) Remote cameras monitor marine assets. Western Australian Marine Monitoring Program newsletter, Feb 2010.

Stanley F, Morris K, **Holmes T, Moore J** (2010). Giant steps: Industry and conservation make history through Gorgon. Landscope 25(4): 10-16

Wilson SK, **Holmes T** (2011) Reef fish and corals: unlocking the secrets. Landscope 26, 18-22

Pamphlets/ Information sheets/ Newsletters

Graham NAJ, Pratchett MS, **Wilson SK**, Munday PL (2009). Climate change and reef fish community structure: response, adaptation and resilience. GBR Foundation Discussion paper.

Munday PL, Cheal AJ, Graham NAJ, Meekan M, Pratchett MS, Sheaves M, Sweatman H**, Wilson SK** (2009) Climate Change Marine report card- tropical fish

Pratchett MS, Graham NAJ, **Wilson SK**, Munday PL (2009). Climate change and habitat complexity of coral reef environments. GBR Foundation Discussion paper.

Simpson CJ (2008). Marine Science Program: Science Division. Department of Environment and Conservation.

Conference posters/abstracts/ papers

2007

Armstrong S, Webster F, **Kendrick AJ**, Mau R, Onton K (2007). Full recovery from winter bleaching at Ningaloo Reef. Poster presented at Australian Coral Reef Society, 83rd Annual Conference, Fremantle, Western Australia, 9-11th October, 2007: East Meets West: Science and Management of Australia's Coral Reefs.

Waples K (Ed) (2007). Proceedings of the Ningaloo Marine Park Symposium, 16-17 July 2007, Murdoch University, Perth. Ningaloo Research Coordinating Committee. Perth, WA

2008

Armstrong SA (2008). Ningaloo Marine Park *Drupella* long term Monitoring Program. Ningaloo Research Program Progress Report. (ed. K Waples). pp. 26-27. Western Australian Marine Science Institution, Perth, Western Australia.

Armstrong S, Webster F, **Kendrick A**, Mau R, Onton K (2008). Summary of the 2006 winter coral bleaching event at Ningaloo Marine Park. In *Discovering Ningaloo: latest findings and their implications for management: Ningaloo research program progress report* (eds K Waples, E Hollander). Ningaloo Research Coordination Committee, Kensington, WA. pp. 65–68

Armstrong SA, Long S, Smith L, **Simpson CJ** (2008). Coral Bay Reff Recovery Study. Ningaloo Research Program Progress Report. (ed. K Waples). pp. 28-30. Western Australian Marine Science Institution, Perth, Western Australia.

Bancroft KP, **Long S** (2008) Modelling suggests connectivity between the Ningaloo Reef and coral reefs of the Pilbara. In Discovering Ningaloo: Latest findings and their implications for management. Ningaloo Research Program Progress Report. (ed. K Waples). pp. 61-64. Western Australian Marine Science Institute, Perth, Western Australia.

Black R, Brearley A, Johnson MS, **Kendrick AJ**, Prince J (2008). Intertidal invertebrate surveys. In *Discovering Ningaloo: latest findings and their implications for management: Ningaloo research program progress report* (eds K Waples, E Hollander). Ningaloo Research Coordination Committee, Kensington, WA. pp. 14–15.

McKenna S, **Waples K.** (2008). Communicating science. In Waples K (ed) Proceedings of the Second Annual Ningaloo Research Symposium: Discovering Ningaloo- latest findings and their implications for management. 28 and 29 May, Murdoch University, WA. Ningaloo Research Coordinating Committee. Perth, WA.

Simpson C J, Waples K, Kendrick AJ (2008). Science and Management: a framework to enhance knowledge transfer. Pp 88-90. In: Waples K (2008). Ningaloo Research Progress Report: Discovering Ningaloo - latest findings and their implications for management. Ningaloo Research Coordinating Committee. Department of Environment and Conservation, WA. 114 pp.

Waples K (Ed). 2008. Discovering Ningaloo: latest findings and their implications for management. Proceedings of the Second Annual Ningaloo Research Symposium, 28-29 May 2008, Murdoch University, Perth. Department of Environment and Conservation. Perth, WA

2009

Bancroft KP (2009) Constructing historical timelines – is it worth the trouble? In *Monitoring for Action*. p. 31. Western Australian Marine Science Institution, Perth, Western Australia.

Eriksson H, De La Torre Castro M, **Friedman K** (2009). Sea cucumber fisheries in the Western Indian Ocean, learning from the South Pacific. Presentation at the symposium at the 6th WIOMSA conference in La Réunion 24-29 August 2009.

Friedman K, Waples K (2009). Evidence Based Management: Monitoring strategies for active adaptive conservation management of marine biodiversity in Western Australia. 7–9 October 2009 Esplanade Hotel, Fremantle, Western Australia.

Friedman K (2009). Western Australian Marine Monitoring Program. Evidence based management. Ningaloo Symposium, 26th and 27th May 2009, Ningaloo Resort, Exmouth, Western Australia.

Friedman K (2009). Monitoring for future conservation. A State outlook for marine monitoring from the perspective of the Department of Environment and Conservation. WAMSI Monitoring for Action Symposium. 24 November 2009. Maritime Museum, Fremantle, Western Australia.

Holmes TH, McCormick MI (2009). Response across a gradient: behavioural reactions of newly settled reef fish to predation cues. 2009 Indo-Pacific Fish Conference, Fremantle, WA.

Kendrick AJ, Wilson SK (2009) Developing and implementing research in WA's marine parks and reserves. State Coastal Conference 7–9 October 2009 Esplanade Hotel, Fremantle, Western Australia.

McClanahan TR, Ruiz SC, Cinner J, Maina J, **Wilson S,** Graham NAJ (2009) Managing fishing gear to encourage ecosystem-based management of coral reefs fisheries. Proc 11th Int Coral Reef Symp 1: 1012-1016

Pratchett MS, Baird AH, Bradbury DM, Coker DJ, Cole AJ, **Wilson SK** (2009) Protracted declines in coral cover and fish abundance following climate-induced coral bleaching on the Great Barrier Reef .Proc 11th Int Coral Reef Symp. 1: 1042-1046.

Prince RIT (2009). Sea turtles in the Western Australian region: what do we now know/still need? PowerPoint presentation at the Australian Mini-Symposium of the 29th Symposium on Sea Turtle Biology and Conservation, 17-19 February, 2009, Brisbane, Australia.

Stanley FJ, **Prince RIT**, Kregor G, Speirs MM (2009). Protecting Western Australian marine turtles through government and industry partnerships: Poster presented at the 29th Symposium on Sea Turtle Biology and Conservation, 17-19 February, 2009, Brisbane, Australia

Sutton P, **Friedman K** (2009). Developing Collaborative Partnerships for Monitoring Marine Park Assets in Western Australia. 7–9 October 2009 Esplanade Hotel, Fremantle, Western Australia.

Waples K, Steele, W. (Eds). 2009. Proceedings of the Ningaloo Research Day for Students. 30 March 2009, Floreat WA. Ningaloo Research Coordinating Committee. Department of Environment and Conservation, Perth WA.

Waples K, Simpson C (2009). Integrating science into management to support marine conservation: a management perspective. Pages 9-16 in Proceedings of the Third Annual Ningaloo Research Symposium: Ningaloo into the future - integrating science into management. 26 and 27 May, Exmouth, WA. Ningaloo Research Coordinating Committee. Perth, WA.

Waples K Steele W (Eds). (2009). Proceedings of the Third Annual Ningaloo Research Symposium: Ningaloo into the future - integrating science into management. 26 and 27 May, Exmouth, WA. Ningaloo Research Coordinating Committee. Department of Environment and Conservation, Perth WA.

Wilson SK, Dolman A, Cheal A, Emslie M, Sweatman H, Pratchett M (2009) Maintenance of fish diversity on disturbed coral reefs. 2009 Indo-Pacific Fish Conference, Fremantle, WA.

Wilson SK (2009) Climate change and coral reef fish. Journal of Experimental Biology Symposium, Survival in a Changing World. Japan, Aug 2-6 2009

Wilson SK (2009). Climate change and coral reef habitat: implications for fish. In: A Changing Climate, Western Australia in Focus. Presenters abstract papers for the CSIRO-AMOS-WAMSI Climate Change Research Symposium

2010

Friedman K (2010). Monitoring, Evaluation and Reporting DEC perspective on the monitoring landscape. Presentation to NRM. 10 March

Holmes TH McCormick MI (2010) Response across a gradiemt: behavioural reactions of newly settled reef fish to predation cues. International Society for Behavioural Ecology Conference, Perth.

Onton K, **Wilson SK,** Page CA, Neale S, Armstrong S. (2010) Coral Disease at Ningaloo. Poster presentation Australian Coral Reef Symposium, Coffs Harbour, NSW

Pittard SD, FitzSimmons NN, Guinea M, Limpus CJ, Limpus D, McCann M, Moritz C, Parmenter CJ, Pendoley K, **Prince RIT**, Whiting A **Whiting S,** Leis B (2010). Conservation Genetics of the Flatback Turtle (*Natator depressus*): A Comparative Analysis Using Microsatellites and mtDNA. Presentation at the 30th Symposium on Sea Turtle Biology and Conservation, 27 - 29 April, 2010, Goa, India.

Waples K, Steele W (Eds). 2010. Proceedings of the Ningaloo Research Day for Students. 30 March 2010, Floreat WA. Ningaloo Research Coordinating Committee. Department of Environment and Conservation, Perth WA.

Wilson SK, Depczynski M, Fisher R, **Holmes TH**, O'Leary RA, Tinkler P (2010) Coral reefs and algal meadows as essential habitat for juvenile reef fish Australian Coral Reef Symposium, Coffs Harbour, NSW

2011

Campbell R (2011) Foraging behaviours of dugong (Dugong dugon) in the West Kimberley: A community approach. Australian Marine Science Association Conference, Fremantle 4th-7th July 2011. Oral presentation.

Evans RD, **Murray K, Shedrawi G**, **Field S** (2011). 'Digitise this! A quick and easy remote sensing method to monitor the daily extent of dredge plumes. AMSA 2011 Poster.

Field S (2011) Effects of the Gorgon Dredging program on selected aspects of the marine biodiversity of the montebello/Barrow Islands MPAs' Oral Presentation AMSA 2011.

Field S (2011) The initial results of the combined impact of dredging and high water temperature bleaching on coral reef communities within the Montebello/Barrow Islands MPAs. Oral Presentation ACRS 2011.

Friedman K (2011). WAMMP: Monitoring strategies for active adaptive conservation management of marine biodiversity in Western Australia. Australian Marine Sciences Association, 'Crossing Boundaries Symposium', 4-7 July 2011, Fremantle Western Australia.

Limpus CJ, **Whiting SD** (2011). Sea turtles in the Arafura and Timor Seas - management at a regional scale. Australian Marines Science Association 2011 Conference. Fremantle, 3-7 July 2011.

Moore JAY, Wilson SK, Bellchambers L, Depczynski M, Evans S, **Field S, Friedman K,** Gilmour J, Heron S, Middlebrook R, Radford B, Ridgway T, Shedrawi G, Taylor H, Thomson D, Tinkler P (2011) *Unprecedented large-scale bleaching of Western Australian reef corals*. Marine 'Heatwave' Workshop, Department of Fisheries, Hillary's, WA, 5 May 2011.

Policy/strategy statement

Simpson CJ (2007). Marine Science Strategy. Department of Conservation and Environment, Perth. WA. 31p.

Simpson CJ (2007). Marine Science Program: Summary of Activities, Outputs and Expenditure for 2006/7. Report to the Marine Parks and Reserves Authority. Unpublished Report, Department of Conservation and Environment. Perth. WA. 22 p.

Simpson CJ (2008). Marine Science Program: Summary of Activities, Outputs and Expenditure for 2007/8. Report to the Marine Parks and Reserves Authority. Unpublished Report, Department of Conservation and Environment. Perth. WA. 34 p.

Waples K, Simpson C J, McKenna S (2008). Marine Science Program Communication Strategy. Unpublished Report, Department of Conservation and Environment. 12 p.

Simpson CJ (2009). Marine Science Program: Summary of Activities, Outputs and Expenditure for 2008/9. Report to the Marine Parks and Reserves Authority. Unpublished Report, Department of Conservation and Environment. Perth. WA. 63 p.

Simpson CJ (2010). State Government Strategic Marine Research Priorities in relation to the Kimberley Science and Conservation Strategy and WAMSI 2. Unpublished Report. Department of Conservation and Environment, Perth. WA. 13p.

Simpson CJ and Waples K (2010). Marine Science Program: Summary of Activities, Outputs and Expenditure for 2009/10. Report to the Marine Parks and Reserves Authority. Unpublished Report, Department of Conservation and Environment. Perth. WA. 70 p.

Kendrick A, Wilson SK, Simpson C, Friedman K (2010) Strategic marine research priorities for the Department of Environment and Conservation. Unpublished Report, Department of Conservation and Environment. Perth. WA. 11 p.

Book Chapter

Lunney D, Dickman C, Matthews A, Cogger H, Baker J, **Waples K** (2007) Overabundant native vertebrates in NSW: the overlooked end of the species' status spectrum. Pages 158 - 173 in *Pest or Guest: the zoology of overabundance,* edited by Daniel Lunney, Peggy Eby, Pat Hutchings and Shelley Burgin. Royal Zoological Society of New South Wales, Mosman, NSW, Australia.

Chin A, Sweatman H, Forbes S, Perks H, Walker R, Jones G, Williamson D, Evans R, Hartley F, **Armstrong S**, Malcolm H, Edgar G, **Bancroft K**, Valentine J, Halstead B (2009). Status of the Coral Reefs in Australia and Papua New Guinea. In Status of coral reefs of the world: 2008. (ed. Wilkinson, C). pp. 159-176. Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre, Townsville, Australia.

Pratchett MS, **Wilson SK**, Graham NAJ, Munday PL, Jones GP, Polunin NVC (2009) Coral Bleaching and Consequences for Motile Reef Organisms: Past, Present and Uncertain

Future Effects Pages 139-158. In: M van Oppen and J Lough (ed). Coral Bleaching: patterns and processes, causes and consequences. Springer.

Wilson SK (2009) Diversity in diet and feeding habits of Blennies. pp 139-162 In: Patzner RA, Goncalves EJ, Hastings PA, Kapoor BG (ed). The Biology of Blennies. Science Piblications, New Hampshire, USA.

Pratchett MS, Munday Pl, Graham NAJ, Kronen M, Pinca S, **Friedman K**, Brewer T, Bell JD, **Wilson SK**, Cinner JE, Kinch JP, Lawton RJ, Williams AJ, Chapman L, Magron F (In press) Effects of Climate Change on Coastal Fisheries in the South Pacific. Secretariat of the Pacific Community.