**Economic Impact Assessment**

**Appendix 2:**

**An Economic Analysis of FRDC’s Investment in Theme 4: Management (Part C)**

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Project Number: 2011/504 - Round 2 Evaluations

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# Executive Summary – Overview of all reports

The FRDC Five Year Plan (FRDC, 2010) divides its investment into 14 themes. The Corporation has set an impact assessment objective of evaluating in economic terms all projects in all themes over the five year period commencing in March 2011. Projects were defined as those having been completed (or substantially completed) in the five years prior to 2011.

The first population of projects was defined in January 2011 and projects were placed into each of the 14 themes. Some of the 14 themes had far more projects than others and those themes with high numbers of projects were divided into two or more clusters of projects. This resulted in 25 clusters across the 14 themes.

Evaluation of the first eight clusters was completed in October 2012 and the evaluation report provided to FRDC. In the second 18 months period (i.e. July 2013 to December 2014) a further nine of the 25 clusters were subjected to impact assessment resulting in the current summary report. The impact assessment used cost-benefit analysis (CBA) to estimate investment criteria for each cluster of projects. The nine clusters evaluated in this second round comprised:

1 cluster from theme 1 (Biosecurity and aquatic animal health),

1 cluster from theme 4 (Ecologically sustainable development),

1 cluster from theme 5 (Governance and regulatory systems),

1 cluster from theme 6 (Resource access and allocation),

4 clusters from theme 7 (Production, growth and profitability), and

1 cluster from theme 8 (Consumers, products and markets).

Each cluster comprised between seven and 50 projects. As the entity for evaluation reporting was the cluster, costs and benefits for each cluster had to be built up from information on the individual projects in the cluster. This was achieved largely through access to the FRDC data base and contact with Principal Investigators of projects, government agencies and industry personnel.

The value of total funding for each of the nine clusters (FRDC plus other investment) ranged from $3.7 million to $44.2 million, with a total value for all clusters of $137.4 million (in nominal $ terms). The FRDC nominal investment in the nine clusters analysed varied for each cluster (32.6% to 62.4% of the cluster total). FRDC contributed 40% of the total nominal investment across all nine clusters.

The majority of the benefits identified from the nine clusters (202 projects in total) were economic in nature although significant numbers of environmental and social/community benefits also were identified. The major beneficiary of the impacts of the nine clusters of research investment has been the fishing industry (51% of the number of benefits identified), with 43% of the identified number of benefits being public in nature and 6% to overseas interests. The results demonstrate the significant spillovers of benefits to the public sector from research targeted at the fishing industry. Insignificant spillover benefits to other Australian industries were identified.

A number of the identified benefits were valued, and investment criteria for each of the clusters of investment calculated. Benefits were estimated over 30 years from the final year of investment in the research. Benefits and costs were expressed in 2013/14 dollar terms, and discounted to 2013/14 using a discount rate of 5%.

The net present values (NPVs) for total investment for the individual clusters ranged from $6 million to $124 million and the Benefit-Cost Ratios (BCRs) ranged from 1.8:1 to 3.9:1. FRDC investment made up 37.9% of the total investment in present value terms, and the NPVs for FRDC investment in individual clusters ranged from $4 million to $60 million.

When all nine clusters are aggregated, the BCR for the $266.5 million investment in the nine clusters (present value terms) was 2.6:1, with the Present Value of Benefits (PVB) of $684.0 million and an NPV of $417.5 million. For the FRDC investment of $101.0 million (present value terms), the NPV was $170.2 million.

**Appendix 2: An Economic Analysis of FRDC’s Investment in Theme 4: Management (Part C)**

**Background**

The FRDC currently has five programs:

1. Environment

2. Industry

3. Communities

4. People development

5. Extension and adoption

The Environment program (Program 1) in the FRDC’s RD&E Plan (FRDC, 2010) has four themes:

Theme 1: Biosecurity and aquatic animal health

Theme 2: Habitat and ecosystem protection

Theme 3: Climate change

Theme 4: Ecologically sustainable development

Theme 4 is concerned with the use and management of aquatic resources. The objective of Theme 4 is to ensure the ecologically sustainable use of aquatic natural resources by the fishing and aquaculture industry.

Theme 4 is divided into three clusters, Parts A, B and C. The current analysis addresses Part C, which covers management. Part A addresses recruitment/movement, stock structure and fisheries modelling. Part B focuses on biology.

The projects funded in Part C covered a range of fisheries management issues. The majority of projects sought improvements in tools and methods for assessing the status of fisheries stocks; many investments aimed at improving and/or extending the extent and quality of information available to industry and fisheries managers; other investments were aimed at new tools and methods for reducing costs of providing information.

It is pertinent to note that this cluster of projects fits closely with one of the strategic research themes of the national RD&E plan for Australian fisheries (Commonwealth of Australia, 2010, page 32) which aims to develop knowledge, tools and processes to support responsible use and management of aquatic resources. Priority issues for RD&E stated in that plan were:

* developing technologies and models to underpin harvest strategy development, delivery and evaluation; including for data poor fisheries
* integrating social, environmental and economic considerations into fisheries management strategies
* identifying and understanding community aquatic values and how these can be integrated into fisheries management
* developing performance indicators, including social, ecological and economic
* understanding the influence of oceanographic and ecological factors on fisheries — e.g. recruitment of fish stocks
* developing and adapting technologies and processes to better understand the impacts of aquaculture systems and to quantify carrying capacity
* developing practical tools for Ecologically Based Fisheries Management, and incorporating them into fisheries management plans
* implementation of environmental management systems, eco-labels and other schemes to foster user-stewardship of the resource

Most of these priority areas are addressed by the 50 projects included in this project cluster.

**Summary of Projects**

There are 50 projects from Theme 4 Part C (Management) included in this analysis. Table 1 gives a list of projects in the cluster and Table 2 provides a summary of each project in the cluster.

Table 1: Projects included in Theme 4 (Part C: Management)

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| **FRDC Project Number** | **Project Title** |
| 2000/123 | Risk analysis and sustainability of the southern rock lobster (*Jasus edwardsii*) resources in SA |
| 2001/042 | Development of the tools for long term management of the giant crab resource: data collection methodology, stock assessment and harvest strategy evaluation |
| 2001/074 | Linking fishery-dependent and fishery-independent assessments of abalone fisheries |
| 2001/076 | Assessing survey methods for greenlip abalone in South Australia |
| 2002/014 | Developing a new method of evaluating catch rates of spatially mobile and aggregating prawn resources |
| 2002/056 | Innovative stock assessment and effort mapping using VMS and electronic logbooks |
| 2002/057 | Sustainability of small-scale, data-poor commercial fisheries: developing assessments, performance indicators and monitoring strategies for temperate reef species |
| 2002/059 | Developing fishery-independent surveys for the adaptive management of NSW’s estuarine fisheries |
| 2002/072 | Assessing the feasibility of an industry-based fishery-independent survey of the SEF |
| 2002/083 | Towards an industry-based abalone fishery monitoring program |
| 2003/017 | Juvenile scallop trashing rates and bed dynamics: testing the management rules for scallops in Bass Strait |
| 2003/044 | Development of a sustainable industry-based observation system for blue grenadier at the primary spawning sites |
| 2003/047 | Evaluation of methods of obtaining annual catch estimates for individual Victorian bay and inlet recreational fisheries |
| 2003/052 | Spatial scales of exploitation among populations of demersal scalefish: implications for wetline management |
| 2003/222 | Innovative Solutions for Aquaculture: spatial impacts and carrying capacity - further developing, refining and validating existing models of environmental effects of finfish farming |
| 2003/223 | Innovative solutions for aquaculture planning and management – Project 5, Environmental audit of marine aquaculture developments in South Australia |
| 2004/006 | ESD Reporting and Assessment Subprogram: strategic planning, project management and adoption |
| 2004/008 | Improving demonstrated environmental accountability in the Northern Territory fishing industry |
| 2004/019 | Towards optimising the spatial scale of abalone fishery management |
| 2004/020 | Validation and extension of acoustic reef habitat mapping methodologies in the western abalone zone, Victoria |
| 2004/096 | The development and production of EMS template documents for the salmonid, oyster and abalone aquaculture sectors in Tasmania |
| 2004/101 | ESD Reporting and Assessment Subprogram: review of the scope, assessment methods and management responses for fisheries ESD and EBFM in Australia |
| 2005/004 | Determination of effective longline effort in the Eastern Tuna and Billfish Fishery |
| 2005/011 | Development of Field Implemented Fillet Identification (FIFI) for coral reef fin fish |
| 2005/031 | Establishing ecosystem-based management for the South Australian sardine fishery: developing ecological performance indicators and reference points to assess the need for ecological allocations |
| 2005/035 | The development, adoption and evaluation of environmental management systems in Western Australian commercial fisheries |
| 2005/038 | Space-time analysis of western king prawns, brown tiger prawns and saucer scallops in Shark Bay for improved fisheries management |
| 2005/044 | Development of the scientific requirements of an Environmental Management System (EMS) for the pearling (*Pinctada maxima*) industry |
| 2005/047 | Utilisation of GIS spatial statistical methods to assist in the development of ecosystem based fishery management strategies using the Northern Territory demersal and Timor Reef fisheries as case studies |
| 2005/238 | ASIC/NAC environmental labelling |
| 2006/008 | Assessing data poor resources: developing a management strategy for byproduct species in the Northern Prawn Fishery |
| 2006/024 | Harvest strategy evaluation to optimise the sustainability and value of the Queensland scallop fishery |
| 2006/036 | Supporting sustainable fishery development in the GAB with interpreted multi-scale seabed maps based on fishing industry knowledge and scientific survey data |
| 2006/057 | Development of a national environmental management and accreditation system for business/public recreational fishing competitions |
| 2007/010 | Integration of socio economic sustainability criteria into a reporting framework for the Australian aquaculture industry |
| 2007/013 | A comprehensive ESD analysis of a fishery: the incorporation of regulatory, ecological, economic and sociological aspects |
| 2007/014 | Developing innovative and cost-effective tools for monitoring recreational fishing in Commonwealth fisheries |
| 2007/016 | Development of national guidelines to improve the application of risk-based methods in the scope, implementation and interpretation of stock assessments for data-poor species |
| 2007/017 | Integrated evaluation of management strategies for tropical multi-species long-line fisheries |
| 2007/018 | Developing techniques to estimate total allowable catches for the NPF major prawn species |
| 2007/048 | Towards evaluating the socio-economic impacts of changes to Queensland’s inshore fishery management |
| 2007/055 | Independent environmental certification for Australia's Northern Prawn fishery marine stewardship council pre-assessment |
| 2007/061 | The progression of abalone fishery performance indicators |
| 2007/064 | Tactical Research Fund: Developing an analytical module for large-scale recreational fishery data based on phone/diary survey methodology |
| 2007/066 | Tactical Research Fund: Rapid response to abalone virus depletion in western Victoria: information acquisition and reefcode assessment models |
| 2008/064 | Tactical Research Fund: Management Strategy Evaluation (MSE) of the harvest strategy for the Small Pelagic Fishery |
| 2008/075 | Tactical research fund: Industry based size-monitoring and data collection program for albacore tuna in the ETBF |
| 2008/097 | Tactical Research Fund: Developing the use of existing technology in cost-effective and reliable Industry-based structured fishing surveys to urgently replace more costly methods and advise finer-scale management of abalone populations |
| 2008/215 | Tactical Response Fund: Implementation of the NEATFish environmental standard for recreational fishing tournaments |
| 2009/031 | Taking female mud crabs (*Scylla serrata*): assessment of risks and benefits |

Table 2: Description of Each of the 50 Projects

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| **Project number 2000/123: Risk analysis and sustainability of the southern rock lobster (*Jasus edwardsii*) resources in SA** | |
| Project details | Organisation: South Australian Research and Development Institute  Period: Sep 2000 to Apr 2009  Principal Investigator: Yongshun Xiao |
| Rationale | A new stock assessment model was required to improve the estimated time series of recruitment, exploitation, and catchability of lobsters in the South Australian lobster fisheries. Of concern was a lack of a capacity to respond to external threats to the industry. The lobster industry was vulnerable to claims of over-fishing because it could not respond with a defence of its management strategies and practices based on a formal risk assessment. |
| Objectives | 1. To undertake a careful review of appropriate models developed and used in other invertebrate fisheries, including those used in Tasmania and Western Australia. 2. To develop a spatial, sex, time and age dependent model taking advantage, where possible, of model components developed elsewhere. 3. To develop a simulation model based on the outputs from the model in (2). 4. To use the simulation model to evaluate various harvesting strategies to empower the fishing industry and managers to make better informed decisions and respond skilfully to critics. 5. Use the model to forecast catch and abundance for individual areas. 6. Use the model to answer the following questions:  * How much risk is associated with any particular TAC or level of effort? * How much more can fishers gain in revenue terms under alternative harvesting strategies while demonstrating long term sustainability with a quantified risk? * Which fishing regime produces a sustainable fishery, while, at the same time, maximises catch and revenue? * How does the current harvesting strategy compare with to the optimal harvesting strategy? * How much more biological information is gained or lost by adopting various harvesting strategies? * What are the implications of lobsters' aggregating behaviour for the assessment of the stock?  1. To develop a modelling option that allows management to produce reports consistent with the ESD reporting framework developed by SCFA. |
| Activities and Outputs | * A review of current fisheries management models used in lobster stock assessment and other invertebrate fisheries was completed. * An integrated sex specific age and time dependent population dynamics model was developed including tagging data, log-book catch and effort data, and length frequency data as input to an integrated stock assessment model. * The model was used as a simulation model to evaluate various harvesting strategies. * Outputs of management interest were provided for both northern and southern zones of the fishery. * Future research areas were identified. |
| Outcomes | * The tool was potentially to assist industry by providing information about the appropriate levels of effort and/or total available catch or other management control methods. * The tool has not been used in Southern Rock Lobster practical management due to lack of confidence by others in the model (Tim Ward., pers. comm., 2013). * The project probably helped to focus effort on a single lobster model. |
| Benefits | * No benefits apparent in terms of improved management. * The project probably saved resources with regard to future investment in South Australia. * Some modelling capacity enhanced. |

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| **Project number 2001/042: Development of the tools for long term management of the giant crab resource: data collection methodology, stock assessment and harvest strategy evaluation** | |
| Project details | Organisation: University of Tasmania  Period: Jul 2001 to Apr 2008  Principal Investigator: Caleb Gardner |
| Rationale | Giant crab, from Western Australia to Tasmania, is considered a single biological stock because the species occurs in all of the southern states. Stock assessment of giant crabs across southern Australia was not formalised although this is a requirement for state management and is also required to meet Federal expectations on export of wildlife under Schedule 4 of the Wildlife Protection Act. The ability to conduct assessments was limited by the data and analytical tools that were available. This project was constructed with the awareness that the giant crab resource was small and the fishery would have little ability to fund expensive data collection systems in the future, beyond catch rate data from logbooks. |
| Objectives | 1. To develop a low cost, long term, giant crab resource assessment and data collection methodology. 2. To quantify biases in the historical logbook data to increase its value for resource assessments. 3. To obtain industry’s understanding/observations of basic biological and market processes (e.g. moulting, egg-bearing, mating, migration, beach price influences) and how their fishing effort is adapted to this knowledge (e.g. targeting of size classes, seasonality of effort, etc.). 4. To develop the ability to investigate alternative harvest strategies (sustainability of different TACs; closed seasons etc.). |
| Activities and Outputs | * The project has developed tools for low cost assessment of the giant crab resource across southern Australia. * Specialised software was developed for conducting model runs to facilitate altering parameters, running a range of alternative scenarios, and plotting outcomes. |
| Outcomes | * Stock assessment and management response is now increasingly based on biomass estimates from this project. Risk of poor management decisions is thus reduced, which contributes to greater business certainty. * The project has enabled high quality assessments to be delivered each year at relatively low cost. * Fishers have adopted electronic calipers combined with an electronic data logger, the solution developed in this project. * This system has dispensed with paper records so that work at sea is easier, and costs for data management (e.g. data entry) are reduced. * Giant crab stock assessments are utilising outputs from this model. * The information in this report was used by the Crustacean Fisheries Advisory Committee and DPIWPE to provide advice to the Minister on setting the annual TAC. * The fishery performance indicators in Tasmania were re-written in a new management plan to formalise the adoption of the model outputs. * The improvements in stock assessment processes through this project have contributed to official approval for export and potentially the maintenance of higher beach prices than could be obtained from local markets (Caleb Gardner, pers. comm., 2013). * Business planning and investment has been assisted by greater certainty in management structures for the fishery. * The TACC for Tasmania was reduced to 47 tonnes in 2012-13; this helped to maintain the catch rate (Caleb Gardner, pers. comm., 2013). |
| Benefits | * Improved quality and usefulness of data for the same stock assessment cost. * Greater certainty of access to export markets. * Greater confidence in the ecological and financial sustainability of the fishery. * Maintenance of profits due to maintenance of the catch rate. |

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| **Project number 2001/074: Linking fishery-dependent and fishery-independent assessments of Abalone fisheries** | |
| Project details | Organisation: University of Tasmania  Period: Jul 2001 to Jul 2007  Principal Investigator: Craig Mundy |
| Rationale | Abalone stocks are vulnerable to localised depletion, followed by fishery collapse, The sustainability of current catch levels was not known with any confidence.  In Tasmania, the inputs currently available to a model being developed include fishery-dependent catch-effort data, fishery-dependent length-frequency data, research length-frequency data, and estimates of biological parameters. The collection of fishery-independent abalone abundance data was considered to be a crucial component of managing abalone fisheries and allowed a more quantitative and independent process for assessing the sustainability of various management decisions. Without fishery-independent data, the accuracy and utility of model predictions was thought to be significantly reduced. |
| Objectives | 1. Establish the most appropriate fishery-independent index of relative abundance for a range of abalone habitats in Tasmania.  2. Develop methods of standardising abalone catch rate data that best relate catch rates to abundance.  3. Establish the optimum means for obtaining validated fishery-dependent data.  4. Synthesise all results so they can be included in the abalone stock assessment model currently under development. |
| Activities and Outputs | * Following a review of the literature relating to abundance estimation techniques in benthic habitats, a number of sampling strategies were considered before selecting a radial transect approach. * The primary improvement achieved was to reduce the spatial bias inherent in the initial application of the technique through the application of increased sampling effort with increasing distance from the centre of the site, and by improving the resolution of bearings along which transects were oriented. * An algorithm to generate coordinates for the modified radial transect technique was developed. * The newly developed radial transect protocol was field tested. * The modified radial transect procedure performed well, and was an efficient technique in all regions and habitats visited. * While the modified radial method has proven to be an effective and efficient method for obtaining robust estimates of abalone density, some limitations needed to be considered: one was the cost-benefit limitations on diving in remote areas imposed by the Australian Scientific Dive Code; a second was the degree to which variation in commercial fishing effort at survey sites masks longer term trends in abalone abundance and population structure obtained from survey estimates. * The conclusion was that while the modified radial transect technique can provide robust data on abalone density, a single annual survey of abalone density may provide an inaccurate estimate of stock abundance due to unpredictable temporal variation in fishing effort at each study site. |
| Outcomes | * Recognition of fundamental flaws in logic of collecting fishery-independent abundance data on an annual basis. * Development of a strategy for bi-annual monitoring of abalone density at key “indicator” sites rather than an extensive fishery wide survey program. * Re-assessment of the data required for harvest strategy simulations using length-based models. * In theory the Tasmanian abalone stock assessment model could be improved by this project but the state cannot afford to roll out a monitoring program based on the strategy (Craig Mundy, pers. comm., 2013). |
| Benefits | * No benefits apparent in term of improved management to date. * Potentially improved future management of the abalone fishery in Tasmania*.* |

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| **Project number 2001/076: Assessing survey methods for greenlip abalone in South Australia** | |
| Project details | Organisation: South Australian Research and Development Institute  Period: Jul 2002 to Dec 2006  Principal Investigator: Richard McGarvey |
| Rationale | Fishery independent surveys of output managed fisheries, such as the South Australian abalone fishery, provide key information on the abundance and size-structure of populations being exploited. The existing surveys at the time did not represent a sufficient basis for quantifying trends in the fishery. There was a need perceived to develop and implement a stock assessment monitoring sampling protocol that was cost effective for purposes of stock assessment and management. |
| Objectives | 1. To field test the precision and practical applicability of diver survey methods for greenlip abalone.  2. To present for industry approval, survey protocol specifications for adoption in South Australian abalone assessment. |
| Activities and Outputs | * The work undertaken here suggested that habitat mapping for stratification in abalone survey design is feasible. * The principal outputs of the project are new abalone survey information delivered to managers for stock sustainability, and for exploring new ground for fishery expansion. * Information about absolute density, spatial distributions, and clustering are provided, notably for greenlip abalone in South Australia. These are not measured by current abalone surveys in Australia and New Zealand. * The results of the fish-down experimental tests of the leaded-line method imply that all of the survey design objectives were met. * The other essential requirement, that research divers are comfortable and confident about the new design has also been attained, principally through extensive involvement and contributions by SARDI researchers/divers in its development, testing and implementation. |
| Outcomes | * Having a direct measure of abalone biomass in any surveyed region has now shown itself to permit immediate quota decision making. * A range of quota options are presented to managers in a ‘decision table’, permitting them to choose the level of risk that biomass may be overestimated, and to choose the fraction of survey-estimated biomass to allocate for harvest. * With surveys that measure relative abundance, it takes approximately 5 years for a time series to become informative to managers. * The leaded-line design, because it measures an absolute quantity that does not depend on the particular survey protocol utilised, can be modified and improved over time. This is not possible for relative measures of abundance which must maintain an unchanging sampling protocol for the time series to be self-consistent. * Thus management can request information on total biomass available for harvest in any given survey study region, in any year. * The ‘leaded line’ survey method developed allows measurement of biomass in any given study region and is now used for all greenlip abalone survey sites in South Australia. It will eventually replace time swims everywhere. Currently time swims are also being run concurrently to give some overlap with the earlier timed swim survey time series permitting the leaded line surveys to extend the earlier time swim time series (Richard McGarvey, pers. comm., 2013). * The leaded line methods were also used to estimate total available biomass at Cowell where a new fishery was developed. Also, the leaded line survey design is now being expanded considerably at Tiparra to address potential problems in that abalone ground, which is the single largest producer of greenlip in Australia but where catches and catch rates have decreased measurably in recent years. Again, an estimate of total available biomass will result from the expanded survey (Richard McGarvey, pers. comm., 2013). * The SA abalone stock assessment process been improved due to this project; for example, information from the survey was used via a decision table at Cowell; also it will be used directly at Tiparra to set a harvest quota for that subregion; moreover, once the overlap of time series with timed swims is long enough, leaded lines will replace timed swims as the survey method for use in the overall State-wide harvest strategy by which greenlip quota is set in the three South Australian abalone fishery zones. * In addition, subsequent to the project completion, a method was also developed for use with blacklip abalone in South Australia based on this leaded line approach (Richard McGarvey, pers. comm., 2013). |
| Benefits | * Reduced risk of overfishing in the medium to long term and higher confidence in a sustainable take. |

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| **Project number 2002/014: Developing a new method of evaluating catch rates of spatially mobile and aggregating prawn resources** | |
| Project details | Organisation: CSIRO, Marine and Atmospheric Research  Period: Oct 2002 to Mar 2007  Principal Investigator: Catherine Dichmont |
| Rationale | The spatial extent of the Northern Prawn Fishery (NPF) had changed over time and effort was concentrated on relatively small hotspots. Little information was therefore provided on the areas no longer fished (including inshore areas that generally have been closed to fishing). However, stock assessment estimates for banana and tiger prawns needed to take into account the abundance of prawns in all areas, including those areas not fished. |
| Objectives | 1. To quantify the movement of banana and tiger prawns between the inshore and offshore waters of the Gulf of Carpentaria. 2. To quantify the within-year temporal dynamics of recruitment for banana and tiger prawns and of spawning for tiger prawns in terms of location, size and relative density of prawns. 3. To establish the relationship between catchability and biomass for banana and tiger prawns. 4. To determine an at-sea predictor-of-prawn catch and use this information to provide advice to management. 5. To revise the models for stock assessments of banana and tiger prawns using the new information on relationships between catch rates and biomass and provide improved assessments of the status of banana and tiger prawns in the NPF. |
| Activities and Outputs | * Three fishing regions of the Gulf of Carpentaria were sampled for total weight and number of prawns during the project. * Modelling or spatial and temporal distribution of three prawn species was carried out. * An examination was made of the relationship between spawning stock size and recruitment to the next generation of adults. * There seemed to be no relationship between rainfall or salinity and the inshore/offshore dispersion of banana prawns. * There was neither a clear positive or negative relationship between catchability and abundance within any stock of banana prawns. |
| Outcomes | * The Northern Prawn Fishery will be the main beneficiary of this research. * Most of the results have been used as input into a later FRDC project 2004/024. * The project therefore has made a significant contribution to stock assessments for banana and tiger prawns, which will allow managers to make more informed decisions regarding future management options. * The improved understanding of the extent of inshore spawning has implications for assessing the potential value of closing these shallow waters and will enable the development of more accurate estimates of spawning stock to use in stock assessment models of prawns in the NPF. |
| Benefits | * Improved stock assessment for target prawn species in the NPF. |

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| **Project number 2002/056: Innovative stock assessment and effort mapping using VMS and electronic logbooks** | |
| Project details | Organisation: Queensland Department of Primary Industries  Period: July 2002 to Nov 2007  Principal Investigator: Neil Gribble |
| Rationale | Information on where trawling does and does not occur was needed by fishery managers, industry, the Great Barrier Reef Marine Park Authority (GBRMPA) and others to inform debate and decision making for the trawl fishery. These maps were required by July 2003 for implementation of the Queensland Trawl Plan. Such maps were also needed to model the ecological effects of trawling, since untrawled areas may provide refuge for some vulnerable bycatch species. |
| Objectives | 1. Review applications and potential of VMS mapping and OceanFARM software and related approaches.  2. Develop trawl track and trawl signature definitions for each fishery sector to use with TerraVision software.  3. Map the spatial and temporal intensity of fishing effort in each trawl sector, and estimate the distribution and extent of trawled and untrawled areas.  4. Map resource density indices for each fishing sector.  5. Use these methods to recommend (and achieve implementation of) improved Trawl Fishery Review Events, and develop improved stock assessment approaches for scallops, eastern king prawns (EKP) and tiger/endeavour prawns. |
| Activities and Outputs | * This project used VMS position information and logbook catch records to map and statistically model the spatial distribution of Queensland otter trawl fisheries, and estimate density indices for selected fisheries. * For all three fisheries explored, fishing effort was found to be spatially aggregated: Analysis of the tiger/endeavour prawns fishery VMS data suggested that targeting occurred in areas of high catch per unit effort (CPUE); interpreted as fishers targeting aggregations of prawns. * Analysis of the scallop and EKP fisheries, in contrast, showed that although effort was aggregated it was not related to areas of high CPUE; interpreted as fishers following spatial patterns determined by external processes which might include management closures, fuel prices, and cost-benefit business decisions. |
| Outcomes | * The most important outcome from the project has been the adoption of the project’s VMS mapping and trawl signature recognition algorithms/software ‘TrackMapper’ by management (i.e. QDPI&F VMSunit). * Another outcome has been the acceptance by the fishing industry of the importance of VMS data in fishing effort mapping and resource assessment. * The methods developed by the project were applied to produce maps detailing the amount of Gross Value of production (GVP) lost as a result of the introduction of the Representative Areas Program. This work was done for the Australian Government Department of the Environment and Heritage (DEH) to aid in developing a structural readjustment package to compensate fishers. * The project has allowed the enhancement of the basic concepts and computer algorithms that will drive the future development of fisheries resource assessment using high-resolution VMS data and electronic logbooks. * The project empowered the trawl industry and fishery managers to meet present and future challenges by providing it with better information about the status and sustainability of the resource, as well as reliable information on the distribution of trawled and untrawled areas. * The information enabled fishery managers and the trawl industry to make informed strategic decisions. * VMS tracking is now an integral part of fisheries management in Queensland trawl fisheries; the GBRMPA uses it for auditing their own management plans and it is used in the Queensland boating and fishing patrol activities (Neil Gribble, pers. comm., 2013). |
| Benefits | * Reduced risk of overfishing in the medium to long term and higher confidence in a sustainable take. |

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| **Project number 2002/057: Sustainability of small-scale, data-poor commercial fisheries: developing assessments, performance indicators and monitoring strategies for temperate reef species** | |
| Project details | Organisation: University of Tasmania  Period: Jun 2002 to Sep 2006  Principal Investigator: Jeremy Lyle |
| Rationale | * The development of live fish markets in the early 1990s has created a strong demand for temperate reef species, specifically banded morwong and wrasse. This demand had resulted in major increases in fishing pressure directed at the reef fish communities. While there had been much work on tropical species, knowledge of how temperate reef species respond to fishing pressure was relatively poor. * In Tasmania, steady declines in catch and catch rates have led to concerns that fishing has already significantly impacted banded morwong stocks. Although key fishery indicators, catches and catch rates (analysed at state-wide or regional scales) had remained relatively stable for wrasse, there were anecdotal reports of localised depletions from Tasmania. * There was therefore an urgent need to develop robust stock assessments, appropriate performance indicators and monitoring strategies for these species if they were to be managed sustainably. |
| Objectives | 1. Develop appropriate and meaningful performance indicators for sedentary reef-dwelling species, using banded morwong and wrasse as models. 2. Determine minimum information requirements for the effective stock assessment of these species. 3. Develop appropriate model frameworks for testing the performance indicators developed for these fisheries. |
| Activities and Outputs | * Construction of age and spatially structured stock assessment models which were used as operating models within a simplified management strategy evaluation framework. * The main output of this project has therefore been the development of a modelling framework that has allowed the value of different performance measures for the assessment and management of spatially structured populations to be tested. * Simple decision rules based on measures derived from catch rate analyses can potentially achieve a preferred or targeted level of mature biomass; at least it can avoid depletion at a large scale. * In this regard, priority needs to be given to achieving a high level of commercial data quality, including appropriate spatial reporting, and the development of clearly defined management objectives and decision rules. |
| Outcomes | * In Tasmania commercial logbooks are being modified to include greater spatial resolution and provision for catch verification. Progress is also being made to develop more explicit performance measures for key scalefish species, including banded morwong. * This study has highlighted the difficulties of managing and assessing spatially structured fish stocks, especially those low value fisheries that are typically data poor. * In relation to Tasmania, a significant and direct outcome of this project has been a review of the management of the banded morwong fishery, with a Departmental paper recently tabled to the Scalefish Fishery Advisory Committee (August 2006) proposing the introduction of output controls (individual quotas) coupled with spatially-explicit performance indicators. * Progress is also being made to develop more explicit performance measures for other key scalefish species in Tasmania and it is hoped that these will be presented as part of the 2006 Scalefish Fishery assessment report. * This project has also raised the awareness by resource managers and industry of the importance of meaningful (and accurate) spatial information relating to catch and effort. Accordingly, the Tasmanian general fishing logbook is being revised to provide for greater spatial resolution in catch and effort reporting (particularly in relation to inshore reef areas), as well as catch verification via catch disposal declaration. * This study will also have broader implications for other small-scale and data poor fisheries. |
| Benefits | * Reduced risk of overfishing in the medium to long term and higher confidence in a sustainable take for Tasmanian Scalefish fisheries. * Reduced risk of biodiversity loss. * Benefits for industry and resource managers in other jurisdictions in terms of management and assessment of other small-scale fisheries. |

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| **Project number 2002/059: Developing fishery-independent surveys for the adaptive management of NSW’s estuarine fisheries** | |
| Project details | Organisation: NSW DPI  Period: Oct 2002 to Oct 2008  Principal Investigator: Charles Gray |
| Rationale | It was deemed necessary to develop a standardised fishery-independent sampling strategy to provide estimates of relative abundances and demographies of populations of fish in the estuaries of NSW. These could then be used in conjunction with existing (and any new) sources of fishery-dependent data (e.g. from commercial and recreational fisheries).  The correct sampling tools and methods needed to be developed. Commercial and scientific fishing gears were available but had to be modified to develop new techniques that would sample wider size ranges and diversities of fish. Once the best tools had been developed, appropriate spatial and temporal scales of sampling and units of replication needed to be determined so that an ongoing survey design based on a rigorous sampling protocol could be implemented for the future. |
| Objectives | 1. Develop scientific sampling tools to catch the widest possible size range and diversity of fish species in NSW’s estuaries. 2. Use the gears developed in objective 1 to do pilot studies to determine the most cost effective optimal number of replicates, sites, locations and habitats to be sampled in and among estuaries. 3. Use the results from objectives 1 and 2 to design the optimal sampling regime that will become the long-term, large-scale survey of the fish populations in NSW estuaries. |
| Activities and Outputs | * The project successfully developed methods to use multi-mesh gillnets and a beam trawl as tools for sampling a wide size range and diversity of fish and crustaceans in estuaries of NSW. * Experiments also measured spatial and temporal variation of estuarine fauna sampled with these gears and provided variances for cost-benefit analyses. * Owing to the variable and dynamic nature of these fauna, however, the project identified numerous challenges that required the further development of novel analytical approaches before a large-scale and long-term survey could be designed and optimised across multiple species. * Additional research was also needed to compare decision-making incorporating fishery-independent methodologies against that using data from fishery-dependent sources. This would identify the most reliable, robust and cost-effective sampling programmes required to improve the sustainability of NSW’s estuarine fisheries resources. |
| Outcomes | * Before commitments are made to do large-scale and long-term surveys (or indeed to develop other types of sampling gears) of estuarine fisheries resources in NSW, research was urgently required to test the benefits of fishery-independent methodologies against data from fishery-dependent sources. * It is understood that such research initially proceeded via another FRDC project (2008/003). The project was implemented to carry out the large scale survey and to test the benefits of fishery-independent methodologies against data from fishery-dependent sources. * The independent survey was implemented but the testing of the data from the two methodologies has not been completed due to staff disruptions at NSW Fisheries. Regular sampling and surveys have therefore not yet commenced (Doug, Rotherham, pers. comm., 2013) * The independent data has had a fisheries management impact in 2008 when it contributed to a policy decision to open the Richmond River to fishing two months after flooding compared to potentially 6 months if only industry dependent data had been available (Doug Rotherham, pers. comm., 2013). |
| Benefits | * Contribution to securing improved information to enhance fisheries management in NSW estuaries. * Some fisheries management impacts associated with the Richmond River re-opening to fishing in 2008. |

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| **Project number 2002/072: Assessing the feasibility of an industry-based fishery-independent survey of the SEF** | |
| Project details | Organisation: Fishwell Consulting  Period: Dec 2002 to Aug 2006  Principal Investigator: Ian Knuckey |
| Rationale | Most stock assessments rely on reported commercial catch per unit effort (CPUE) data as their main index of abundance. One of the problems with commercial  CPUE data as an index of abundance in a multispecies quota fishery such as the SETF, is that fishers often modify their fishing practices to target or avoid particular species, to suit quota availability or meet market demands. These factors are usually not well recorded. A need was identified to investigate and develop fishery-independent methods for surveying the relative abundance of SEF fish stocks. |
| Objectives | 1. Conduct a power analysis of the shot-by-shot data from commercial logbooks and the ISMP so that an initial assessment can be made of the sampling intensity that will be required to develop robust indices of relative abundance on the basis of trawl surveys. 2. Design and hold a workshop involving industry, scientists, managers and invited experts with experience in industry-based surveys in multi-species, shelf edge and slope fisheries like the South East Fishery. 3. Develop industry support for implementing industry-based surveys. |
| Activities and Outputs | * The project produced estimates of costs and sampling requirements needed to undertake surveys. * Thus was achieved via an analysis of CPUE data and some statistical analyses followed by two workshops, one for the SETF and one for the GABTF. |
| Outcomes | * The two workshops highlighted the shortcomings of using CPUE data as an index of abundance and raised the profile and value of fishery-independent surveys among industry members. * The project established the foundations for undertaking independent surveys in trawl fisheries in Commonwealth waters. * During the year following the SETF workshop, a number of meetings were held with SETF industry to discuss the feasibility of conducting a fishery-independent survey. * The SETF industry considered it too expensive given the current economic situation of the fishery and there was no agreement to proceed with the implementation of the surveys as part of this project. * There was ongoing support by GABIA to fund and conduct the GABTF survey. * The GABTF went on to implement the first comprehensive fishery independent survey in the SESSF and has continued to carry out surveys of the GAB shelf trawl fishery for 3 consecutive years from 2005 to 2007; these surveys have been used to help support the setting of TACs (since TACs were introduced in 2006). * The subsequent success of the GABTF survey has given the survey method strong credibility, and may encourage participants in the SETF to adopt an industry-based fishery-independent survey for their fishery. * In the SETF, initial industry support was not as strong, but subsequent to the structural adjustment it is recognised that fishery-independent surveys will be an integral part of the fishery. A subsequent project FRDC 2006/028 “Implementation of fishery-independent surveys for the Southern and Eastern Scalefish and Shark Fishery” has ensured this commitment is achieved. * The independent surveys for the SETF and GABTF are still being undertaken by industry as of 2013; for the GAB, surveys have undertaken in 6 of the past 7 years; for the SETF, they have been undertaken in 3 of the past 6 years (Ian Knuckey, pers. comm., 2013). * The cost has been much higher for the SETF that the GABTF due to the larger area in the fishery and cost is major factor in determining the frequency of the independent surveys. * The survey information has been used in fisheries management to alter TACs and for analysing bycatch and by product species (Ian Knuckey, pers. comm, 2013). |
| Benefits | * Reduced risk of overfishing in the medium to long term and higher confidence in a sustainable take for SETF and GABTF fisheries. * Reduced risk of biodiversity loss. |

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| **Project number 2002/083: Towards an industry-based abalone fishery monitoring program** | |
| Project details | Organisation: Seafood Industry Victoria Inc.  Period: Sep 2002 to Jul 2007  Principal Investigator: Ross McGowan |
| Rationale | There appeared a strong and urgent need to make better use of the catching sector as a vehicle for sampling and data acquisition. It was recognised that industry (e.g. abalone divers) potentially provide sampling opportunities that are at least an order of magnitude more numerous than those provided by fisheries agencies and research institutions. The central issue is how to effectively utilise this industry potential for fishery assessment.  The abalone industry offers one of the best opportunities for obtaining good growth data for a large number of locations, but experience has shown that effective participation of industry members requires support from scientifically trained persons. |
| Objectives | 1. Facilitate acquisition of data via industry including tagging for growth, size at maturity and length frequency of the catch.  2. Promote industry self-sufficiency in data collection including the training of deckhands and divers in sampling, measuring and recording techniques.  3. Develop appropriate management protocols to support on-going voluntary data collection by industry. |
| Activities and Outputs | * During the project, emerging micro management needs influenced the direction of the project and the monitoring strategies that were explored. * The initial focus on data collection centred on the needs of the management of the fishery by Fisheries Victoria. * The initial emphasis was on using divers and their deckhands in lieu of field technicians to obtain growth and size at maturity data and in using questionnaires to acquire divers’ observations of resource status. However, these endeavours acquired less importance as the project progressed. * The focus of the project then tended to split between practical tasks in which industry could engage to improve prospects for sustainability, for example stock rehabilitation and exploration of seldom fished reefs, and providing mechanisms for meaningful engagement of industry in the synthesis and analysis of resource information on a reef by reef basis. * Several workshops were held during the course of the project. * Data acquired and analysed during the project were used to make management recommendations or were summarised and collated for use by industry during reef scale assessment workshops. * The project provided some clear guidance for the most appropriate approaches for efficiently collecting the different kinds of data necessary for quantitative fisheries assessments. |
| Outcomes | * The outputs from the project have already translated into tangible management outcomes for the Victorian abalone fishery, including: * Establishment of voluntary micro-management strategies in terms of higher minimum sizes, catch caps and daily boat limits for individual reefs. * Intervention by industry to rehabilitate depleted reefs. * Improved access to seldom fished stocks via new management arrangements. * Better informed catching sector with respect to abalone biology and assessment. * A nucleus for future self-governance by Australia’s abalone industry. |
| Benefits | * Reduced risk of overfishing in the medium to long term and higher confidence in a sustainable take for Victorian abalone fisheries. |

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| **Project number 2003/017: Juvenile scallop trashing rates and bed dynamics: testing the management rules for scallops in Bass Strait** | |
| Project details | Organisation: University of Tasmania  Period: Jul 2003 to May 2007  Principal Investigator: Malcolm Haddon |
| Rationale | The scallop fisheries in Central Bass Strait and in Tasmanian waters were both moving to area based management schemes in which only part of the available fishing grounds would be opened to fishing each year. Three major needs were to determine whether area based management would succeed in permitting a sustainable scallop fishery to operate, to formalise and refine the management rule relating to the assumed destruction of juvenile scallops when a bed is fished, and to examine the actual extent of fishing and its impact on benthic communities. |
| Objectives | 1. To determine, using VMS, the relative fishing intensity and extent of scallop dredging in both the Bass Strait Central scallop fishery and the Tasmanian scallop fishery, in the areas opened to fishing in 2003 and 2004. 2. To determine the relative impact of fishing on different size classes of scallops on those beds open to fishing, especially the rate of survival of undersized scallops. 3. To determine whether a relationship exists between juvenile settlement success in different areas and the relative fishing intensity, as defined by VMS data, experienced by those different areas. 4. To determine the major by-catch species taken with commercial scallop dredging gear on the main scallop beds fished in Bass Strait (including Tasmanian, Central Bass Strait and, if possible, Victorian scallop beds). 5. To study the effects of scallop dredging on benthic fauna by comparing closed areas and areas open to fishing in a before and after sampling design. 6. To generate management options aimed at optimising the use of area based management strategies for scallop fisheries. |
| Activities and Outputs | * This project aimed to explore alternative spatial management strategies that would provide the best outcomes for the fishery. * Also, a study was made of exactly how extensive dredging activities are along the coast, and what other benthic organisms (by-catch) are impacted when dredging of a scallop bed occurs. * In this study growth was found to vary with location and density. * These spatial variations observed in the growth of scallops could potentially be used to advantage in the spatial management system where most of the fishery is closed, and only small areas are open. * By identifying age classes in the size frequencies of scallops it was possible to determine that successful settlement was widespread in 1999, with other more localised but significant settlements occurring in 2000 and 2001. * Results of this study, however, found that while commercial fishing of scallop beds did not remove or wipe out all scallops present (not even the undersize scallops), subsequent recruitment to those beds which were fished was not observed. As such, the mechanisms leading to successful recruitment within a given area are unknown and are most likely to be complex. * Scallop beds found to reoccur in the same places they had occurred previously, despite their complete absence in earlier surveys. This indicated that dredging (sufficient to cause collapses of the fishery during the 1980s and 1990s) was not sufficient to damage the benthic habitat to an unrecoverable state. * It is clear that a “most closed, little open” management strategy, where an array of possible scallop beds are fished in a rotational manner, provides the best opportunity for recruitment within areas, and a subsequent fishery each year. |
| Outcomes | * The results of the project have assisted in developing a more collaborative approach to scallop management in Bass Strait. * Options for spatial management have been identified. * An earlier confusion over shell height and shell width was corrected and the Legal Minimum Size of scallops in Tasmania and the Commonwealth was increased from 80 mm to 90mm maximum diameter. This led to a greatly improved product. * The Tasmanian fishery has moved from being a competitive and potentially wasteful operation into a more cooperative arrangement involving a high degree of self-management. * Industry now conduct pre-season surveys to determine the optimum opening date, in terms of scallop condition, irrespective of the official opening date. By agreement, nobody goes fishing until the scallops are in a condition that provides for better profits. * By increasing internal cooperation fished scallop beds are utilized more effectively by intensively fishing to an Industry determined pattern leading to less wastage and greater overall profits. * A following project 2005/027 should also be attributed some benefit from this outcome. |
| Benefits | * Improved stock assessment for Bass Strait scallop fishery, with reduced risk of overfishing in the medium to long term and higher confidence in a sustainable take. |

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| **Project number 2003/044: Development of a sustainable industry-based observation system for blue grenadier at the primary spawning sites** | |
| Project details | Organisation: CSIRO Marine Research  Period: May 2003 to Sep 2007  Principal Investigator: Rudy Kloser |
| Rationale | The Tasmanian west coast blue grenadier spawning grounds comprise a long and narrow strip from 300 to 600 metres seafloor depth running along the shelf break for 100 nautical miles. An acoustic survey of the Tasmanian west coast stock was carried out in 1992 by a research vessel but the results have not been used in the stock assessment process; at that time egg survey biomass estimates were preferred due to the uncertainty with fish residency times on the grounds affecting the accuracy of acoustic based biomass estimates. In 2002 a consortium of industry partners funded CSIRO to conduct a pilot study to assess the potential for obtaining quantitative biomass estimates based on data collected from the factory freezer vessels during fish processing time The success of this study led to this 3-year FRDC funded project. |
| Objectives | 1. Develop and implement an industry-based acoustic monitoring system to provide an estimate of the absolute snapshot blue grenadier abundance and their dynamics at the primary spawning sites. 2. Develop the acoustic methodology to estimate target strength of the dominant species for absolute snapshot biomass assessment and investigate methods to determine species composition and reduce error. 3. Summarise the technical issues associated with the use of acoustic surveys to survey aggregated blue grenadier in the form of a how to guide and an estimation of error. 4. Evaluate the use of industry-based methods to monitor the ecological environment for sustainable fishing and sustainable ecosystems. 5. Evaluate the technology and best transfer of methodology for sustaining an industry-based optimised observation system its long-term use and incorporation into the management of the fishery. |
| Activities and Outputs | * This three year study has developed an industry-based acoustic observation system for blue grenadier at the primary spawning sites. * The technical challenges of using industry acoustic systems, with appropriate data collection, calibration and quality controls have been solved during the project. * During the three year project six vessels were calibrated and 600 GBytes of data were collected during a total of 440 vessel operation days. * Industry participants have trialled a variety of survey methods that can monitor features from fine scale canyons to larger broad scale upper slope regions. * The overall sampling strategy was that industry would be encouraged to survey the largest aggregations of blue grenadier throughout the spawning season. * This strategy took advantage of the fact that industry vessels were on the grounds throughout the survey period and would know the best time to survey in order to obtain a maximum biomass index. * This maximum biomass index could then be tracked over time to determine trends in abundance. * This survey strategy is also in line with the precautionary principle of fisheries management by shifting the burden of proof to industry to measure a maximum stock size to include in the stock assessment process. |
| Outcomes | * The biomass estimates have been used in the stock assessment of blue grenadier to test various stock size hypotheses. Of note was the ability of the acoustic biomass to provide confidence about the lower bound of the stock size when including uncertainty about the proportion of the stock surveyed and target strength. * The acoustic data also inform the debate about spatial closures and demonstrated the highly dynamic nature of fish schools within and between seasons on the west coast of Tasmania. * This project has developed an acoustic method with associated sampling protocols for use on industry vessels. Based on this project it is possible for industry vessels to carry out surveys following basic survey protocols and for the data collected to be analysed to produce a snapshot biomass of blue grenadier. However, several areas require ongoing development of both the acoustic method and its application. These include (Rudy Kloser, pers. comm., 2013): * Based on the monitoring needs an appropriate incentive for industry needed to be established to continue to engage in the monitoring of the stock; management did provide a research catch incentive and industry have taken up the routine monitoring of the data since the project. * Experiments that verify the species and length of in situ target strength measurements and/or that directly estimate the density of blue grenadier within schools were to be supported; a project was supported by AFMA that did the experiments and a research paper was written that resolved the uncertainty. * Research is supported that automates the processing of these data into acoustic indicators that can be used within the ecological models; such components were taken up by IMOS (Australia’s Integrated Marine Observing System) and routine data is now collected with automated processing to input into ecological models). * A review of environmental indicators of blue grenadier spawning events and correlations with a range of physical and biological indicators be undertaken to see if any significant correlations can be determined; such a review has not been supported by FRDC and AFMA, but the topic has become topical recently. * The annual acoustic surveys were incorporated into the assessment but due to industry funding issues the surveys will be every two years in the future. * Management changes have been made where the information provided the floor biomass estimate that provided certainty about the minimum biomass; in later years due to large variation and turnover rate uncertainty, the surveys have not been that informative in the model (Rudy Kloser, pers. comm., 2013). * However, the indirect information that the surveys provide about species location, dynamics and an independent biomass estimate to the model has provided extra confidence in the model trajectory (Rudy Kloser, pers. comm., 2013). |
| Benefits | * Reduced risk of overfishing in the medium to long term and higher confidence in any TAC set for the Blue Grenadier. |

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| **Project number 2003/047: Evaluation of methods of obtaining annual catch estimates for individual Victorian bay and inlet recreational fisheries** | |
| Project details | Organisation: Department of Primary Industries Victoria  Period: Jul 2003 to Apr 2008  Principal Investigators: Karina Ryan and Simon Conron |
| Rationale | Victorian commercial fishers record their daily catch and effort in logbooks, which are submitted to the Catch and Effort Unit (DPI, Queenscliff). These data provide a census of the total commercial catch and valuable information on the dynamics of fished populations and fishing activity. Estimates of catches of recreational anglers are difficult and expensive to obtain and annual estimates of total catch from the recreational sector in individual Victorian bays and inlets have not been obtained routinely. An estimate of the total recreational catch of important fish stocks is required for regular monitoring of recreational fishing activity, assessment of fisheries where the recreational component is significant and where fisheries that require decisions concerning resource allocation between commercial and recreational sectors. |
| Objectives | 1. From the results of past surveys, statistically assess the costs and sampling requirements of different survey methods for providing unbiased estimates of total recreational catch and effort, with acceptable precision. 2. From the results of past surveys, statistically assess the costs and sampling requirements of different survey methods for providing unbiased estimates of total recreational catch and effort, with acceptable precision. 3. Conduct a workshop to evaluate alternative angler survey methods. 4. Develop a cost‐effective survey design to provide annual estimates of recreational catch for main recreational fisheries. 5. Trial the recommended design. 6. Review the success of the pilot survey at a second workshop and recommend a final survey design. |
| Activities and Outputs | * The primary output of the project has been the identification of an angler survey design for obtaining regular harvest estimates for key recreational fisheries in a cost‐effective manner. * An initial workshop to evaluate alternative survey methods for estimating total recreational catch was held in 2005. * Considerations from this workshop were incorporated into the design of the 2006/07 phone‐diary survey. * A final project workshop was held in 2007 to review the phone‐diary survey of recreational fishing in coastal Victoria with representatives from stakeholder groups, managers and researchers. * Outputs included recommendations for design features of an off‐site survey to estimate total recreational catch using a Recreational Fishing Licence (RFL) sampling frame. * Results from this project have been presented to FRDC, Fisheries Victoria, VRFish and at various scientific forums. |
| Outcomes | * The present survey has demonstrated that accurate estimates of the annual snapper harvest can be cost effectively obtained for the vast majority of the recreational fishery through an off‐site survey of RFL holders. * Subject to further analysis of the database, similar data quality and coverage are likely for other marine species, where RFL holders dominate the total recreational harvest. * The project has demonstrated the importance of the RFL database as a cost‐effective sampling frame and also identified areas for improvement in the database that would further enhance data quality for future surveys and substantially reduce costs, especially through more efficient sampling in the screening and calibration surveys. * The excellent response rates achieved across all components of this survey have been attributed to careful development work, the use of skilled interviewers and high levels of co‐operation by anglers, who appreciate the importance of such research to ongoing sustainability of these fisheries. * The survey has provided information on the value of the recreational fishery so that the relative impacts of both commercial and recreational fisheries is now known; although the fishery is considered sustainable, the new knowledge is important for future effective management of the fisheries (Simon Conron, pers. comm., 2013). * The method will be used again in a survey being planned by Fisheries Victoria (Simon Conron, pers. comm., 2013). * Other states (e.g. NSW) also are using the cost-effective survey method where appropriate. |
| Benefits | * Reduced risk of overfishing in inshore fisheries in the medium to long term and higher confidence in fisheries management decisions that apply to joint commercial/recreational fisheries. |

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| **Project number 2003/052: Spatial scales of exploitation among populations of demersal scalefish: implications for wetline management** | |
| Project details | Organisation: WA Department of Fisheries  Period: Jul 2003 to Oct 2007  Principal Investigator: Rod Lenanton |
| Rationale | The key issues concerning WA’s reef fish resources were commercial and charter fishing viability, ongoing enjoyment of recreational fishing by the majority of Western Australia’s population, provision of local world-class table fish for the non-fishing public, and equitable allocation of resources among all sectors.  The key needs for management of the west coast demersal scalefish fishery were improved knowledge of key indicator species populations along the West Coast Bioregion, knowledge of the regional variation in their biology, estimation of the exploitation status of the stocks of the key indicator species, and educating stakeholders about the biology and the exploitation of the scalefish resources by involving them in the management process. |
| Objectives | 1. To examine the level of intermixing among populations of both pink snapper and dhufish along the West Coast to determine the appropriate geographical scales for management.  2. To determine whether there are regional differences in the biology of dhufish and pink snapper populations along the West Coast, particularly in growth and reproduction.  3. To evaluate the spatial variation in the exploitation status of dhufish, pink snapper and baldchin groper within the West Coast Bioregion.  4. To develop a suite of alternative management scenarios to assist the multiple fishing sectors of the Bioregion to select and adopt an optimal management strategy. |
| Activities and Outputs | * The levels of exploitation on both dhufish and pink snapper across all sections of the West Coast Bioregion and for baldchin groper at the Abrolhos Islands were found to be above international benchmark standards. * This indicated that these stocks are currently being over-fished and therefore are being depleted to levels below those necessary to ensure their long-term sustainability. * The current reliance of the dhufish catch on a single recruitment pulse together with the extremely truncated age distribution of pink snapper indicates that both these stocks are particularly vulnerable. |
| Outcomes | * The project has provided fishery managers for the first time with stock assessments and multi-sector catch information for snapper and dhufish in three sub-regions within the West Coast Bioregion. * The stock assessment findings contributed to fisheries management changes since 2007 such as recreational fishing closure for demersal finfish from the 15th of October to the 15th of December each year, as well as the removal of commercial fishing from certain parts of the region (Jeff Norriss, pers. comm., 2013). * The project and associated changes are likely to improve the sustainability of the resource. |
| Benefits | * Reduced risk of overfishing in in the West Coast Bioregion of WA with greater sustainability of the resource in the medium to long term and higher confidence in fisheries management decisions that have been undertaken. |

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| **Project number 2003/222: Innovative Solutions for Aquaculture: spatial impacts and carrying capacity - further developing, refining and validating existing models of environmental effects of finfish farming** | |
| Project details | Organisation: South Australian Research & Development Institute  Period: Oct 2003 to Feb 2008  Principal Investigator: Jason Tanner |
| Rationale | Increased understanding was needed to determine the impacts of aquaculture on the environment in order to determine appropriate levels of production that a given area can sustain. |
| Objectives | 1. To develop an understanding of yellowtail kingfish metabolism, with specific regard to determining the proportions of feed inputs that end up as dissolved/particulate waste versus respired CO2. 2. To gain a basic understanding of nutrient flows around yellowtail kingfish cages, and thus further develop and refine an existing model of nutrient outputs to the environment. 3. To validate the outputs of both models against field data to confirm their validity for estimating potential carrying capacities in aquaculture production areas. |
| Activities and Outputs | * Scientific and technical data for input into other projects was provided. Such projects were focused on developing solutions for aquaculture planning and management, including decision support systems. * Models were developed that provided greater understanding of how carbon, nitrogen and phosphorus are dispersed into the environment from yellowtail kingfish farming in Fitzgerald Bay. * From the models estimates were able to be provided of the total amount of nitrogen and phosphorus released into the water column in a soluble form, and the sediments in an insoluble form, allowing direct comparisons to other input sources. * The carbon model developed provides a visual indication of how organic matter is likely to be deposited around cages and where the areas of greatest accumulation are likely to occur. It found that increased sedimentation rates outside of leases would only be appreciable if pens are located very close to the lease boundary. * An understanding was developed of the nutrient outputs from yellowtail kingfish (YTK) cages, and how they relate to natural spatial and temporal variation in nutrient levels. * The nutrient budget work showed that an annual production of 2,000 tonnes of YTK in Fitzgerald Bay will lead to a release of approximately 400 tonnes of nitrogen and 100 tonnes of phosphorus into the environment. * The carrying capacity model then suggests that an additional 1,463 tonnes of YTK can be in produced in Fitzgerald Bay annually, on top of the current production levels of approximately 2,000 tonnes before existing water quality guidelines are breached. |
| Outcomes | * The refined model enables better management of aquaculture zones in an environmentally sustainable fashion. Specifically it allows PIRSA Aquaculture to make decisions on lease allocations and total allowable stocking densities in Fitzgerald Bay with greater confidence. * Farm managers and regulators can utilise the carbon deposition model to allow to them to arrange pens so as to minimise areas of overlap and thus of high sedimentation. For example, previously a single company may have four leases widely dispersed, however the findings of the model show it is possible to locate those farmers closer together and combine as one and not have any increased impact on the environment. The co-location will save the industry costs in travel to service cages. * The metabolic data will give industry greater understanding of the oxygen requirements of their fish and therefore reduce stress imposed on the fish. * The information will also allow direct comparisons of nutrient inputs to the marine environment between aquaculture and other industries. * It was recommended that further work be undertaken on the models to develop user-friendly interfaces and to develop them further, and this has occurred. * The models have also been used in other YTK farming areas in South Australia where farming practices are similar. * The SA EPA and DEH have indicated an interest in the nutrient model with the intention of using it for assessing new applications, and the WA Dept of Fisheries have indicated they would be interested in the models to assist with the development of the aquaculture industry in that state. The Queensland government has adapted the approach and is using it in the Great Sandy region to make decisions on aquaculture development in the region. |
| Benefits | * Ensuring access to farm sites, and security of tenure to farmers through greater certainty in planning. * Facilitation of aquaculture development approvals through assistance in determining the carrying capacity of farm environments and indications of the most appropriate number of farms a region can accommodate. * The improved understanding of the interaction between YTK farming and the environment has allowed greater confidence of YTK producers to optimise the productivity and locations of their systems without compromising environmental health. * Refining of regulatory frameworks by government agencies responsible for licensing and managing the industry. * Improvements of government and community perceptions of aquaculture developments. |

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| **Project number 2003/223: Innovative solutions for aquaculture planning and management – Project 5, Environmental audit of marine aquaculture developments in South Australia** | |
| Project details | Organisation: South Australia Research & Development Institute  Period: Aug 2003 to May 2008  Principal Investigator: Jason Tanner |
| Rationale | There was a lack of environmental information for aquaculture industries to allow environmental risk assessments and impact assessments to be undertaken. |
| Objectives | 1. Review the current environmental status of marine aquaculture in South Australia by assessing the level and adequacy of existing information and information collection protocols in relation to environmental impacts. 2. Assess and prioritise the actual and perceived environmental impacts of marine aquaculture in South Australia using a formal risk assessment framework. 3. Investigate identified high priority environmental impact issues through targeted field based R&D, including the development and evaluation of methodologies and sustainability indicators. 4. Develop aquaculture sector-based optimal environmental monitoring programs, including identifying the parameters to be measured (environmental as well as farm management), the spatial and temporal frequency of monitoring required, and select critical decision points against which ESD performance can be measured. |
| Activities and Outputs | * A detailed assessment of the impacts of yellowtail kingfish aquaculture in Fitzgerald Bay was undertaken using a range of benthic and pelagic environmental variables. * It was found that yellowtail kingfish aquaculture in Fitzgerald Bay is currently having minimal environmental impact. While some effects of farming were detected on several sediment chemistry parameters, there were no effects on benthic fauna that could be clearly attributed to aquaculture. * Several options for revising environmental monitoring programs for finfish were presented, as well as indications of the required level of sampling to determine if an effect is occurring. * Surveys of land-based abalone farms were conducted at the three main farming regions, and at all three regions discharge waters contained elevated levels of dissolved nutrients that can be detected in adjacent intertidal and subtidal waters and in the nitrogen content of subtidal seagrass. * However, no major changes to subtidal communities occurred due to farm discharges with diverse communities of macroalgae, seagrasses and invertebrates present directly adjacent to farm outfalls. * A number of options for a land-based abalone environmental monitoring program were proposed. |
| Outcomes | * The recommended monitoring programs have been taken up by the yellowtail kingfish and abalone aquaculture industries in South Australia. * Lessons from the project have contributed to the development of monitoring programs for other industries in other locations. * The monitoring data demonstrated the limited impact the yellowtail kingfish industry was having, and therefore led to the development of new sites to grow-out yellowtail kingfish and allowed the expansion of the size of aquaculture zones in Fitzgerald Bay. |
| Benefits | * Contributed to allowing sustainable expansion of yellowtail kingfish and abalone aquaculture industries in South Australia. * Informed policy development for environmental planning and access to sites. |

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| **Project number 2004/006: ESD Reporting and Assessment Subprogram: strategic planning project management and adoption** | |
| Project details | Organisation: Department of Fisheries, Western Australia  Period: Jun 2004 to Oct 2006  Principal Investigator: Rick Fletcher |
| Rationale | There was a need for effective coordination of the activities needed to progress the implementation of Ecologically Sustainable Development (ESD) within the fisheries and aquaculture sectors. Due to the diversity of concepts and disciplines covered by ESD and the diversity of stakeholders involved, the existing consultative structures were not sufficient to progress implementation. As the ESD initiative was not yet complete, this project was deemed necessary to assist in the effective management and coordination of the remaining activities (and any future developments) an extension of the subprogram for a further three year period would be required. |
| Objectives | 1. Facilitate the discussion and coordination of ESD related issues amongst the various stakeholder groups.  2. Coordinate and facilitate the development and evaluation of ESD related project application submitted to FRDC.  3. Coordinate the preparation and delivery of the ESD subprogram communications strategy.  4. Facilitate travel of ESD Reference group members to the annual workshop and meetings. |
| Activities and Outputs | * Facilitation of regular meetings with the ESD reference group, including communication of meeting deliberations via reports, newsletters and the ESD website. * Additional coordination was also achieved by the direct attendance of the subprogram leader at meetings of AFMF and MACC (which included the heads of all fisheries agencies, DEH -DEWHA, NOO and a number of State conservation agencies). * A number of workshops and conferences on ESD related topics were held during this period that were directly or indirectly sponsored or supported by the ESD subprogram. * Extension of the concepts and tools that had been developed by the subprogram being extended for use within a number of fishery jurisdictions outside of Australia and within a number of non-fishery sectors within Australia. * A review workshop was held in 2008 (FRDC 2008/057). This reviewed the progress that had been made by the subprogram activities over the past 7 years to determine if the subprogram had achieved its objectives and whether any further work was required. |
| Outcomes | * The second stage of the operation of the ESD Subprogram was successful in a consolidation manner rather than from the generation of significant new tools. * The ESD Subprogram as a whole was successful in moving industry and Government forward to an improved approach to fisheries management. * Specific outcomes of Stage 2 included: * The coordination and facilitation of the development of ESD related tools and processes. * A vehicle for the extension and promotion of the tools, concepts and processes generated by the subprogram and related projects. * Providing a forum for high level discussion on ESD related issues and concepts. * Providing a credible authority and legitimacy of recommendations for some purposes. * Provision of a group of experts on ESD related issues for input into other purposes and processes. |
| Benefits | * Along with Stage 1, an important contribution to: * Improved access to fish resources for a wide range of wild catch fisheries. * Increased environmental responsibility and improved sustainability of wild catch fisheries. * Increased awareness and accounting of contribution of fisheries to communities when making resource use decisions. * Reduced use of industry and government resources in monitoring and evaluating environmental status of industries. * Raising the profile of Australian fisheries management. |

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| **Project number 2004/008: Improving demonstrated environmental accountability in the Northern Territory fishing industry** | |
| Project details | Organisation: Northern Territory Seafood Council  Period: Jan 2004 to Oct 2006  Principal Investigator: Iain Smith |
| Rationale | Developments in the Northern Territory had resulted in significantly heightened awareness within industry of the importance of being able to demonstrate sustainability. As well there had been an increasing interest in and understanding among licensee Associations in the NT of the role that environmental performance would play in the future viability of wild catch fisheries in the NT. |
| Objectives | 1. To develop and implement comprehensive Codes of Practice in the: NT Shark fishery; NT Spanish Mackerel fishery; NT Coastal Net fishery; NT Coastal Line fishery; NT Demersal fishery; NT Timor Reef fishery; NT Trepang fishery; NT Aquarium fishery. 2. To develop full Environmental Management Systems for the: NT Shark fishery; NT Spanish Mackerel fishery; NT Timor Reef fishery. 3. To facilitate the development of a comprehensive communications strategy within industry and between industry and the wider community in regard to the benefits flowing from these initiatives. 4. To assist in engendering at the grass roots level within industry, a culture of continual improvement in environmental performance and maximisation of product quality and value. 5. To assist in the review of the existing NT Crab Fishery Code of Practice. |
| Activities and Outputs | * Nine EMSs for wild catch fisheries in the NT have been completed. A standard format for each EMS was pursued. * Fishery specific reference groups were established. * A communication strategy for promoting the EMS to the general NT community was developed and implemented. |
| Outcomes | * Increased security of resource access for the professional fishing industry based on factual and quantifiable information available to all. * Potentially improved market prices and continued sustainable management of fisheries might lead to improved profitability. * A heightened awareness and understanding of the importance of demonstrating compliance with the principles developed through the EMS vehicle. * A major attitudinal shift within industry generally, with industry’s environmental responsibility and performance now widely understood. * The Northern Territory government has contributed in-kind and cash resources for extension of the program, and all fisheries are continuing to use the EMS developed. |
| Benefits | * Increased security of resource access for the professional fishing industry. * Contribution to continued sustainable management of fisheries could lead to improved profitability. |

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| **Project number 2004/019: Towards optimising the spatial scale of abalone fishery management** | |
| Project details | Organisation: South Australian Research and Development Institute  Period: Jul 2004 to May 2008  Principal Investigator: Stephen Mayfield |
| Rationale | Abalone populations are characterised by a complex spatial structure evident at fine spatial scales. Populations (or stocks) respond independently to the effects of fishing. Broad-scale management in these fisheries as currently exists, places fast-growing populations at risk of being over-exploited, while leaving slow-growing components under-utilised. The increased recognition of their complex spatial structure has led to renewed calls for the scales of abalone fishery management to be more closely aligned with those of the component populations (i.e. creation of ‘management units’). |
| Objectives | 1. To identify and investigate the utility of a ‘morphometric marker’ as a rapid, non-destructive approach for determining boundaries among blacklip populations. 2. To evaluate the spatial variation in the fisheries biology, morphology and population genetics of blacklip populations in the Southern Zone of the South Australian abalone fishery. 3. To evaluate approaches for effective compliance at finer spatial scales; 4. To establish a framework that will assist in the development of ‘management units’ appropriate to the spatial variation observed and in accordance with both management and compliance limitations. 5. To model populations of blacklip at a scale appropriate to the spatial variation observed. |
| Activities and Outputs | * Development of a simple, practical and cost-effective measure to discriminate among, and estimate key life-history parameters of blacklip abalone. * The measure was a ‘morphometric marker’, based on the ratio between shell length and shell height, which could both discriminate among blacklip stocks and predict their biological characteristics. * Identification of potential management units (MUs) and their associated life-history characteristics * Outline of an initial framework, including consideration of population genetics, fisheries compliance and stock-assessment modelling, for MU implementation. * The data suggest that only two current fishing areas constitute potential MUs and that the creation of at least six additional MUs is warranted. * The biological characteristics of each MU were estimated, providing initial information (e.g. on size limits) to underpin their appropriate management. |
| Outcomes | * When used within a suitable management framework, the measure developed can provide the necessary information to enable practical reductions in the scale of blacklip fishery management, previously been hampered by the inability to gather detailed demographic data at appropriate spatial scales. * The approach can aid optimisation of blacklip fishery management because individual stocks can now be identified and then separately managed on the basis of their key life-history characteristics. * This provides the opportunity for better resource use and, consequently, a reduction in the risk of fishery collapse. * Management of the SA southern zone fishery has changed substantially as a result of the investment. * The new season commenced in September 2013 with revised management arrangements: Southern Zone is now managed in 13 spatial cells, each with their own minimum legal size and catch allocation. Also, compliance arrangements trialled during the project now enable fishers to move among areas on the same fishing day (Stephen Mayfield, pers. comm., 2013). * These changes will reduce the risk of over-fishing the resource. It is also likely they will lead to increased catches (and profits) in coming years without compromising that sustainability (Stephen Mayfield, pers. comm., 2013). |
| Benefits | * Reduced risk of overfishing in SA abalone fisheries (Southern Zone) with greater sustainability of the resource in the medium to long term and higher confidence in fisheries management decisions that are undertaken. |

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| **Project number 2004/020: Validation and extension of acoustic reef habitat mapping methodologies in the western abalone zone, Victoria** | |
| Project details | Organisation: Department of Primary Industries, Victoria  Period: Aug 2004 to Nov 2008  Principal Investigator: David Ball |
| Rationale | The then current Victorian Abalone Management Plan (2002) had identified the preferred option for achieving an optimal spread of fishing effort at the local level in the future was to be sub-zonal TAC setting. It is noted in the management plan that management at this more refined spatial scale would require information that enables a better understanding and modelling of the spatial aspects of the fishery.  The success of future reef mapping programs will be dependent on application of effective mapping methodologies that are consistent with habitat classification techniques. Enhancing the methodology in Victorian marine environments will provide an extension of this approach. |
| Objectives | 1. To validate and extend acoustic reef mapping techniques and habitat classification methodologies developed in SA and Tasmania through their application in the Victorian Western Abalone Zone. 2. To target high value reef habitats in the Western Abalone Zone for application of acoustic mapping and habitat classification methodologies. 3. To integrate acoustic reef data and mapping in a GIS database. |
| Activities and Outputs | * This project tested and extended mapping techniques previously applied in Tasmania and South Australia to successfully map abalone habitats in Victoria’s Western Zone. * This demonstrated that a level of consistency in marine and abalone habitat mapping can be achieved between States, and between regions with relatively similar marine environments. * Liaison with the TAFI and SARDI took place to ensure consistent aerial photography interpretation, acoustic field data collection and analyses and habitat classifications as those being developed in other projects. * This project demonstrated the potential benefits to marine habitat mapping studies of working with inexpensive sidescan sonars for agencies with limited budgets. This was an unplanned output of the project and resulted in two other marine research agencies (i.e. South Australia and Northern Territory) acquiring the same equipment to conduct marine mapping programs. * The mapping data were made accessible to Fisheries Victoria staff through the Department of Primary Industries network. |
| Outcomes | * Incorporation of mapping results in Western Abalone Zone management plans and catch and effort system. * Fishers in the Western Abalone fishery benefited from the maps using these to identify and access new areas of the reef when forced to fish in areas not devastated by a virus outbreak. * This project will have a direct benefit to the abalone fishery by providing a validation and enhancement of new reef mapping methodologies. * A shift towards “sub-zonal” management planning will benefit from methodologies that enable data collection to provide an accurate picture of the location and distribution of reef habitat within the Western Zone at the scale of individual reefs. * Consistency in marine habitat mapping methodologies and classifications between Tasmania, SA and Victoria will establish a mapping standard for the south-east region and other States. |
| Benefits | * Short term benefits to abalone divers during a virus outbreak via maps that reduced time to identify and access reef areas not usually fished. * Reduced risk of overfishing in Western Zone abalone fisheries with greater sustainability of the resource in the medium to long term and higher confidence in fisheries management decisions that are undertaken. |

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| **Project number 2004/096: The development and production of EMS template documents for the salmonid, oyster and abalone aquaculture sectors in Tasmania** | |
| Project details | Organisation: Tasmanian Seafood Industry Council  Period: Feb 2004 to Nov 2006  Principal Investigator: Neil Stump |
| Rationale | There was a need for demonstrating environmentally sustainable resource use in the Tasmanian aquaculture industry. National and state ESD and NRM strategic initiatives (along with legislative requirements) needed to be incorporated into any industry EMS project development. A partnership between regulators, industry and the peak representative body (TFIC) was being formed to develop and implement EMS within the Tasmanian aquaculture industry. The employment of an EMS officer for the aquaculture industry would have been instrumental in capitalising on previous FRDC/industry investments and in demonstrating aquaculture producers were proactive in dealing with industry impacts on the environment. |
| Objectives | 1. To demonstrate environmentally sustainable use of natural resources where industry does not live off the environmental capital but from the return gained from using that resource, incorporating intergenerational responsibility into the process. 2. To develop and produce an EMS template document as a tool for each of the salmonid, oyster and abalone sectors of the Tasmanian aquaculture industry for use as a generic framework that is the backbone of local and regional individualised EM systems. |
| Activities and Outputs | * A Steering Committee (comprising of key stakeholder representatives and funding contributors) guided the project. * An appointed EMS officer (in conjunction with industry representatives) produced three key EMS templates based on the Green Chooser model. * The EMS officer facilitated working groups, workshops and the overall process of EMS within the Tasmanian aquaculture industry. * The EMS officer used this process to develop and produce three EMS templates for the contributing industry sectors. * The eight steps of the Green Chooser model were accepted by the Steering Committee as the appropriate framework to establish regional and industry specific EM systems that will embrace and enhance the stated goals of the Natural Resource Management (NRM) national cooperative approach to coastal issues. * These documents embodied stated national, state and local ESD/NRM goals in conjunction with all relevant legislative requirements. * Risk assessment exercises relating to specific regions were developed by stakeholders, with risks identified, interpreted and prioritised. * Each region that developed an EMS formed a working group to flesh out the basic framework described in the Green Chooser model. * The final outputs were the production of template documents for the abalone, oyster and salmonid sectors. * The templates were promoted within industry media and meetings. |
| Outcomes | * The principal outcome from this project has been the commitment from industry to implementing the EMS developed through this project at a facility level. * The involvement of industry members on the steering committee has engendered a fuller understanding of potential benefits to the industry in meeting environmental best practice through the development and implementation of an EMS. * Behavioural and attitudinal change within the Tasmanian aquaculture industry that strives to demonstrate environmental management excellence. * Industry excellence in ESD and incremental improvement in environmental management practices from participants within the Tasmanian aquaculture industry, allowing industry stakeholders to achieve community leadership in environmental responsibility. * Improved public perceptions, confidence and appreciation of the benefits that environmentally responsible aquaculture can produce for local communities, specifically with regard to employment and economic benefits to regional areas. |
| Benefits | * Continued access to resource for aquaculture, with associated community economic benefits. * Reduced use of industry and government resources in monitoring and evaluating environmental status of industries * Potentially increased domestic and export demand from some consumers and markets who are highly environmentally conscious * Potential cost reductions along the supply chain through adoption of best management practices to address EMS. |

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| **Project number 2004/101: ESD Reporting and Assessment Subprogram: review of the scope, assessment methods and management responses for fisheries ESD and EBFM in Australia** | |
| Project details | Organisation: CSIRO Division of Marine Research  Period: Dec 2004 to Jun 2008  Principal Investigator: Helen Webb |
| Rationale | In the previous six years there has been a huge investment in developing and conducting ESD reports and assessments, and in management actions to implement fisheries ESD. In addition, the previous few years had seen a proliferation of names and concepts develop in relation to addressing the broader ecosystem issues of fisheries. Fisheries agencies, individually and collectively through the MACC and the Australian Fisheries Management Forum, were seeking clarity on the scope of fisheries ESD in relation to other concepts and terms that bring broader ecosystem considerations into fisheries. The project funded was to review the current experience to inform that decision making. |
| Objectives | 1. Compare and contrast the scope, principles and criteria of fisheries ESD and EBFM. 2. Review and report on the major issues raised from the Environment Protection and Biodiversity Conservation (EPBC) strategic assessment process for ESD and Ecosystem Based Fisheries Management (EBFM), and implications for research and development. 3. Review the recent developments in fishery assessment methods, indicators and benchmarks used in Fisheries ESD/EBFM assessments and their state of development, and develop agreed directions on future assessment processes by end users (i.e. fishery regulators and DEWHA). 4. Review the response by fishery management agencies and Fisheries Research Advisory Board (FRABs) to the fisheries ESD/EBFM assessment methods, their status, development and future directions, and identify gaps and implications for research and development. 5. Identify possible bottlenecks for implementation and cost implications to fisheries. 6. Develop and deliver presentations and ‘plain English’ written summaries of the results of the review to Commonwealth and State fisheries departments, and other relevant Commonwealth agencies. |
| Activities and Outputs | * A key finding was that there is an ongoing need for a national forum to coordinate approaches to EBFM. Such a national forum should bring together a range of stakeholders involved in the development and implementation of EBFM, including fishery managers, industry, environmental agencies and Non-Government Organisations (NGOs), and various disciplinary experts. * There is a need for improvements in coordination and consistency in approach across fisheries, jurisdictions and departments. * There are considerable variations in use of assessment and management tools by ESD components, and variations within and between jurisdictions in use of assessment and management tools. * A key issue/challenge for implementation of ESD/EBFM across all jurisdictions is the need for adequate resources (funding and people) and data, analysis, research and decision support. * Closely linked to capacity is the need for education and training for fisheries managers, industry and researchers to enable them to develop a set of skills that better match the expected roles and responsibilities necessary for implementing EBFM. |
| Outcomes | * Improved understanding of the status, approach, and application of EBFM in all of Australia’s jurisdictions: Commonwealth, states and territories. * A greater understanding of the fishery management response to ESD and EBFM nationally and in each jurisdiction. * Potentially, increased coordination in EBFM approaches, implementation, and use of assessment and management tools. * Potentially, an increase in resources allocated to EBFM and an increase in effective education and training for implementation of EFBM. * The potential outcomes above cannot be validated at this time (Helen Webb, pers. comm., 2013). |
| Benefits | * Potentially, more effective use of EBFM with greater relevance to improved decisions concerning fisheries management. * Potentially, a more targeted connection between use of EBFM and fisheries management resulting in leading to more efficient use of resources allocated to EBFM. * Enhanced scientific capacity. |

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| **Project number 2005/004: Determination of effective longline effort in the Eastern Tuna and Billfish Fishery (ETBF)** | |
| Project details | Organisation: CSIRO Marine and Atmospheric Research  Period: Jul 2005 to Feb 2008  Principal Investigator: Robert Campbell |
| Rationale | There was a need to develop an improved understanding of the relationship between catch rates and resource availability within the ETBF. These needs included the development of indicators of resource availability off Eastern Australia, the need to improve the data and methods used to standardise catch rates, the need to avoid the incidental capture of important bycatch species, and the need to improve indicators of stock status in the Western and Central Pacific Ocean (WCPO). |
| Objectives | 1. Determination of the depths attained by longline fishing gears deployed in the ETBF and investigation of the relationships between targeting and gear setting practices and hook depths and longline shape characteristics.  2. Investigation of the relationships between hook depth and the capture depths and associated water temperatures for the principal species caught by longline gears in the ETBF.  3. Investigation of the time-of-capture of the principal catch species caught by longline gears in the ETBF.  4. Investigation, and where necessary refinement, of the technical assumptions used in the habitat based models being used to standardise longline catch per unit effort in the WCPO.  5. Development of habitat based method for standardising longline catch rates and application to the ETBF.  6. Investigation of the relationships between longline fishing practices, gear configurations and the incidental capture of bycatch and byproduct species in the ETBF.  7. Determination of the adequacy of information currently recorded in vessel logbooks for standardisation of longline CPUE and, where necessary, recommended changes. |
| Activities and Outputs | * The project provided the first systematic examination of the depths and temperatures fished by longlines deployed across the ETBF and the associated times-of-capture. * By combining these depth data with the catch-by-hook position data collected by AFMA observers, this project has achieved the first systematic understanding of the range of depths at which individual species are caught within the ETBF. * By combining the observed depth-profiles of the longline hooks with observations of the depth-profiles of bigeye tuna obtained from archival tags, it has been possible for the first time to apply the habitat-based method to standardising catch rates to an Australian fishery. |
| Outcomes | * Increased understanding of the targeting practices and the behaviour of longline fishing gears used in the ETBF, and of the relationship between catch rates and resource availability of the principal target species off Eastern Australia. * Improved understanding of species-specific effective longline effort in the ETBF. * In turn, this knowledge has allowed the application and further development of an alternative habitat-based method for the standardisation of catch per unit effort, which in turn has allowed the further development of indices of stock abundance used to assess the impact of the ETBF on the available fish resources. * Improving indices of stock status is important for application of the Harvest Strategy within the ETBF. Furthermore, the outcomes of this project will assist the further development of the habitat-based standardisation model used in the stock assessments for the main tuna species within the WCPO. * An additional outcome of this project will be an improved understanding of the relation between depths attained by longline gears and the distribution of threatened and endangered species. * There will also be a direct benefit to the domestic longline fishery by providing feedback to fishers on the effectiveness of their present gear setting practices and information on the most effective gear settings. * The project may have contributed to changes in industry practice such as hook types (Trent Timmiss, pers. comm., 2013). * The results of this project will contribute to the international pool of knowledge required to improve understanding of the fishing characteristics of longline gears, the habitat preferences of the main target species caught and the need to test, refine and further develop the methods used to standardise catch and effort data in pelagic fisheries. * The improved understanding and improved indices of stock status used in stock assessments for management of the ETBF have contributed to improved management decisions (Trent Timmiss, pers. comm., 2013). |
| Benefits | * Contribution to a reduced risk of overfishing in the ETBF with greater sustainability of the resource in the medium to long term and higher confidence in fisheries management decisions that are undertaken. * Potential for improved fishing efficiency. |

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| **Project number 2005/011: Development of Field Implemented Fillet Identification (FIFI) for coral reef fish** | |
| Project details | Organisation: Department of Agriculture, Fisheries and Forestry, Queensland  Period: Jul 2005 to Oct 2008  Principal Investigator: Jane Oakey |
| Rationale | To ensure compliance with the Coral Reef Fin Fish Management Plan 2003, officers needed to be able to identify the fish they were inspecting, and there was no suitable test to identify fish fillets in the field and to confirm that commercial and recreational fishers comply with quota and possession limits, thus assuring sustainability of the resource. There was a need for a tool that could identify fish species, be rapidly and easily used at sea, and sufficiently discriminatory to differentiate between closely related coral reef fin fish. |
| Objectives | 1. To develop a rapid, simple and inexpensive method to indicate the presence of target mitochondrial DNA (mtDNA) sequences from restricted and protected coral reef fin fish species. 2. To optimise and validate this method as a field test to detect the presence of, and to identify, restricted species of coral reef fin fish species from samples that have had phenotypic markers removed (such as fillets), and to confirm that cross-reactivity with unrestricted species will not occur. This will form the basis of FIFI (Field Implemented Fillet Identification), and subsequently be used by fisheries officers as a compliance tool for the Fisheries (Coral Reef Fin Fish) Management Plan. 3. To workshop and demonstrate FIFI in order to train and familiarise fisheries officers and any other interested parties in its use (extension). 4. To use media coverage to create public awareness of FIFI and deter non-compliance with fishing regulations. 5. To investigate the most appropriate scientific communication of FIFI technology based upon the optimum procedures used (from objectives 1 and 2) and any current patents held on those procedures. This may include either publication or commercialisation. |
| Activities and Outputs | * The envisaged output was a test procedure that could be used by fisheries officers in the field to check compliance with the Fisheries (Coral Reef Fin Fish) Management Plan 2003. It was anticipated that the tool would be used as an initial screening process prior to, and to justify, the confiscation of suspect fish fillets that would subsequently be confirmed to species identity through mtDNA sequencing analysis if evidence is required for prosecution purposes. * A number of techniques were assessed and compared, along with some in-house designed methods that included a novel method of coating a plastic dipstick that showed great promise. However, validation with respect to reproducibility showed the method was not sufficiently robust or reliable in its current form to perform as a precursor for potential legal action. Re-optimisation of the method did not improve this adequately. * It is not known why the inconsistencies occurred. The experiments above demonstrated that each phase of the technique was successful, yet in combination the method was not reproducible. |
| Outcomes | * While not achieving its primary aim, the project has identified species–specific probe sequences that may be applied to recently-described hand-held devices that employ multiple scientific strategies from the fields of physics, chemistry and biology. * Also, recent advances suggest that such a device has great potential using more sophisticated technology based on the probe sequences identified in this project. * Biosensors are a rapidly growing area and the combination of electrochemistry, microfluid engineering and biology are highly likely to produce cost effective usable applications from the prototypes developed in the project. * The final report suggested therefore, that QPIF and FRDC retain the probe sequences intellectual property as commercial-in-confidence for this eventuality. * To the knowledge of the Principal Investigator, the probe sequence data has not been used in any other applications to date (Jane Oakey, pers. comm., 2013). |
| Benefits | * No immediate fisheries or community benefits. * Potential future contribution to reef fisheries management and sustainability. * Potential future reduction in compliance and legal costs. |

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| **Project number 2005/031: Establishing ecosystem-based management for the South Australian sardine fishery: developing ecological performance indicators and reference points to assess the need for ecological allocations** | |
| Project details | Organisation: South Australian Research and Development Institute  Period: Jul 2005 to Nov 2008  Principal Investigator: Tim Ward |
| Rationale | The management plan for The South Australian Sardine Fishery (SASF) identifies the biological, ecological, economic and social objectives of the SASF and outlines the framework of the performance indicators, reference points and decision rules that have been established. Fishery independent stock assessments are undertaken annually or biannually.  Because data on ecosystem processes are expensive to collect and difficult to incorporate into fishery models, management typically has a single-species focus, aimed at ensuring that fish stocks provide the optimal yield. However, there has been increased recognition that improved knowledge of ecosystem processes will reduce the risk to populations of predators that use the fisheries species. In 2004, the SASF licence holders, the fishery managers and Australian scientists initiated a broad ecological study, which aimed to assess the impact (if any) of the fishery on the natural predators of sardines, to determine whether an explicit ecological allocation of sardines was required. |
| Objectives | 1. To identify species of key marine predators that consume significant quantities of sardine and could potentially be used to assess the need for ecological and/or spatial allocations in the SA Sardine Fishery.  2. To identify population parameters for these key marine predators, such as measures of foraging and/or reproductive success, that are likely to be affected by changes in the distribution and abundance of sardine, and which could potentially act as ecological performance indicators for the fishery.  3. To examine the spatial and temporal scales at which these performance indicators vary in order to develop reference points that could be used to assess the need (if any)to establish ecological allocations in the fishery.  4. To use the results of this study to revise the management plan and establish cost-effective systems for ongoing monitoring and assessment of the ecological effects of the SA Sardine Fishery. |
| Activities and Outputs | * Identification of diets and habitats of several ecologically- and/or economically important species of pelagic fishes, squids, marine mammals and seabirds, which could potentially be used to assess the need for ecological and/or spatial allocations in the SASF. * Overall, the most important prey were krill, followed by sardines, anchovies, arrow squid and other crustaceans * The importance of sardines to several predators highlights the need for the ongoing monitoring of ecosystem processes in this region. * The distributions of foraging effort from more than 300 marine predators were estimated; sardines only made up about 1% of the total prey biomass consumed by the five apex predators, and only 2% of the total fish biomass consumed. * The total estimated consumption of sardines by these predators (753 t/y), is very small (3%) relative to the current annual TACC (~30,000 t) of the SA sardine fishery. * The catch of sardines by the fishery exceeds the consumption by these predators wherever fishing effort occurs, but there are also large areas where consumption of sardines by these five apex predators exceeded that of the fishery. * Despite the rapid growth of the sardine fishery since 1991, sensitivity analyses, based on mixed trophic impacts, detected negligible fishery impacts on other groups, but Ecosim indicated that many of these groups were sensitive to changes in sardine biomass. This finding suggests that current levels of fishing effort are not impacting negatively on the ecosystem function. |
| Outcomes | * This report provides information that is needed to ensure that the South Australian Sardine Fishery is managed according to the principles of Ecologically Sustainable Development (ESD). * Information in the report will be used to address recommendations in the strategic assessment of the fishery, as required by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities. * Data from this report provided a basis for PIRSA Fisheries to assess the suitability of establishing Ecological Performance Indicators for the fishery. * The trophodynamic modelling developed in this study provides the ability to resolve and attribute potential impacts from multiple fleets and environmental changes that are needed to develop and assess potential Ecological Performance Indicators for the SASF. * More widely, further development of these long-term monitoring datasets could provide opportunities to assess human impacts and environmental forcing on the health of various exploited ecosystems. |
| Benefits | * Greater confidence by managers and the community in the ecosystem sustainability of the SA sardine fishery (Tim Ward, pers., comm. 2013). * Enhanced scientific capacity on the interaction between species management and ecological systems. |

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| **Project number 2005/035: The development, adoption and evaluation of environmental management systems in Western Australian commercial fisheries** | |
| Project details | Organisation: Western Australia Fishing Industry Council  Period: Jul 2005 to Oct 2008  Principal Investigator: Felicity Horn |
| Rationale | The WA South Coast Estuarine Fishery (SCEF) risked losing access through their allocation of the resource to other sectors unless they proactively engaged with community groups to improve their perception of the industry. The Marine  Aquarium Fishery (MAF) also needed to minimise any future loss of access, particularly through the State marine planning processes, by ensuring its current management and collection practices met community expectations.  Also, with two WA inshore fisheries embarking on Environmental Management Systems (EMSs), there was a need to evaluate their effectiveness as a tool to improve public perception. With growing interest amongst other WA fisheries to develop EMS there was a need to educate the wider industry on the associated costs, benefits and options of EMS.  For the pearling industry, the template produced from the National Seafood EMS Pilot Project needed to be extended from some components throughout the industry. |
| Objectives | * To develop and implement auditable environmental management systems in Western Australia’s (WA’s) South Coast Estuarine and Marine Aquarium Fisheries. * To assess the effectiveness of ‘Objective 1’ in changing community attitudes. * To extend the National Seafood EMS Pilot Project to the whole WA pearling industry. |
| Activities and Outputs | * EMSs for the SCEF and the MAF were developed. * Survey results for the SCEF indicated that the EMS had slightly improved community attitudes towards the fishery. * Survey results for the MAF showed that the EMS did not improve community attitudes towards the fishery. * The National Seafood EMS Pilot Project was extended to the broader pearling industry. * Valuable guidance has been evident from this project on how to maximise the benefits of developing EMS in fisheries. * Full implementation of the EMS still needs to occur in both fisheries. * Summarised results of the surveys have been circulated to licence holders in both fisheries. * While the results suggest that EMS can be effective in improving community attitudes, WAFIC needs to determine a policy position on EMS and whether it will seek resources to promote the uptake of EMSs in the future. * Further funds will be spent on extension of this project by Oceanwatch Australia. |
| Outcomes | * Improved community/stakeholder knowledge and input on the value, management regimes and fishing practices of WA’s South Coast Estuarine Fishery (SCEF) and Marine Aquarium Fishery (MAF). * Increased community awareness and understanding of the use of Environmental Management Systems (EMS) in commercial fisheries. * The application of EMS consistently across the pearling industry through the attendance of all pearling companies at a Broome workshop; however, not all pearling industry enterprises have implemented an EMS by the end of the project. * Most pearling companies have now implemented an EMS (Felicity Horn, pers. comm., 2013). * Full implementation of the EMS for the SCEF has taken place but not for the MAF (Felicity Horn, pers. comm., 2013) * Increased level of stewardship and cohesion between licensees in the SCEF. * No other WA fisheries have initiated an EMS (Felicity Horn, pers. comm., 2013). * WAFIC has decided on a policy position on EMS; the position is to support EMS only where there is unanimous industry support behind it as this was an impediment when undertaking the 2005/035 project (Felicity Horn, pers. comm., 2013). |
| Benefits | * Reduced risk of loss of access by fishers to fisheries via more positive community perceptions. * Greater confidence in the ecological and financial sustainability of at least one wild catch fishery and one aquaculture industry. |

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| **Project number 2005/038: Space-time analysis of western king prawns, brown tiger prawns and saucer scallops in Shark Bay for improved fisheries management** | |
| Project details | Organisation: Edith Cowan University  Period: Jul 2005 to Jun 2008  Principal Investigator: Ute Mueller |
| Rationale | Spatial-temporal opening and closing of fishing areas is a key component of the management of prawn and scallop fisheries in Western Australia. This assessment required the development of a space-time model for catch, catch rate and fishing effort for both prawns (including by grade class) and scallops in the Shark Bay managed fisheries to identify abundance and fishing patterns and to document when and where prawn and scallop trawlers target higher abundance areas. Also, a spatial analysis of the pre-season scallop survey data for each year, and its relationship with the spatial distribution of the subsequent scallop catch would enable an assessment of the effect that prawn trawling prior to scallop fishing may have on the scallop catch. These analyses would improve the management of these fisheries ensuring optimum sustainable exploitation of valuable fish stocks. |
| Objectives | 1. To develop a space-time model for catch, catch rate, and % tiger prawns for western king prawns and brown tiger prawns in the Shark Bay Prawn Managed Fishery.  2. To identify areas and times of high abundance of tiger prawns relative to king prawns to enable fine tuning of tiger prawn spawning closures.  3. To determine the spatial relationship of the pre-season saucer scallop abundance with the spatial distribution of the subsequent commercial scallop catch and to assess the impact of prawn fishing prior to scallop fishing on the subsequent scallop catch. |
| Activities and Outputs | * The spatial distribution of prawn catch and effort data has been analysed from 2001 to 2005 using a temporal scales year, lunar month and lunar week and detailed maps were constructed. * Space time models for the catch rate data for king and tiger prawns and percentage tiger prawn catch have been developed. The models were shown to accurately represent the data and to be suitable for the production of smoothed spatial maps. Limited time prediction is also possible using the models. * An evaluation of possible extension of the tiger prawn spawning area and an inclusion of an additional boundary for the extended nursery area has been made. The assessment indicated that flexible closure lines compared to fixed lines provide a better management tool. * The spatial relationship of the pre-season saucer scallop abundance with the spatial distribution of the subsequent commercial scallop catch has been investigated in detail using the 1999-2004 pre-season survey data and the catch data from both fleets for 2000-2005. * An assessment of the impact of pre-season prawn trawling on the subsequent scallop catch in Shark Bay North has been made. It was found that there is no statistically measurable impact of the pre-season prawn trawling on the scallop catch. |
| Outcomes | * Improved identification of the tiger prawn spawning areas in the Shark Bay prawn fishery and the time to implement the closures with minimal effect on the king prawn catch. * Greater understanding of the interaction of the prawn fleet on the scallop stocks within the Shark Bay scallop fishery, which is also fished by the prawn fleet. * Some of the results of this project have been used to provide advice to managers and the prawn and scallop industries on fleet interaction issues in addition to the analysis of pre-season effort by prawn boats on scallop grounds. * An evaluation of changes to current closure areas indicated that flexible closure lines compared with fixed lines provide a better management tool and this has become a feature of both prawn and scallop management over the last few years. * From the analysis of the scallop survey data and abundance estimation, the results show that overall the annual pre-season scallop survey is a fairly robust method of determining best areas to target scallop fishing when the season commences early the following year. * The analysis of scallop density estimates versus actual catch by level of pre-season effort on scallop grounds by prawn boats indicates that for the years compared, there was no clear correspondence with trawl effort and catches thereby not supporting the perception that pre-scallop season prawn trawl effort reduces overall scallop abundance. * Even though the Exmouth Gulf prawn fishery logbook data or survey data have not been used during this project, the project has demonstrated that spatial logbook data is very amenable to geo-statistical methods. The Exmouth Gulf and other trawl fisheries (with detailed spatial catch and effort data) will also benefit from the methodologies developed during this project. This is because the Exmouth Gulf fishery is also based on the same two key species, king and tiger prawns, as in Shark Bay. |
| Benefits | * Built capacity for reducing risk of overfishing in the prawn and scallop fisheries in Shark Bay in Western Australia, with greater sustainability of the resource in the medium to long term and higher confidence in fisheries management decisions that are taken. |

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| **Project number 2005/044: Development of the scientific requirements of an Environmental Management System (EMS) for the pearling (*Pinctada maxima*) industry** | |
| Project details | Organisation: Pearl Producers Association (PPA) and University of Newcastle  Period: Aug 2005 to Sep 2009  Principal Investigator: Brett McCallum |
| Rationale | Prior to this study it was not known through evidentiary research whether or not pearl oyster aquaculture in the Kimberley had the potential to foul the benthic layer under the farms through the deposition of faeces and pseudo‐faeces from the cultured oysters and fouling organisms, and the fallout of debris from the long lines that suspend the pearl oysters |
| Objectives | 1. To determine relevant scientific requirements for a pearl industry EMS. 2. To determine if the benthic physical / chemical or ecological variables beneath established pearl farms differ from the surrounding environment. 3. To develop the PPA’s capacity to initiate and co‐ordinate strategic research. 4. To demonstrate the effects of removing a long-term pearl farm on the benthic in fauna and sediment physico-chemistry under that farm. |
| Activities and Outputs | * The study employed an exhaustively designed sampling regime incorporating three spatial scales (10’s of metres, 1‐5 km, >100’s km) and random sampling through time. A multi‐control sampling strategy was undertaken to give an estimate of the natural variability of the region and to test for benthic impacts at three pearl farms that have been in use for up to 40 years. * Multiple lines of evidence showed that the variability in benthic conditions (e.g. extent of eutrophication, consistent differences in the benthic macrofauna below the pearl oyster farms) at the farms was within the bounds of the natural variability at the reference locations. * Previously published information have indicated the main mechanisms that influence the impact of shellfish aquaculture are considered to be: the farming method, the density of the cultivated shellfish (or stocking rate), the water depth of the farm area and the hydrographical conditions in the area. * All these factors favour the northern Australian cultured pearl industry and would contribute to the lack of a benthic footprint documented by this study. |
| Outcomes | * The conclusion was drawn that current pearl oyster culture techniques in northern Australia have no detectable effect on the sediments of the lease sites. * Also, it was concluded that it would not be a wise use of scarce industry funding to include benthic monitoring protocols in the standard EMS for the industry. * If major changes to farming practice creates uncertainty in the future on this issue, or political climate requires revalidation of these findings, a further study such as this, conducted as corporate industry research, such as this project, could again test the issue. * No further monitoring of sediments of lease sites has taken place since the project as the results were so conclusive there has been no need and production practices have not changed since the research (Brett McCallum, pers. comm., 2013) * NGOs and conversation management agencies now quote the research as demonstration of the benign nature of the pearling industry (Brett McCallum, pers. comm., 2013). |
| Benefits | * Enhanced image of the pearl industry as operating in an environmentally sustainable manner through scientific evidence. * Avoided costs of including benthic monitoring in the industry EMS, at least in the short term. |

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| **Project number 2005/047: Utilisation of GIS spatial statistical methods to assist in the development of ecosystem based fishery management strategies using the Northern Territory demersal and Timor Reef fisheries as case studies** | |
| Project details | Organisation: NT Department of Regional Development, Primary Industries, Fisheries and Resources  Period: Jul 2005 to Apr 2009  Principal Investigator: Julie Lloyd, Julie Martin |
| Rationale | The offshore snapper fisheries of the Northern Territory (NT) exemplify the problems that many fisheries scientists and managers face when dealing with small scale fisheries and small data sets. Traditional statistical methods are not well suited to small data sets, with bias associated with a small number of operators, and fisheries that are limited spatially to certain bottom structures and depth ranges. Therefore, there was an urgent need to develop tools suitable for NT offshore snapper fisheries and other fisheries with similar limitations. |
| Objectives | 1. To develop new techniques using GIS spatial statistical methods to analyse the complex interactions and relationships that occur within an ecosystem, enabling managers to develop an ecosystem based fishery management approach. 2. To develop indices of over-harvesting and “trigger points”, especially for multi-species fisheries. 3. To develop spatial statistical techniques to determine relationships between habitats, environmental conditions and catch rates in the Timor Reef Fishery. 4. To create in an Excel environment, fuzzy rule-based predictive models that incorporate existing data indices derived from spatial analysis and human knowledge. 5. To develop visual methods using GIS techniques and fuzzy rule-based modelling systems that allow stakeholders greater participatory access to interpret information and manage the process. |
| Activities and Outputs | * Environmental factors that affect fish catches in the Timor Reef Fishery were identified. * The project results demonstrated that fish catches were strongly related to geomorphology and depth. * The usefulness of spatial statistical techniques to determine the relationships between gold-band snapper catch rates and environmental conditions were demonstrated. * Gold-band snapper grounds in the Arafura Sea were identified using the information gained from the spatial analysis of fish catches in the Timor Reef Fishery. This allowed a better understanding of the total extent of gold-band snapper habitat and the portion that is actually fished. * A “fuzzy logic” expert system was applied for the estimation of intrinsic extinction vulnerability of gold-band snapper to fishing pressure. |
| Outcomes | * A method was developed (fuzzy logic expert system) to allow stakeholders greater participation in the interpretation of information and management of the process by combining qualitative and quantitative data. * The visual nature of GIS techniques enabled stakeholders to clearly see the relationships that were being investigated and there was greater agreement between scientists and fishers on the results from the analyses. * Improved understanding by fishers and fishery managers of the Timor Reef and Demersal Fisheries. * The approach allowed the fishing and gas industries to identify the key areas of importance and minimise the impacts on fishing activity. * The project won the 2007 NT Seafood Industry R&D Award. * The fuzzy logic approach has not been applied in NT fisheries management since this project was completed (Julie Martin, pers. comm., 2013.) * Spatial analysis (GIS) techniques are being increasingly used in the management of NT fisheries, for example): * The spatial information gained from the FRDC project has been critical to the development of a new management framework and to stock assessments for several species in the offshore snapper fisheries (Demersal and Timor Reef). * Spatial analysis techniques are being used in the development of a management approach for a new developmental fishery. * Fish tagging and electronic surveillance of effort are being used in several fisheries with a view to using spatial analysis in their management.   (Julie Martin, pers. comm., 2013) |
| Benefits | * Potentially contributed to improvements in NT offshore fisheries management due to greater stakeholder involvement. * Potentially contributed to reduced risk of overfishing in the offshore snapper fisheries of the NT with greater sustainability of the resource in the medium to long term and higher confidence in fisheries management decisions that are taken. |

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| **Project number 2005/238: ASIC/NAC environmental labelling** | |
| Project details | Organisation: Corvon P/L  Period: Nov 2005 to Jun 2008  Principal Investigator: Glenn McBride |
| Rationale | The rationale for environmental labelling is to link marketplace benefits with environmental improvement in seafood industries. Environmental labelling can provide market drivers for positive environmental activities in fisheries, while taking advantage of growing demand in the market place for verifiably sustainable produce. This study was funded to provide guidance to the wild catch and aquaculture sectors that may be considering some form of environmental labelling. |
| Objectives | 1. Provide an environmental labelling guide for industry. 2. Provide an environmental labelling strategic plan for ASIC and NAC. |
| Activities and Outputs | * The guide to seafood environmental labelling defines environmental labelling as well as eco-labelling. * Seafood producers may create a market advantage through environmental labelling of their products to meet consumer preferences and expectations relating to environmental protection. * The guide covers the different types and characteristics of environmental labels, and identifies the implications of Type I and Type II environmental labels for the Australian seafood industry. * The guide provides a set of questions for a seafood entity to check if considering some form of environmental labelling. * The guide covers certification issues and bodies and presents some case studies where environmental labels have been developed for Australian seafood. |
| Outcomes | * The guide has provided a greater understanding of the issues involved for Australian seafood entities who may be considering some form of environmental labelling. * The guide may have increased the extent of environmental labelling in the Australian sea food industry. * It is not clear if increased interest in environmental labelling stimulated by the guide may have increased the adoption of environmentally friendly practices in the seafood industry. |
| Benefits | * Potentially contributed to an increase in the extent of an enhanced clean and green image for some seafood industry members and the seafood industry as a whole. |

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| **Project number 2006/008: Assessing data poor resources: developing a management strategy for by product species in the Northern Prawn Fishery** | |
| Project details | Organisation: CSIRO Marine and Atmospheric Research  Period: Aug 2006 to Jan 2010  Principal Investigator: David Milton |
| Rationale | Byproduct in the Northern Prawn Fishery (NPF) includes four major groups: squid, cuttlefish, bugs and scallops, comprising of at least eight species. Limited data was available on the catches and biology of these byproduct species. Models that utilise minimal data to help assess the relative benefits of alternative management strategies provide a first step towards assessing fishery sustainability. |
| Objectives | 1. To identify, collate and analyse all available data on the distribution, biology, population dynamics and catches of byproduct species (or at least species groups) in the NPF in order to identify knowledge gaps and provide critical life-history parameters for modelling byproduct populations. 2. To investigate the feasibility of dividing the byproduct groups recorded in NPF commercial logbooks into individual component species on the basis of available research data. 3. To develop models of impacts on byproduct species with the purpose of (a) assessing the sensitivity of results to uncertainty in the biological parameters with a view to determining minimum data requirements and (b) assessing the relative effect on population size of each byproduct species (or group) under alternative prawn management scenarios. |
| Activities and Outputs | * The species composition of the byproduct of the Northern Prawn Fishery was identified and trends in the catch examined. * Life-history characteristics of bug, squid, cuttlefish and species caught as byproduct by the NPF have been documented from the Gulf of Carpentaria. * Statistical models have been developed to predict the proportions of squid, cuttlefish and bug species from aggregated data reported in logbooks. * Estimates of harvest reference catch limits for each byproduct group were made using a new method. * Simple models of the bug catch in the NPF have been developed and alternative management scenarios evaluated. For each scenario, models optimise benefits to the fishery and the bug population while taking compliance costs into account. The models incorporate environmental and economic factors that influence catch. * The current minimum legal size (MLS) fishery regulation restricting the retention of bugs < 75 mm carapace width was best for the bug population, but not the fishery under all scenarios except when catch increased substantially. If a large increase in catch occurs, the best management regulation was to increase the minimum legal size to 80 mm. When compliance costs are ignored, the best MLS falls to between 65 and 70 mm CW. * A simple model predicted that total catch and overall value were maximised when the MLS was set at 65 mm. This is consistent with the large maximum sustainable catch limits found with the new method. * The Australian Fisheries Management Authority manager, the Northern Prawn Fishery Management Advisory Committee and the NPF Resource Assessment Group have been advised on the most appropriate management strategy for each byproduct group and the report updated following feedback. |
| Outcomes | * Operational advice from this project has contributed to at least two possible management strategies: the first would be to control fishing on byproduct through species specific stock assessments. * The second would be to control effort on byproduct through spatial and temporal closures by identifying the key areas and seasons when these byproduct groups are most vulnerable. * The most efficient approach to assess the relative merit of alternative management options is to adapt existing trawl impact assessment scenario models to account for non-target catch in their strategy evaluations. * The management of the NPF changed due to the information provided by this project; the optimal size of Moreton bay bugs taken that was estimated by the project was adopted as the minimum legal size (David Milton, pers. comm., 2013). * The species specific stock assessments have now been changed so that the take of Moreton bay bugs has increased after it was demonstrated that the stock was only lightly exploited. * Fisheries management has not used the information to use or modify spatial and temporal closures to protect bycatch species (David Milton, pers. comm., 2013). |
| Benefits | * Increased gross value of the fishery. * Reduced the possibility of a species crash. * Greater confidence in the ecological sustainability of the Northern Prawn Fishery. |

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| **Project number 2006/024: Harvest strategy evaluation to optimise the sustainability and value of the Queensland scallop fishery** | |
| Project details | Organisation: Queensland Department of Agriculture, Fisheries and Forestry (formerly the Department of Employment, Economic Development and Innovation)  Period: Sep 2006 to May 2010  Principal Investigator: Matthew Campbell |
| Rationale | Prior to 2006, the annual catch of scallops from the Queensland East Coast Otter Trawl Fishery has fallen dramatically to about a third of the annual catch weight and value. There was a need to evaluate the management measures applied to the scallop fishery, particularly the range of minimum legal sizes, the effects of the southern closure and the rotational closures. It was important to assess whether these management measures were effective and what alterations are required to ensure the long-term sustainability of the fishery. |
| Objectives | 1. Measure spatial and temporal trawl frequency of scallop grounds using VMS data. This will provide a relative measure of how often individual undersized scallops are caught and graded using a “tumbler”.  2. Estimate discard mortality and growth rates for saucer scallops using cage experiments.  3. Evaluate the current management measures, in particular the seasonal closure, rotational closure and seasonally varying minimum legal sizes using stock assessment models. Recommend optimal range of management measures to ensure long-term viability and value of the scallop fishery based on a formal management strategy evaluation. |
| Activities and Outputs | * Improved understanding of the survival rates of discarded sub-legal scallops. * Preliminary von Bertalanffy growth parameters using data from tagged-and-released scallops. * Changing trends in vessels and fishing gear used in the Queensland scallop fishery and their effect on scallop catch rates over time using standardised catch rates quantified. * Increases in fishing power of vessels operating in the Queensland scallop fishery quantified. * Trawl intensity mapped and quantified for all Scallop Replenishment Areas. * Harvest Strategy Evaluations (HSEs) completed. * The significant reductions in discard mortality of sub-legal scallops quantified as part of the current project, combined with the reductions in bycatch quantified during previous research, was an important output from the project. |
| Outcomes | * The primary project output is the formulation of a dynamic HSE model which can be used for the assessment of a combination of management arrangements. * These management arrangements can then be used by Fisheries Queensland as a basis for discussion with stakeholders. * From these discussions, the most appropriate management arrangements can be applied to the fishery. * Although the HSE does not identify specific options for the optimal management of the fishery, it highlighted two very important aspects to improve the management of the scallop fishery. * Firstly, the scallop fishery is best managed using a rotating harvest strategy, involving the use of Scallop Replenishment Areas **(**SRAs). The SRAs should be closed for between 2 and 3 years to maximise catch rates at present levels of fishing effort. * Secondly, the imminent imposition of square mesh codends (SMCs) will be of great benefit to the scallop fishery (as it will reduce scallop discard mortality by approximately 50%). * The HSE model was used to explore management arrangements and was upgraded by Alex Campbell in a subsequent FRDC funded project (Matthew Campbell, pers. comm., 2013). * As fishers and marketers of scallops required year round supply, the winter minimum legal size (MLS) of 95mm was removed. MLS was increased from 90mm during the winter spawning period and acted as a quasi-winter closure, allowing a large proportion of the adult scallops to spawn. The removal of the 95mm MLS was not supported by the HSE model developed as part of this project (Matthew Campbell, pers. comm., 2013). * Catch rates are currently decreasing in the fishery but whether this is due to the changed management decisions or due to some environmental influence is uncertain. |
| Benefits | * Increased capacity for understanding the Queensland scallop fishery and potential for improved fisheries management in future. |

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| **Project number 2006/036: Supporting sustainable fishery development in the GAB with interpreted multi-scale seabed maps based on fishing industry knowledge and scientific survey data** | |
| Project details | Organisation: CSIRO Marine and Atmospheric Research  Period: Oct 2006 to Jul 2009 Principal Investigator: Alan Williams |
| Rationale | Spatial management is now an integral part of the overall management of the Southern and Eastern Scalefish and Shark Fishery (SESSF). To ensure that spatial management could meet the needs and expectations of all stakeholders, it was critical to have a sound understanding of the underlying marine habitats and their vulnerability and availability to different fishing methods. The Great Australian Bight (GAB) remained mostly unmapped at the scales relevant to the needs of managers, industry members and scientists when evaluating options for ecosystem based management (EBM). |
| Objectives | 1. Acquire, collate and map information on the spatial extent and use of the GAB seabed habitats from multi-sector fishing industry and scientific sources.  2. Validate and complement industry information gathered for Objective 1 by  ground-truth sampling with cameras from a chartered industry vessel.  3. Integrate information from Objectives 1 and 2 to generate interpreted seabed maps at scales relevant to management needs: fishing grounds, features, terrains and bottom types.  4. Quantify habitat vulnerability using the ERA methodology and upload a representative set of video and photographic images into the CSIRO seabed image database.  5. Interpret and summarise this information to permit informed area management (spatial and temporal) of the GAB.  6. Evaluate and summarise this information in relation the recommendations of the strategic assessment of the fishery and for stock assessments. |
| Activities and Outputs | * Scientists and the GAB fishing industry collaborated successfully to produce a credible, quality controlled, map-linked database of spatial information that covered the entire Great Australian Bight fishery across an area of 360,000 km2. * Acquisition, collation and mapping of information on the spatial extent and use of the GAB seabed habitats from multi-sector fishing industry and scientific sources. * Validation and complement industry information gathered by ground-truth sampling with cameras from a chartered industry vessel. * Integration of above information to generate interpreted seabed maps at scales relevant to management needs: fishing grounds, features, terrain sand bottom types. * Quantification of habitat vulnerability using the ERA methodology and uploading of representative set of video and photographic images into the CSIRO seabed image database. * Interpretation and summary of the information to permit informed area management (spatial and temporal) of the GAB. * Evaluation and summary of information in relation to the recommendations of the strategic assessment of the fishery and for stock assessments. |
| Outcomes | * Analyses completed during the project had an initial uptake by supporting the implementation of a network of closures to replace a blanket deepwater closure under a co-management arrangement between AFMA and GABIA. * Submissions by industry to the DEWHA in relation to (1) gulper sharks, (2) Southwest bioregional marine planning, and (3) trawling as a key threatening process. * Management processes were complex and the data were used indirectly in a number of ways (Alan Williams, pers. comm., 2013). * The information had an important role in informing each process and supported an improved management outcome than would have been possible without it (Alan Williams, pers. comm., 2013). |
| Benefits | * Conservation of vulnerable species and valuable fishery habitats. * Reduced risk of overfishing in the medium to long term and higher confidence in a sustainable use of fisheries resources. |

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| **Project number 2006/057: Development of a national environmental management and accreditation system for business /public recreational fishing competitions** | |
| Project details | Organisation: Recfish Australia - Period: May 2006 to Jul 2008  Principal Investigator: Bill Sawynok |
| Rationale | Development of an environmental Standard for recreational fishing competitions was needed to promote the sustainability of recreational fishing and proactively address a number of community concerns which were being directed at recreational fishing. |
| Objectives | 1. Develop a National Fishing Competition Accreditation system that is supported by competition organisers and sponsors, fishing industry groups, government fisheries agencies and other relevant entities.  2. Develop an ISO 14001 environmental Standard for fishing competitions.  3. Negotiate with insurance companies over insurance for accredited competitions.  4. Trial the accreditation system in at least one high profile fishing event in each state and trial the ISO Standard in at least one high ranking competition.  5. Obtain endorsement of the accreditation system from key environment groups. |
| Activities and Outputs | * A National Environmental Assessment of Tournament Fishing system (called NEATFish) has been developed, trialled and established. * The Standard is based on ISO/IEC Standard 17050-1:2004 with a pathway to certification under ISO 14001. * NEATFish involves an assessment of a fishing competition under the Standard and results in a rating out of five stars. * The Standard is based on a questionnaire which assesses the environmental, social and economic performance of a competition as well as the management of risk. * Each question receives a score with a total of 100 points available (excluding bonus points). A score of over 90 is required to achieve the highest five star rating. |
| Outcomes | * NEATFish is a voluntary industry standard developed by the recreational fishing industry for the industry. * NEATFish is online as an interactive website (www.neatfish.com) where organisers of fishing tournaments can complete the NEATFish environmental standard online. * NEATFish is claimed to be the world’s first environmental standard designed specifically for fishing tournaments. * Tournaments which undertake the NEATFish process are better able to demonstrate their environmental, social and economic credentials to the wider community. * Organisers who run NEATFish accredited tournaments report that they are better placed when dealing with government authorities, media and environmental groups on a range of issues related to their tournament activities. * Only a small proportion of Australian fishing tournaments currently use NEATFish and the number has not been increasing (Ben Diggles, pers. comm., 2013). * While overseas tournament are able to use NEATFish, no usage has been recorded (Ben Diggles, pers.comm., 2013) |
| Benefits | * Improved image of the fishing industry by demonstration of its environmental, social and economic credentials to the wider community. * Maintained or increased access to fisheries resources in some areas. * Increased the sustainability of Australian fisheries in some areas. |

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| **Project number 2007/010: Integration of socioeconomic sustainability criteria into a reporting framework for the Australian aquaculture industry** | |
| Project details | Organisation: National Aquaculture Council  Period: Sep 2007 to Mar 2010  Principal Investigator: Justin From |
| Rationale | There did not exist adequate social and economic frameworks or data to allow a holistic assessment of the sustainability of the aquaculture industry. This lack of data was impeding and constraining the growth of aquaculture. The ensuing need therefore was to identify what information to gather to inform ESD tailored to the aquaculture industry. The need related also to the development of a method of ongoing collection and analysis that can be implemented by individual sectors, and appropriately accessed by the national representative body and government agencies. |
| Objectives | 1. To identify a set of easily understood and defensible indicators and their underpinning questions to inform ESD Reporting Groups appropriate to each of the key Australian aquaculture sectors.  2. To develop a system for presenting aquaculture information on these indicators that can be easily integrated within the existing reporting frameworks.  3. To develop methods of use and communication that promotes the use of the ESD reporting framework as an essential tool for the aquaculture industry and its stakeholders. |
| Activities and Outputs | * A review of indicators used elsewhere in aquaculture and other NRM industries, and what data is collected to inform these. * A list of suggested questions was developed that were applicable to the ESD Reporting Groups and Indicators, which might be used by the industry. * A generic survey of social and economic questions that can be used by all sectors of the Australian Aquaculture industry to facilitate ESD reporting, structured in such a way that reporting can, if required and appropriate, be broken down into sectoral, regional or national results. * A ‘tool box’ of methods and resources for the industry to guide them in their collection, collation, interpretation, and presentation of the data, in their performance against ESD requirements. * An in-principle agreement from a majority of the industry’s sector associations to collect the data on an annual basis, report against it as required, and provide a copy of it to the National Aquaculture Council for aggregation to national level. |
| Outcomes | * The aquaculture industry now has the capacity to report against ESD Reporting Groups and associated indicators. * Sectors characterised by a small number of participants, such as the salmon industry, declined participation due to the problems of being able to maintain confidentiality of data. The confidentiality issue was also identified in the Abalone sector, leading to analysis of the data on national basis only rather than a regional basis. The pearling industry underwent a consolidation of industry participants during the project and also declined to provide data due to the impact on capacity of the industry resulting from the impacts of the 2008-09 Global Financial Crisis. * In many cases the number of businesses operating in an area or region were so few that in any regional analysis or comparison made, it would be clear as to which individual operations were being compared, raising issues of privacy and non-ethical disclosure of business data. Hence, such a regional population analysis of either general communities and/or industry sectors was not practical. * Despite some reticence to participate in some quarters, the sector has been drawn together via a common purpose, which has increased industry communication and collaboration. * The initiative has positively contributed to building industry capacity, flexibility and sustainability into the future. |
| Benefits | * Improvement in addressing policy priorities by both industry and government. * Contribution to maintenance of access to resources by aquaculture industries. |

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| **Project number 2007/013: A comprehensive ESD analysis of a fishery: the incorporation of regulatory, ecological, economic and sociological aspects** | |
| Project details | Organisation: WHAT  Period: Aug 2007 to Jul 2010  Principal Investigator: Tor Hundloe |
| Rationale | The benefits of including social science and economic information in fisheries management were not well recognised. |
| Objectives | 1.To provide a tool for today's fisheries managers  2. To provide a reference/text for the next generation of managers |
| Activities and Outputs | * The output from this research was a small book: Hundloe, T., Morison, J., Brooks, K., & Sullivan, A. (2011). Fishing for sustainability: Will your grandchildren have the option to eat seafood? Gold Coast: Bond University Press. * The book is a "How to Guide" for today's managers and fishers, and to be able to be used as a text for the next generation. * The book contains a major case study for the by the South Australian Marine Scalefish Fishery (MSF) Net Sector. |
| Outcomes | * The resource contributes to better-informed discussions on fisheries management in terms of the roll-out of Marine Protected Areas, resource allocation, and restructuring. * Illustration to the fishing industry how to integrate all decision-making data and approaches in the management of fisheries. * The resource has served as a text in fisheries courses. |
| Benefits | * Potentially improved management of fisheries by inclusion of economic and social factors, as well as environmental factors, in policy discussions and decisions. |

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| **Project number 2007/014: Developing innovative and cost-effective tools for monitoring recreational fishing in Commonwealth fisheries** | |
| Project details | Organisation: CSIRO Marine and Atmospheric Research  Period: Aug 2008 to Nov 2010  Principal Investigator: Shane Griffiths |
| Rationale | In Commonwealth waters, there was no formal management arrangements for recreational fisheries. This was partly because recreational fisheries were managed by States, but also because most Commonwealth-managed fish species were distributed in offshore waters that were previously assumed to be inaccessible by the majority of recreational fishers. However, there was a relatively small but increasing, number of highly specialised recreational fishers who probably accounted for the majority of the total recreational catch of Commonwealth-managed species. However, there was limited data on the recreational fishing catch of Commonwealth-managed species. |
| Objectives | 1. Undertake a comprehensive review of the global literature relating to the existing methods used to monitor recreational fishing, which may be transferable to Commonwealth fisheries.  2. Develop innovative operational and statistical tools for collecting, integrating and analysing recreational fisheries data, for the purpose of integration into stock assessment and to support resource allocation in Commonwealth fisheries.  3. Recommend a cost-effective and statistically robust long-term recreational fisheries monitoring program for Commonwealth fisheries. |
| Activities and Outputs | * A global literature review of recreational fishing survey methods determined potential cost-effective methods for monitoring recreational fishing. * National stakeholder workshops facilitated exchange of current knowledge of recreational fishing survey methodologies. * The workshops prioritised Commonwealth managed species and fisheries that required monitoring. * Scenario modelling using stock assessments applied to data-rich and data-poor species demonstrated that the inclusion of recreational catch that exceeds 10% of commercial catches and the inclusion of age structure data from recreational fisheries can significantly influence assessment outcomes. * An innovative and cost-effective approach to sampling hard-to-reach specialised recreational fishers in the absence of a sampling frame was developed using Respondent-Driven Sampling (RDS). * After reviewing all available methodologies, RDS was the recommended method for obtaining the total recreational catch of Commonwealth managed species when combined with a mark-recapture survey of fishers in a complemented “RDS-Recapture” survey design, after the method undergoes thorough testing. |
| Outcomes | * The primary outcome from this project has been the development of cost-effective methods that are specifically designed to representatively sample hard-to-reach populations of specialised recreational fishers. * The statistical grounding, efficacy and relatively low cost of RDS provides researchers with an alternative to traditional probability-based methods for representatively sampling important but hard-to-reach components within recreational fisheries. * This will allow researchers to cost-effectively obtain more reliable estimates of the total catch, and thus improve the quality and reliability of outcomes from stock assessments. * This will in turn benefit fishery managers to develop the most appropriate management measures to be implemented to ensure the biological sustainability of resources, allow equitable sharing of the resource among sectors, and fulfil state, national and international reporting obligations and legislative requirements. * Enough evidence was produced for a new project to be funded to assess whether it works effectively. |
| Benefits | * Reduced risk of overfishing in the medium to long term and higher confidence in a sustainable use of Commonwealth fishery resources. |

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| **Project number 2007/016: Development of national guidelines to improve the application of risk-based methods in the scope, implementation and interpretation of stock assessments for data poor species** | |
| Project details | Organisation: New South Wales Department of Primary Industries  Period: Sep 2007 to Nov 2009  Principal Investigator: James Scandol |
| Rationale | Significant resources and opportunity costs are associated with fishery assessments. Risk-based methods are integral to stock assessments of fisheries. It was considered desirable to review the work completed and compile some national guidelines for moving forward with risk assessments. These issues were particularly pertinent for data-poor species, where uncertainties may initially appear to dominate assessments.  There are potential drawbacks to a national fragmentation of methods, particularly the divergent applications of risk-based methods. Benchmarks for the use of risk-based approaches could provide agencies with a valuable tool to better understand the strengths and weaknesses of the approach they adopt. |
| Objectives | 1. Review the use of “risk” within the scope, implementation and interpretation of stock assessments of data-poor species in Australia and, with lesser detail, within the international domain.  2. Define benchmarks (which are likely to include quantitative, qualitative and procedural factors) to compare and contrast the use of “risk” within the scope, implementation and interpretation of stock assessments across all Australian jurisdictions.  3. Using the review and the benchmarks, identify the strengths and weaknesses of the various applications of risk-based methods used to scope, implement and interpret stock assessments in Australia.  4. Develop national guidelines that will assist jurisdictions to develop and apply risk-based methods to the assessment of data-poor species. These guidelines will promote the adoption of nationally consistent standards but be cognisant of diverse institutional arrangements that exist. |
| Activities and Outputs | * A comprehensive review (literature and interview of fisheries scientists and managers) of the extensive risk and stock assessment work undertaken for data-poor species in Australia. * Using this semi structured information, a series of national guidelines were drafted that aimed to capture the strategies that were being used for the assessment and management of data-poor species. * The guidelines represent the full spectrum of issues involved in improving risk management for Australian fisheries. * Although the focus of this project was the so-called “data-poor species”, many of the guidelines developed have in-principle application to conventional stock management issues, as well as habitat and ecosystem issues. * The national guidelines were communicated to over 47 scientists and 31 managers during a series of 9 workshops. Various approaches, including case studies, were used to illustrate how the guidelines could be used in real-world examples of data-poor fisheries management. |
| Outcomes | * The project stimulated important debate about the future of risk management for Australian fisheries and potentially will enable assessment scientists and key managers to rapidly evaluate options for the assessment of data-poor species. * Some guidelines may simply state, "don’t go there", others might suggest refinements to existing programs to reduce costs, progress inter-jurisdictional arrangements or adapt managerial interpretations. * The final benchmarks as presented provide a comparison of how individual jurisdictions performed with respect to the guidelines. |
| Benefits | * Contribution to reduced risk of overfishing in the medium to long term in data-poor fisheries and higher confidence in sustainable use of fishery resources. |

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| **Project number 2007/017: Integrated evaluation of management strategies for tropical multi-species long line fisheries** | |
| Project details | Organisation: CSIRO Marine and Atmospheric Research  Period: Mar 2007 to Nov 2010  Principal Investigator: Dale Kolody |
| Rationale | This project was developed in relation to the 2005 Ministerial Direction to AFMA that required simulation testing and implementation of harvest strategies for all Commonwealth fisheries by January 2007. For the Eastern Tuna and Billfish Fishery (ETBF) and the Western Tuna and Billfish Fishery (WTBF), AFMA's response was initially progressed through the establishment of a Harvest Strategy Working Group (HSWG), which was charged with development of individual harvest strategies for the five target species. However, it was recognised from the outset that the HSWG would not be able to meet all of the expectations of the Ministerial Direction before the January 2007 deadline.  An important focus of this FRDC project therefore was to develop simulation models that were explicitly conditioned to the regional WCPFC stock assessments, and to represent the uncertainty associated with these models. The project was also to provide an interface with the RAGs and MACs to illustrate HS management performance trade-offs and to stimulate the discussion which would allow the MAC to ultimately select specific harvest strategies for implementation as part of the ETBF Management Plan. |
| Objectives | 1. Evaluate the performance of the individual target species Harvest Strategies developed by the Eastern Tuna and Billfish Fishery - Western Tuna and Billfish Fishery Harvest Strategy Working Group.  2. Evaluate the likely relative performance of the Harvest Strategies in meeting the sustainability objectives of the Commonwealth Harvest Strategy Policy.  3. In consultation with DAFF, AFMA, DEH and relevant regional bodies, develop and provide initial evaluations of alternative approaches for incorporating linkages with regional stocks and/or management organisations in the formal harvest strategies for highly migratory, shared stocks. |
| Activities and Outputs | * The project provided a Management Strategy Evaluation for the Australian ETBF. * Development of single species operating models to represent each of the five target species (yellowfin, bigeye and albacore tunas, swordfish, and striped marlin). * The simulation testing of a range of Harvest Strategies (HSs) for each target species. * A stakeholder consultation process that was undertaken with the ETBF Resource Assessment Group and Management Advisory Committee to illustrate trade-offs among management objectives and facilitate selection of the HSs. |
| Outcomes | * The project results facilitated Eastern Tuna and Billfish Fishery (ETBF) Resource Assessment Group (RAG) and Management Advisory Committee (MAC) discussions about the management objectives for the fishery, and allowed a Harvest Strategy (HS) to be adopted for each ETBF target species. * This has led to the adoption of HS-regulated management arrangements for the ETBF under interim Total Allowable Effort (TAE) management arrangements from November 2009 and for quota-management from March 2011. * The development of operating models for the project has helped to identify key uncertainties in the understanding of ETBF target species population dynamics and potential problems which could adversely affect the expected performance of the adopted harvest strategies. * This should assist the prioritisation of future research activities to reduce these uncertainties and improve future management performance. * The project also has helped to establish a broader dialogue with regional fisheries interests on how to address joint management concerns for the highly migratory and straddling stock fisheries of the Western and Central Pacific Ocean. |
| Benefits | * Contribution to reduced risk of overfishing in the medium to long term and higher confidence in a sustainable use of resources in the ETBF and WTBF. |

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| **Project number 2007/018: Developing techniques to estimate total allowable catches for the NPF major prawn species** | |
| Project details | Organisation: CSIRO Marine and Atmospheric Research  Period: Mar 2007 to Sep 2010  Principal Investigator: Cathy Dichmont |
| Rationale | The Northern Prawn Fishery (NPF) is a multi-species fishery. However, stock assessment was only done for two out of the eight commercial species. The evaluation of output controls for the Northern Prawn Fishery became a priority with the recommendation from NORMAC that the fishery be managed via output controls. Controlling catch of only two species cannot secure the long-term sustainability of the whole NPF. Therefore, a whole-fishery approach was needed, and stock assessment needed to be extended to a greater number of species.  This project therefore was established with the main objective of developing techniques for calculating and delivery of TAC estimates for the two tiger prawn species and non-tiger prawn species that include both biological and economic information thus meeting the need that methods to estimate TACs be evaluated. |
| Objectives | 1. Development of techniques for calculating and delivery of TAC estimates for the two tiger prawn species and non-tiger prawn species that include both biological and economic information. 2. Estimation of fishing power effort creep of the fishery. 3. Assessment of the species distribution for tiger and endeavour prawns to enable splitting group specific catch and effort data. 4. Evaluation of economic efficiency under different TACs. |
| Activities and Outputs | * This project first assessed how many TACs are necessary to effectively manage the fishery. * Given these results, the project developed new methods to assess the relevant species (or groups) and methods relating to standardising catch rates (based on a fishing power analyses), as well as considering optimal vessels size under various TAC conditions. * Assessment methods for each major target species or group were developed. * Two methods were the development of the size structured model for the tiger prawn stocks and the Bayesian biomass dynamic models (for “data poor” stocks such as the blue endeavour prawns). * The projects newly developed assessment methods have been reviewed by the Northern Prawn Fishery Resource Assessment Group (NPFRAG) over several meetings and at times by the Northern Prawn **Fishery** Management Advisory Committee (NORMAC). |
| Outcomes | * The NPF RAG adopted both these methods for the Standard NPF assessment in 2010 onwards to manage the tiger prawn fishery. * The project developed methods for setting TACs that could feed directly into the development and evaluation of Harvest Strategies (HS) under output control. * Several of the methods have also been submitted (with approval from FRDC) to journals. |
| Benefits | * Reduced risk of overfishing in the medium to long term, higher confidence in a sustainable use of resources in the Northern Prawn Fishery, and an improvement in the economic efficiency of the fishery. |

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| **Project number 2007/048: Towards evaluating the socio-economic impacts of changes to Queensland’s inshore fishery management** | |
| Project details | Organisation: James Cook University  Period: Aug 2007 to Aug 2009  Principal Investigator: Renae Tobin |
| Rationale | Previous changes in fisheries management have had significant socio-economic impacts on recreational, charter and commercial fisheries. A more accurate measure of the extent of socio-economic impacts of the rezoning was unavailable, due to the lack of established methodologies to monitor such changes, and lack of baseline socio-economic data prior to any changes. |
| Objectives | 1. Develop a set of socio-economic indicators that are appropriate to monitor over time for Queensland’s east coast inshore fisheries stakeholders (i.e. recreational, charter and commercial fishers and seafood consumers).  2. Collect baseline socio-economic data for Queensland’s east coast inshore fisheries stakeholders (i.e. recreational, charter and commercial fishers and seafood consumers).  3. Develop, in cooperation with fishers and managers, a practical and cost-effective  socio-economic indicators monitoring system that can be used to measure and  assess change in the socio-economic status of the inshore fisheries on  Queensland’s east coast. |
| Activities and Outputs | * The outputs of this project include a detailed socio-economic baseline for commercial, charter and recreational fishers and seafood consumers within the Inshore Fishery * A list of the most important and useable socio-economic indicators for use in long-term monitoring of these stakeholders. |
| Outcomes | * The socio-economic indicators can assist fishery managers by helping ensure all Inshore Fishery sectors remain socially and economically sustainable, making meeting the goal of ESD more complete. * Some of the indicators may indicate a change in a resource before a biological indicator detects the change, so providing benefits to managers via rapid feedback about biological issues and the potential to improve communication between fishers and managers. * Fisheries Queensland has provided commitment to include the socio-economic indicators in the Performance Measurement System (PMS) for the Inshore Fishery. * Fisheries Queensland are commencing a review of the PMS for the Inshore Fishery early in the 2010-11 financial year. They will be using the project report as a base for the socio-economic section of the review. * Some of the indicators were used in the Inshore Fishery review in 2011. * The project has contributed to further efforts to develop and establish long term economic and social indicators for managing multiple uses of inshore fisheries in Queensland’s east coast (e.g. Great Barrier Reef Marine Park) (Renae Tobin, pers. comm., 2013). |
| Benefits | * Potentially improved management and balance of multiple uses within east coast fisheries and marine parks in Queensland. |

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| **Project number 2007/055: Independent environmental certification for Australian Northern Prawn Fishery marine stewardship council pre-assessment** | |
| Project details | Organisation: Pro-Fish P/L  Period: May 2007 to Jun 2007  Principal Investigator: Annie Jarrett |
| Rationale | The Northern Prawn Fishery (NPF) Strategic Plan 2001-2006 identifies independent environmental certification as one of the key strategies to be adopted in pursuit of ESD and a key component of an environmental management strategy. The Marine Stewardship Council (MSC) was deemed appropriate for this purpose as it was a market-driven eco-labelling initiative which recognised (and rewarded) sustainably managed fisheries. The project was needed as MSC pre-assessment was a necessary step in determining whether the fishery is eligible for MSC full assessment. |
| Objectives | 1. To undertake an evaluation of the likelihood of the fishery passing a more detailed certification assessment and if relevant, to assist the certification body with planning for a full assessment against the MSC’s Principles and Criteria for Sustainable Fishing. 2. Identification of the strengths and weaknesses of the fishery. 3. Indicators on information gaps and research required to address gaps relevant to MSC certification. |
| Activities and Outputs | * The information on which the pre-assessment report was based included * The background of the fisheries * The location and scale of the fisheries * Fishery management arrangements * Other relevant fisheries * Key stakeholders in the fisheries * Limit of identification of landings from the fisheries * Obstacles or problems for certification for each fishery * Preliminary evaluation of the fisheries against the MSC Principles and Criteria for a) Banana Prawn, b) Tiger Prawn, c) Endeavour Prawn, d)King Prawn * Recommendation were made as to whether or not (and in what form) each fishery should move to main assessment. * The Northern Prawn Fisheries (Tiger Prawn, Banana Prawn and Endeavour Prawn) appears well placed and were recommended to go forward to Main Assessment against the MSC’s Principles and Criteria for Sustainable Fishing, subject to the meeting specific requirements * The Northern Prawn Fishery (King Prawn) was not recommended to proceed to proceed to Main Assessment at that time, although in the future this fishery may be appropriate with the completion of additional research studies. |
| Outcomes | * The NPF sought a Main Assessment by MSC and the application for certification was successful. * The MSC assessment process led to the review of some of AFMA’s management arrangements for the NPF. For example it led to a review of the species list in the fishery’s ecological risk assessment and a refinement of the NPF harvest strategy (Brodie Macdonald, pers. comm., 2013). * The NPF has benefitted from the MSC accreditation through an improved image in the community and greater confidence in the licence to operate in future (Annie Jarrett, pers. comm., 2013). * The MSC accreditation has contributed to an increased demand for prawns in the domestic market and in some export markets (Annie Jarrett, pers. comm., 2013). |
| Benefits | * Improved management of the NPF. * Increased demand for NPF product in both domestic and export markets. |

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| **Project number 2007/061: The progression of abalone fishery performance indicators** | |
| Project details | Organisation: Abalone Council of Australia (ACA)  Period: Sep 2007 to Jun 2008  Principal Investigator: Michael Tokley |
| Rationale | The FRDC requested the development with respect to abalone of “an application that takes a national approach to management strategy evaluation development and implementation. This should include economic, environmental, social and governance indicators.” In order to achieve this a workshop was proposed that brings together representatives from Industry, Management and Research from the abalone producing States plus other invited experts in abalone and management strategy evaluation. To maximise the value of outcomes from the proposed Workshop, the ACA needed to focus on the strategic direction of finer scale data collection, its incorporation into fishery Performance Indicators (PIs) and their assessment through techniques such as Management Strategy Evaluation (MSE). |
| Objectives | * Determine R&D requirements relating to appropriate performance measures and indicators and the modelling of these measures and indicators. * Identify available data, and the relevance of current research. * Assess the commitment of management to move towards finer scale spatial management; and the associated performance measures and indicators for this shift in management. * Identify and assess the utility of different performance indicators and the methodology for assessment against future management needs. * Develop an application that takes a national approach to management strategy evaluation development and implementation. This should include economic, environmental, social and governance indicators. * Evaluate hierarchical approaches to application of Performance Indicators (PI) for abalone fishery assessment. * Provide a range of performance indicators to Haddon et al for testing within the Management Strategy Evaluation (MSE) framework. |
| Activities and Outputs | * The ACA convened a half-day meeting with a small group of people who met in the morning, and reported to all ACA Directors in the afternoon, before the broader Workshop the following day. * The plan for R&D investment to address performance indicators considered the current initiatives and projects for finer scale data collection and management, their extension to future funding applications, the potential benefits and role of greater industry capacity and involvement in data collection. * This involved the identification of priority applications or projects within this R&D direction, and preferred outcomes prior to future application development. * The ACA was then able to make its plans clearer to researchers, managers and other stakeholders. * The broader stakeholder Workshop to progress planning for R&D investment in the direction, assessment and application of abalone fishery Performance Indicators was held the next day. * The wider workshop discussion resulted in the development of a draft plan for R&D investment in this direction as suggested in the Workshop Objectives proposed by FRDC. |
| Outcomes | * A more focused national approach to R&D investment that takes account of Performance Indicators for the abalone industry. * This was facilitated by a plan for specific R&D investment in the development of industry capacity and finer scale information. * Another key output was an agreed plan for an application that takes a national approach to MSE development and implementation. |
| Benefits | * A strategic, national approach to R&D investment that should deliver benefits to fishery sustainability and profitability. * More efficient use of abalone R&D resources |

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| **Project number 2007/064 Tactical Research Fund: Developing an analytical module for large scale recreational fishery data based on phone/diary survey methodology** | |
| Project details | Organisation: University of Tasmania  Period: Apr 2008 to May 2010  Principal Investigator: Jeremy Lyle |
| Rationale | While the efficacy of the telephone-diary methodology in providing detailed and robust information about recreational fishing had already been established, a need to further develop and refine the statistical tools necessary to do the analyses remained. There was a requirement to develop an analytical module that was robust, efficient and flexible, enabling further analysis to be conducted on existing and future datasets. |
| Objectives | 1. Review and document statistical procedures for analysing large-scale phone/diary recreational survey data.  2. Develop an integrated and flexible data analysis module for phone-diary recreational survey data.  3. Undertake a re-analysis of key National Recreational Fishing Survey (NRFS) data outputs.  4. Roll-out and demonstrate the analysis module to potential users. |
| Activities and Outputs | * The principal output was the development of a statistically robust analytical framework, the RecSurveypackage, which can be applied to re-analyse existing NRFS and future recreational fishing survey data. * The package enables users to specify analyses that are relevant to their needs, particularly in relation to data disaggregation, and provide estimates with associated statistical uncertainty. * The RecSurveypackage is also flexible enough for users to make decisions about how and what assumptions are used in the calibration and adjustment processes, enabling the sensitivity of estimates to differing assumptions to be assessed. * At a workshop held in October 2009, researchers, fisheries managers and recreational fisher groups were provided with a practical demonstration of the package. * The workshop generated considerable interest, with researchers expressing interest in a full re-analysis of NRFS data relating to their jurisdiction and in applying the package to the analysis of future recreational fishing surveys. * The RecSurveypackage, an example database, worked data example and manual was distributed electronically to each of the Australian fisheries research agencies and made available for download from the TAFI and FRDC websites. |
| Outcomes | * The primary outcome of this project was provision of support for sustainable fisheries management through the inclusion of statistically robust information relating to the recreational sector. * The RecSurvey package represented a significant development in the analysis of complex survey data, providing an efficient, flexible and statistically robust tool that will benefit many jurisdictions as they seek to quantify and account for the impacts of recreational fishing activities. * The package has been applied in the re-analysis of NRFS data for Tasmania and South Australia, and in the analysis of recently completed state-wide surveys in each of these states. * For example, results from the survey of recreational fishing in Tasmania conducted for the 2007/08 fishing season, have been compared to the previous state wide survey conducted in for the 2000/01 fishing season (a component of the national survey). * The RecSurvey package is now applied routinely to recreational fisher survey data in Tasmania (Jeremy Lyle, pers. comm., 2013). * The package has been used or adapted for use in other recreational fisheries surveys in other states, for example in Queensland in 2010 and currently, in the Northern Territory in 2010, and some adaption for use currently in NSW (Jeremy Lyle, pers. comm., 2013). |
| Benefits | * Reduced risk of overfishing in the medium to long term. * Higher confidence in a sustainable take for recreational fisheries. |

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| **Project number 2007/066: Tactical Research Fund: Rapid response to abalone virus depletion in western Victoria: information acquisition and reefcode assessment models** | |
| Project details | Organisation: University of Melbourne  Period: Feb 2008 to Jul 2008  Principal Investigator: Harry Gorfine |
| Rationale | As a result of a devastating abalone virus outbreak in Victorian zone reefs, a mid- 2007 workshop was organised to discuss the implications for monitoring, stock assessment and management advice. The workshop review concluded that there were significant gaps and limitations in the existing information on the status of the abalone populations across reefs in western Victoria and exposure of these populations to the virus; also, that the current regional model was inadequate to represent the current situation in the western zone or to evaluate management options. |
| Objectives | 1. Conduct the scientific surveys at the DPI reef-code sites, using the Victorian survey methods, augmented by genetic sampling and extended survey of the extent of aggregations.  2. Develop a long-term monitoring strategy for continued assessment of reef-stock status and management options.  3. Use existing models to broadly illustrate the likely impacts of the outbreaks.  4. Compile existing information on the outbreaks in an accessible, informative form, develop reef-code growth, maturity and abundance trajectories, and agreed catch histories.  5. Develop and apply a quantitative model that is spatially resolved to the scale of reefcodes, and use this to assess the status of populations and inform the Total Allowable Catch setting process. |
| Activities and Outputs | * Surveys were conducted at 38 fixed survey sites previously established. * These surveys were used to establish a basis for continued assessment of stock status and management options. * Samples comprising tissues taken from 10 individual abalone from each of about 100 sites were collected from the majority of reef codes throughout Victoria during 2007. * Models were used to inform both government and industry about the broad situation in the short-term. * Information on the timing and geographic extent of the outbreaks was summarised from Victoria’s DPI and industry sources. * The project delivered the samples and model to allow reef-code stock assessment and evaluation of management options in the future. The methodology was based on the assumption that other research and management activities would be required to enable full use to be made of the outputs from the project. |
| Outcomes | * The project provided survey and other information to support assessment of individual reefcodes in Victoria's Western and Central zones, and basic models to assess population status and examine management options for these reef-codes. * The project provided a basis for design and testing of models for reef-scale management of stocks elsewhere, and a tested template for the information that will be required when/if the virus spreads to other regions. * The information generated by the project ensured that there was a conservative attitude towards the resumption of fishing such that a structured approach eventuated. This progressively opened up recovering reefs post-AVG (see FRDC 2008/077) with a very conservative size limit (Harry Gorfine, pers. comm., 2013). * The modelling and the data have become an important component of the litigation currently before the Supreme Court in Victoria, both for the plaintiff and the defendant. Use of the technology i.e. model code, has also been included in a current TRF project 2012/236 “Tactical Research Fund: developing the decision process for setting the TAC for abalone in Victoria, particularly with reference to recovery of AVG impacted reefs” (Harry Gorfine, pers. comm., 2013). * Some of the technical products from the project e.g. equations, computer code and parameter estimates, have been incorporated as refinements in the stock assessment model that has been recently used to analyse those regions of the Central Zone unaffected by AVG and set the quota for 2013/14. Although a different approach has been used to set quotas in the Eastern Zone, where AVG did not occur, the same refined version of the stock assessment model has been used to corroborate those quota decisions. It seems reasonable to conclude that there was a more general impact on improved management of the Victorian abalone fishery (Harry Gorfine, pers. comm., 2013). |
| Benefits | * Reduced risk of overfishing in Victorian abalone fisheries in the medium to long term and higher confidence in a sustainable take for abalone fisheries. |

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| **Project number 2008/064: Tactical Research Fund: Management Strategy Evaluation (MSE) of the harvest strategy for the Small Pelagic fishery** | |
| Project details | Organisation: Bureau of Rural Sciences  Period: Mar 2008 to Dec 2009  Principal Investigator: Patricia Hobsbawn |
| Rationale | Commonwealth fisheries have been required to implement harvest strategies in accordance with the recently released *Commonwealth Fisheries Harvest Strategy Policy*. The policy requires an MSE be conducted to demonstrate that each harvest strategy is robust to the uncertainty inherent in the assessment and management of the respective fishery.  Based on the outcomes of a review in 2007 the Small Pelagic Fishery Resource Assessment Group (SPFRAG) and Small Pelagic Fishery Management Advisory Committee (SPFMAC) agreed to the harvest strategy. In June 2008, the AFMA Board approved the SPF Harvest Strategy. However, further testing of the harvest strategy was required to investigate its robustness under a range of harvest scenarios. |
| Objectives | 1. Develop and implement an appropriate management strategy evaluation (MSE) to aid the review of the Small Pelagic Fishery (SPF) Harvest Strategy.  2. Use the MSE to investigate the harvest strategy’s performance under a range of plausible scenarios.  3. Develop a research plan, including indicative costs, to collect the data required for the harvest strategy (all Tiers) to meet its objectives. |
| Activities and Outputs | * A new management strategy evaluation (MSE) tool was developed for the Small Pelagic Fishery (SPF). * The sensitivities of this operating model have been tested and various harvest strategies explored, as outlined in the SPF Harvest Strategy as well as alternatives to these. * A research plan was developed to underpin the SPF Harvest Strategy. |
| Outcomes | * The current SPF Harvest Strategy has a three-tiered approach. The maximum recommended biological catch (RBC) is set at different levels for each Tier for each stock. * The research plan is currently being implemented with a project led by the South Australian Research and Development Institute (SARDI) in collaboration with the Tasmanian Aquaculture and Fisheries Institute (TAFI) and the Bureau of Rural Sciences (BRS). * The results produced in this study show that Tier 1 harvest strategies, using proportions of the spawning biomass to determine RBCs, are most likely sustainable. * Results for Tier 2 and Tier 3 harvest strategies should be treated with caution as these use absolute tonnages for harvest quantities that may not be meaningful for the model. |
| Benefits | * Contributed to a reduced risk of overfishing in in the Small Pelagic Fishery with greater sustainability of the resource in the medium to long term and higher confidence in fisheries management decisions that have been undertaken. |

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| **Project number 2008/075: Tactical Research Fund: Industry based size-monitoring and data collection program for albacore tuna in the ETBF** | |
| Project details | Organisation: CSIRO Atmospheric and Marine Research  Period: Dec 2008 to Jun 2009  Principal Investigator: Jessica Farley |
| Rationale | Dramatic increases in the catch of albacore occurred in the ETBF in 2006 as several domestic longliners switched from targeting broadbill swordfish to albacore tuna landing the catch in Mooloolaba. These high catches were maintained in 2007, and given that localised depletion of albacore had been observed in several Pacific island nations, it raised concerns about the long-term sustainability of the fishery. The Eastern Tuna and Billfish Fishery Management Advisory Committee (ETMAC) explicitly identified the determination of life-history parameters and improved stock assessments for albacore tuna as a high priority project. |
| Objectives | 1. Design and implement, in consultation with industry, a practical, cost-effective industry based monitoring program for obtaining representative sized data for albacore in the Eastern Tuna and Billfish Fishery (ETBF).  2. In collaboration with SPC, develop a biological sampling program to ensure that unbiased estimates of biological parameters for albacore are also obtained for the southwest Pacific region.  3. Collect biological samples (otoliths, spines, gonads & muscle tissue) from at least 500albacore caught in the ETBF in 2008/09. |
| Activities and Outputs | * Simulation modelling using existing size data for albacore was undertaken to determine the sampling regime required to achieve target levels of precision for specific size-based indicators and the size distribution of the catch. * Size data for albacore were obtained from AFMA logbook records and the AFMA observer databases for 2005 and 2006. * The simulation modelling showed that reliable estimates of size composition may be obtained by measuring 15 fish per trip for at least 90 % of trips where albacore were caught. * A biological sampling program was developed albacore for the southwest Pacific region to provide unbiased estimates of biological parameters for albacore for the southwest Pacific region * Biological samples (gonads, otoliths, dorsal spines, muscle tissue) and associated data (length and weight) were collected from 500 albacore caught in the ETBF in 2008/09. |
| Outcomes | * This study provides an improved way to collect and analyse size data for albacore to ensure that representative estimates of the size composition of the catch are obtained for the ETBF. * Processors, not already collecting unbiased size data, have agreed to collect individual size data based on the simulation results from the project. * This industry-based size monitoring program will reduce monitoring costs to the fishery and build greater ownership and understanding of data inputs for the harvest strategy. * The size monitoring program will provide a consistent data source to review the inputs and indicator values for the ETBF Harvest Strategy and provide improved size-based catch data for regional stock assessment. * The development of a biological sampling plan for albacore in the southwest Pacific (and the collection of biological material) will contribute to the regional stock assessment and ensuing management strategies. * The project has directly addressed stock assessment needs for one of the principal target species in the region, and will therefore represent a direct contribution from Australia to the regional management arrangements and assist Australia’s advocacy for the sustainable use of the resources. |
| Benefits | * Reduced risk of overfishing in in the ETBF with greater sustainability of the resource in the medium to long term and higher confidence in fisheries management decisions that are undertaken. * Improvements in cost-efficiency of monitoring programs in the ETBF. |

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| **Project number 2008/097: Tactical Research Fund: Developing the use of existing technology in cost effective and reliable industry–based structured fishing surveys to urgently replace more costly methods and advise finer-scale management of abalone populations** | |
| Project details | Organisation: Abalone Council of NSW  Period: May 2009 to May 2010  Principal Investigator: Duncan Worthington |
| Rationale | While surveys of abalone completed independent of fishing have been completed in NSW for over 10 years, it has not been possible to collect representative information throughout the fishery because of their prohibitive cost. There had been large reductions in Total Allowable Catch, GVP and profitability of the commercial abalone Industry in NSW, as well as large reductions in recreational bag limits. One consequence of these changes was a reduced ability to contribute to the cost of outsourced independent surveys of abundance, in addition to uncertainty about how representative the surveys were of the changes in stock that had occurred. These independent surveys of abundance were not continued from July 2009. The cessation of these surveys, together with very little other information available to assess stocks in the closed areas of the fishery, led to an urgent need to develop more cost-efficient methods of the assessment of stocks throughout the fishery, and particularly at a fine spatial scale. |
| Objectives | 1. Train commercial divers in the use of GPS loggers to record observations of the abundance of under-size abalone.  2. Assess the reliability of logged observations by commercial divers through comparison within and among divers, and with estimates from surveys completed independent of fishing.  3. Develop a cost-effective and targeted program to measure the lengths of abalone being landed in the Structured Fishing Program and compare with existing methods of estimating the size of abalone landed.  4. Improve the existing survey design for structured fishing, by developing the database of sampling sites, standardised techniques and historical information for estimating changes in abalone stocks. |
| Activities and Outputs | * The project developed a detailed spatial information collection, management and analysis system for delivering fine scale spatial information about fishing and stocks in the NSW abalone fishery. * The information collected in GPS and Depth loggers clearly provides detailed information about patterns of fishing effort, observations about stocks, and through links to logbook catch reporting, related catch. * Capacity was developed to train divers and implement industry-based surveys of abalone populations. |
| Outcomes | * Use of the tools developed in this project, together with an ongoing commitment to resource and implement appropriate structured fishing designs, have better informed fine scale assessments for TAC setting and catch planning through a process with strong industry involvement that is currently being developed in the fishery. * The tools developed have assisted the re-opening to fishing of large sections of the NSW coast. * Further development of logger based data is necessary for information to be used in TAC setting. |
| Benefits | * Some improvement in cost-efficiency of monitoring programs for the NSW abalone industry and some contribution to a reduced risk of overfishing in NSW abalone fisheries in the medium to long term. |

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| **Project number 2008/215: Tactical Response Fund: Implementation of the NEATFish environmental standards for recreational fishing tournaments** | |
| Project details | Organisation: DigFish Services  Period: Oct 2008 to Nov 2009  Principal Investigator: Ben Diggles |
| Rationale | Recfish Australia with assistance from the FRDC and DigsFish Services developed NEATFish, a world first environmental standard for fishing tournaments through FRDC projects 2005/235 and2006/057. Feedback from the recreational fishing industry during the development of NEATFish suggested that the major challenge for the concept was to create a better awareness of what it has to offer clubs another bodies. The current project was designed to facilitate this process of raising awareness through development of a website, promotional materials, and a profile for NEATFish in the fishing media and at various industry events, including tackle shows and conferences. |
| Objectives | 1. To develop an interactive website with dynamic content to manage and promote the NEATFish standard and facilitate its uptake by industry. 2. To publicise the standard and website in the fishing media. 3. To publicise the standard and website at trade tackle shows and conferences. 4. To liaise with industry bodies, tournament organisers, government authorities and environmental groups. |
| Activities and Outputs | * The principal output of the project was development of the www.neatfish.com website and database in liaison with professional website developers. * Magazine articles and editorial were published in Fishing World, Bluewater and Modern Fishing, as well as FISH Magazine, Queensland Fishing Monthly, SA Angler, WA Angler, Bream, Barra and Bass and NAFA magazines. * Extension activities were undertaken at several tackle shows, including the Brisbane Tinnie and Tackle Show, the Sydney International Boat Show, the AFTA Trade tackle show on the Gold Coast, and the National Off-road, Fishing and Outdoors Expo, Melbourne. Promotional materials in the form of several professionally designed stickers and an A4 brochure were distributed at the various fishing tackle shows that were attended. * Meetings concerning NEATFish included those at the 5th World Recreational Fishing Conference, Great Barrier Reef Marine Park Authority (GBRMPA), Fishing World Magazine, Bluewater boating and Sportfishing magazine, Modern Fishing, FISH Magazine, Queensland Fishing Monthly, NAFA, Bream, Barra and Bass, fishing tournament insurers, NEATFish sponsors as part of establishment of incentive schemes, Fishing tournament organisers to discuss benefits of joining the scheme, and meetings with recreational fishers and conservation groups. |
| Outcomes | * Compared to the previous website, the new online interface is user friendly and intuitive, scoring is automatically done by the website software, and the process of obtaining a NEATFish rating has become relatively quick and easy. * The profile for NEATFish has been maintained in the fishing media and at various industry events, including tackle shows and conferences. * Publicity for the NEATFish standard has been provided through articles in recreational fishing magazines, features on fishing TV, manning of booths at boat shows and trade tackle shows, and presentations at conferences. * NEATFish has become more accessible and recognised by the recreational fishing industry and continues to provide a viable alternative for governments that are scrutinising fishing events. * Only a small proportion of Australian fishing tournaments currently use NEATFish and the number has not been increasing (Ben Diggles, pers. comm., 2013). * While overseas tournament are able to use NEATFish, no usage has been recorded (Ben Diggles, pers. comm., 2013). |
| Benefits | * Improved image of the fishing industry by demonstration of its environmental, social and economic credentials to the wider community. * Maintained or increased access to fisheries resources. * Increased the sustainability of Australian fisheries. |

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| **Project number 2009/031: Taking female mud crabs (Scylla serrata): assessment of risks and benefits** | |
| Project details | Organisation: QLD Department of Primary Industries and Fisheries  Period: Aug 2009 to Sept 2010  Principal Investigator: Ian Brown |
| Rationale | There were various viewpoints about the relevance and need for the single sex harvest policy (SSHP) for mud crabs, but there was little hard evidence. It was considered that two primary issues needed addressing in relation to changing the SSHP – sustainability and profitability. The risks associated with both of these issues needed to be determined objectively before a decision could be made to progress any investigation into the effects of the policy. |
| Objectives | * Evaluate the risks and benefits of allowing the harvest of female mud crabs in Queensland. * Depending on results of objective 1, develop a plan for implementing a change to the single-sex harvest policy (SSHP) arrangement. |
| Activities and Outputs | * A workshop was held on Bribie Island from 2nd - 6th of November 2009 to evaluate the risks and benefits of allowing the harvest of female mud crabs in Queensland. * Workshop participants included commercial and recreational crab fishers, GBRMPA, Qld Seafood Marketers’ Association, local and interstate fisheries personnel, fisheries economics expert, a population modelling expert, fisheries scientists, social scientists, FRDC, fisheries managers and compliance personnel. * Presentations were given on background to the single sex harvest policy, status of mud crab fisheries throughout Australia, economics of the Queensland mud crab fishery, modelling research of the Queensland mud crab fishery, and market structure and opportunities * Following this the workshop a risk-assessment process was undertaken and the design of an experiment was developed to determine the stock, economic, and social outcomes of permitting the harvest of female mud crabs. * It was concluded that in principle there was no justification for pursuing the single-sex harvest policy for mud crabs in Queensland; however, until such time as a reliable indicator of stock abundance is developed it would not be wise to allow the take of female crabs. * When such an indicator becomes available, a minimum legal size for female crabs should be set to minimise the risk of overexploitation * Transition to a both-sex harvest arrangement should be done by way of a controlled adaptive management experiment, allowing for immediate policy reversal should there be any indication of undesirable or unsustainable ecological, economic or social consequences. * Economic modelling demonstrated that there were substantial gains both to the individual operator and to the State’s economy by allowing the harvest of female mud crabs. On the basis of existing market arrangements, and assuming that the biological system would sustain such a scenario, the net benefit to the industry (currently between $10 and $15 million p.a.) could rise from between $1.5 million and $4.25 million p.a. |
| Outcomes | * Peak industry bodies and other key stakeholders were invited to provide views on the proposed experiment; these views were mixed. * Government was then to decide whether the experiment went ahead. * The experiment was not carried out, and the current situation regarding the taking of female mud crabs is as it was previously - i.e. prohibited in both the recreational and commercial fisheries. * This was largely due to the various industry sectors retreating for differing reasons to the long-standing historical/social belief in the value of protecting female mud crabs (Ian Brown, pers. comm., 2013). * However, the project was successful in its main focus, which was to assess the risks and benefits of changing the management arrangements for mud crabs. * Queensland's crab fisheries are currently being reviewed, and the likelihood of the proposed adaptive management experiment going ahead at some later stage is highly dependent on just how the mud crab fishery is to be managed in future (Ian Brown, pers. comm., 2013). * One element that's essential to the success of any adaptive management arrangement is a significant improvement in the ability to track changes in population size and structure with precision and confidence. |
| Benefits | * Potential contribution to future net benefits to commercial and recreational fishers of Queensland mud crabs. |

**Project Investment**

The following tables show the annual investment by project for both the FRDC (Table 3) and for researchers and others (Table 4). Table 5 provides the total investment by year from both sources.

Table 3: Investment by FRDC by Project for Years Ending June 2001 to June 2011

(nominal $)

| **Project** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **Total** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2000/123 | 31,539 | 0 | 96,525 | 0 | 35,052 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 163,116 |
| 2001/042 | 0 | 31,823 | 72,351 | 0 | 93,084 | 24,657 | 0 | 24,657 | 0 | 0 | 0 | 0 | 246,572 |
| 2001/074 | 0 | 107,302 | 79,616 | 92,282 | 82,114 | 20,000 | 0 | 31,257 | 0 | 0 | 0 | 0 | 412,571 |
| 2001/076 | 0 | 54,093 | 121,315 | 40,904 | 0 | 27,046 | 27,046 | 0 | 0 | 0 | 0 | 0 | 270,404 |
| 2002/014 | 0 | 0 | 183,067 | 179,378 | 211,921 | 83,274 | 0 | 0 | 0 | 0 | 0 | 0 | 657,640 |
| 2002/056 | 0 | 0 | 98,942 | 151,801 | 145,025 | 0 | 78,942 | 21,151 | 0 | 0 | 0 | 0 | 495,861 |
| 2002/057 | 0 | 0 | 78,571 | 77,925 | 0 | 0 | 39,124 | 0 | 0 | 0 | 0 | 0 | 195,620 |
| 2002/059 | 0 | 0 | 205,288 | 307,904 | 157,392 | 150,570 | 153,966 | 0 | 0 | 51,322 | 0 | 0 | 1,026,442 |
| 2002/072 | 0 | 0 | 34,111 | 35,516 | 0 | 8,703 | 0 | 0 | 8,703 | 0 | 0 | 0 | 87,033 |
| 2002/083 | 0 | 0 | 148,199 | 119,285 | 0 | 33,436 | 0 | 0 | 0 | 33,436 | 0 | 0 | 334,356 |
| 2003/017 | 0 | 0 | 0 | 234,399 | 106,079 | 0 | 60,053 | 0 | 0 | 0 | 0 | 0 | 400,531 |
| 2003/044 | 0 | 0 | 0 | 242,624 | 105,112 | 43,467 | 0 | 43,467 | 0 | 0 | 0 | 0 | 434,670 |
| 2003/047 | 0 | 0 | 0 | 76,013 | 98,855 | 70,942 | 40,000 | 18,242 | 0 | 76,012 | 0 | 0 | 380,064 |
| 2003/052 | 0 | 0 | 0 | 167,351 | 125,826 | 118,325 | 0 | 51,438 | 0 | 51,438 | 0 | 0 | 514,378 |
| 2003/222 | 0 | 0 | 0 | 77,289 | 36,982 | 88,430 | 25,338 | 25,338 | 0 | 0 | 0 | 0 | 253,377 |
| 2003/223 | 0 | 0 | 0 | 105,503 | 226,517 | 66,790 | 0 | 99,702 | 0 | 0 | 0 | 0 | 498,512 |
| 2004/006 | 0 | 0 | 0 | 0 | 68,001 | 57,579 | 28,554 | 0 | 19,268 | 0 | 0 | 0 | 173,402 |
| 2004/008 | 0 | 0 | 0 | 32,000 | 0 | 96,000 | 32,000 | 0 | 0 | 0 | 0 | 0 | 160,000 |
| 2004/019 | 0 | 0 | 0 | 0 | 194,832 | 130,785 | 118,708 | 45,541 | 35,541 | 0 | 0 | 0 | 525,407 |
| 2004/020 | 0 | 0 | 0 | 0 | 15,000 | 0 | 45,000 | 7,500 | 7,500 | 0 | 0 | 0 | 75,000 |
| 2004/096 | 0 | 0 | 0 | 21,600 | 29,997 | 34,803 | 0 | 12,430 | 7,837 | 0 | 0 | 0 | 106,667 |
| 2004/101 | 0 | 0 | 0 | 0 | 29,933 | 0 | 89,799 | 0 | 29,932 | 0 | 0 | 0 | 149,664 |
| 2005/004 | 0 | 0 | 0 | 0 | 0 | 25,721 | 77,164 | 0 | 6,431 | 19,291 | 0 | 0 | 128,607 |
| 2005/011 | 0 | 0 | 0 | 0 | 0 | 61,546 | 58,885 | 0 | 56,004 | 0 | 0 | 0 | 176,435 |
| 2005/031 | 0 | 0 | 0 | 0 | 0 | 409,575 | 230,424 | 0 | 0 | 0 | 160,000 | 0 | 799,999 |
| 2005/035 | 0 | 0 | 0 | 0 | 0 | 36,646 | 6,792 | 14,061 | 32,501 | 0 | 0 | 0 | 90,000 |
| 2005/038 | 0 | 0 | 0 | 0 | 0 | 70,122 | 70,104 | 40,087 | 16,582 | 0 | 0 | 0 | 196,895 |
| 2005/044 | 0 | 0 | 0 | 0 | 0 | 90,000 | 152,251 | 140,241 | 57,508 | 48,359 | 0 | 0 | 488,359 |
| 2005/047 | 0 | 0 | 0 | 0 | 0 | 25,648 | 33,872 | 0 | 6,834 | 6,834 | 0 | 0 | 73,188 |
| 2005/238 | 0 | 0 | 0 | 0 | 0 | 41,671 | 0 | 0 | 0 | 0 | 0 | 0 | 41,671 |
| 2006/008 | 0 | 0 | 0 | 0 | 0 | 0 | 54,827 | 48,191 | 25,483 | 16,063 | 16,063 | 0 | 160,627 |
| 2006/024 | 0 | 0 | 0 | 0 | 0 | 0 | 117,993 | 123,147 | 88,522 | 82,416 | 0 | 0 | 412,078 |
| 2006/036 | 0 | 0 | 0 | 0 | 0 | 0 | 103,510 | 68,307 | 49,727 | 42,693 | 27,693 | 0 | 291,930 |
| 2006/057 | 0 | 0 | 0 | 0 | 0 | 19,765 | 37,740 | 19,056 | 0 | 0 | 0 | 0 | 76,561 |
| 2007/010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33,210 | 72,510 | 27,120 | 33,210 | 0 | 166,050 |
| 2007/013 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 129,169 | 0 | 16,146 | 16,146 | 0 | 161,461 |
| 2007/014 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 51,454 | 88,544 | 35,000 | 0 | 174,998 |
| 2007/016 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 95,710 | 73,103 | 23,028 | 0 | 0 | 191,841 |
| 2007/017 | 0 | 0 | 0 | 0 | 0 | 0 | 51,602 | 0 | 35,910 | 144,696 | 0 | 25,801 | 258,009 |
| 2007/018 | 0 | 0 | 0 | 0 | 0 | 0 | 160,346 | 80,674 | 220,084 | 247,047 | 85,173 | 0 | 793,324 |
| 2007/048 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 85,195 | 43,267 | 70,034 | 22,055 | 0 | 220,551 |
| 2007/055 | 0 | 0 | 0 | 0 | 0 | 0 | 8,200 | 0 | 0 | 0 | 0 | 0 | 8,200 |
| 2007/061 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30,000 | 0 | 0 | 0 | 0 | 30,000 |
| 2007/064 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 44,203 | 26,669 | 0 | 0 | 70,872 |
| 2007/066 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21,000 | 49,000 | 0 | 0 | 0 | 70,000 |
| 2008/064 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 68,718 | 17,179 | 0 | 0 | 85,897 |
| 2008/075 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23,405 | 15,604 | 0 | 0 | 39,009 |
| 2008/097 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22,500 | 45,000 | 7,500 | 0 | 75,000 |
| 2008/215 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 46,900 | 11,100 | 0 | 0 | 58,000 |
| 2009/031 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 59,499 | 0 | 0 | 59,499 |
| Total | 31,539 | 193,218 | 1,117,985 | 1,961,774 | 1,761,722 | 1,835,501 | 1,902,240 | 1,308,771 | 1,199,427 | 1,219,530 | 402,840 | 25,801 | 12,960,348 |

Source: FRDC Project Management Database

Table 4: Investment by Researchers and Others by Project for Years Ending June 2001 to June 2011

(nominal $)

| **Project** | **2001** | **2002** | **2003** | **2004** | **05** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **Total** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2000/123 | 238,428 | 245,661 | 248,654 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 732,743 |
| 2001/042 | 103,048 | 130,632 | 48,535 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 282,215 |
| 2001/074 | 0 | 202,565 | 164,533 | 153,736 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 520,834 |
| 2001/076 | 0 | 38,998 | 124,068 | 38,045 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 201,111 |
| 2002/014 | 0 | 0 | 93,392 | 91,510 | 108,112 | 0 | 84,965 | 0 | 0 | 0 | 0 | 377,980 |
| 2002/056 | 0 | 0 | 196,592 | 217,742 | 218,032 | 0 | 0 | 0 | 0 | 0 | 0 | 632,366 |
| 2002/057 | 0 | 0 | 223,148 | 241,846 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 464,994 |
| 2002/059 | 0 | 0 | 165,439 | 170,963 | 173,839 | 0 | 0 | 0 | 0 | 0 | 0 | 510,241 |
| 2002/072 | 0 | 0 | 17,600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17,600 |
| 2002/083 | 0 | 0 | 178,100 | 219,947 | 79,595 | 0 | 0 | 0 | 0 | 0 | 0 | 468,642 |
| 2003/017 | 0 | 0 | 0 | 169,648 | 76,776 | 14,475 | 28,989 | 0 | 0 | 0 | 0 | 289,888 |
| 2003/044 | 0 | 0 | 0 | 409,076 | 244,218 | 194,156 | 0 | 0 | 0 | 0 | 0 | 847,450 |
| 2003/047 | 0 | 0 | 0 | 180,375 | 220,372 | 79,318 | 0 | 0 | 0 | 0 | 0 | 480,065 |
| 2003/052 | 0 | 0 | 0 | 277,695 | 283,705 | 109,205 | 0 | 0 | 0 | 0 | 0 | 670,605 |
| 2003/222 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2003/223 | 0 | 0 | 0 | 5,714 | 12,268 | 3,617 | 0 | 5,400 | 0 | 0 | 0 | 27,000 |
| 2004/006 | 0 | 0 | 0 | 0 | 84,717 | 87,384 | 87,229 | 0 | 0 | 0 | 0 | 259,330 |
| 2004/008 | 0 | 0 | 0 | 32,502 | 0 | 97,505 | 32,502 | 0 | 0 | 0 | 0 | 162,508 |
| 2004/019 | 0 | 0 | 0 | 0 | 254,626 | 300,541 | 218,111 | 0 | 0 | 0 | 0 | 773,278 |
| 2004/020 | 0 | 0 | 0 | 0 | 55,000 | 0 | 0 | 0 | 0 | 0 | 0 | 55,000 |
| 2004/096 | 0 | 0 | 0 | 0 | 139,246 | 113,198 | 30,693 | 0 | 0 | 0 | 0 | 283,137 |
| 2004/101 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2005/004 | 0 | 0 | 0 | 0 | 0 | 41,645 | 50,654 | 0 | 0 | 0 | 0 | 92,300 |
| 2005/011 | 0 | 0 | 0 | 0 | 0 | 129,625 | 196,904 | 178,722 | 0 | 0 | 0 | 505,251 |
| 2005/031 | 0 | 0 | 0 | 0 | 0 | 271,137 | 278,384 | 292,452 | 0 | 0 | 0 | 841,973 |
| 2005/035 | 0 | 0 | 0 | 0 | 0 | 68,000 | 68,000 | 0 | 0 | 0 | 0 | 136,000 |
| 2005/038 | 0 | 0 | 0 | 0 | 0 | 83,742 | 81,254 | 0 | 0 | 0 | 0 | 164,996 |
| 2005/044 | 0 | 0 | 0 | 0 | 0 | 158,487 | 158,487 | 158,287 | 0 | 0 | 0 | 475,261 |
| 2005/047 | 0 | 0 | 0 | 0 | 0 | 21,000 | 89,488 | 0 | 0 | 0 | 0 | 110,488 |
| 2005/238 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2006/008 | 0 | 0 | 0 | 0 | 0 | 0 | 90,681 | 105,987 | 0 | 0 | 0 | 196,668 |
| 2006/024 | 0 | 0 | 0 | 0 | 0 | 0 | 18,000 | 272,581 | 66,103 | 0 | 0 | 356,684 |
| 2006/036 | 0 | 0 | 0 | 0 | 0 | 0 | 82,237 | 154,670 | 31,530 | 0 | 0 | 268,437 |
| 2006/057 | 0 | 0 | 0 | 0 | 0 | 0 | 62,080 | 25,560 | 0 | 0 | 0 | 82,640 |
| 2007/010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 63,000 | 80,000 | 0 | 0 | 143,000 |
| 2007/013 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10,000 | 0 | 0 | 0 | 171,461 |
| 2007/014 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60,580 | 76,323 | 0 | 311,901 |
| 2007/016 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 47,600 | 0 | 0 | 0 | 47,600 |
| 2007/017 | 0 | 0 | 0 | 0 | 0 | 0 | 77,325 | 168,333 | 85,356 | 0 | 0 | 331,014 |
| 2007/018 | 0 | 0 | 0 | 0 | 0 | 0 | 44,058 | 137,604 | 149,523 | 64,696 | 0 | 395,881 |
| 2007/048 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 210,049 | 119,014 | 0 | 0 | 329,064 |
| 2007/055 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2007/061 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2007/064 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 83,489 | 48,165 | 0 | 0 | 131,654 |
| 2007/066 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 299,757 | 0 | 0 | 0 | 299,757 |
| 2008/064 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42,000 | 0 | 0 | 42,000 |
| 2008/075 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 35,372 | 0 | 0 | 35,372 |
| 2008/097 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100,000 | 100,000 | 0 | 200,000 |
| 2008/215 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30,750 | 0 | 0 | 30,750 |
| 2009/031 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 83,469 | 0 | 83,469 |
| Total | 471,890 | 830,244 | 1,935,050 | 2,796,614 | 2,419,033 | 2,124,654 | 2,273,741 | 2,521,022 | 905,283 | 348,622 | 0 | 13,665,904 |

Source: FRDC project management database

Table 5: Annual Investment in Cluster (nominal $)

|  |  |  |  |
| --- | --- | --- | --- |
| **Year ending June** | **FRDC** | **Researchers and Others** | **Total** |
| 2001 | 31,539 | 341,476 | 373,015 |
| 2002 | 193,218 | 617,856 | 811,074 |
| 2003 | 1,117,985 | 1,478,759 | 2,596,744 |
| 2004 | 1,961,774 | 2,190,101 | 4,151,875 |
| 2005 | 1,761,722 | 1,941,506 | 3,703,228 |
| 2006 | 1,835,501 | 1,773,035 | 3,608,536 |
| 2007 | 1,902,240 | 1,936,799 | 3,839,039 |
| 2008 | 1,308,771 | 2,244,241 | 3,553,012 |
| 2009 | 1,199,427 | 817,643 | 2,017,070 |
| 2010 | 1,219,530 | 324,488 | 1,544,018 |
| 2011 | 402,840 | 0 | 402,840 |
| 2012 | 25,801 | 0 | 25,801 |
| **Total** | 12,960,348 | 13,665,904 | 26,626,252 |

**Benefits**

The various projects undertaken in this cluster have helped to generate a number of potential and actual economic, environmental and social benefits. Table 6 summarises the major benefits and potential benefits by category delivered by each of the projects.

Table 6: Projects and Benefit Categories

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Project code | Project Title | 1.Wild catch Fisheries: Improvement in sustainability for a specific fishery | 2.Wild catch Fisheries: Improvement in sustainability  (General)  (Includes recreational fisheries) | 3.Wild catch Fisheries: Increase in net profit via catch rate, cost reduction, or increased price through exporting | 4.Wild catch Fisheries: Avoided loss of access via image improvement | 5.Aquaculture: improvement or avoided loss in resource access | 6.Research resource allocation  improvements | 7.Industry /scientific capacity and governance |
| 2000/123 | Risk analysis and sustainability of the southern rock lobster (Jasus edwardsii) resources in SA |  |  |  |  |  |  | ✓ |
| 2001/042 | Development of the tools for long term management of the giant crab resource: data collection methodology, stock assessment and harvest strategy evaluation | ✓ |  | ✓ |  |  |  |  |
| 2001/074 | Linking fishery-dependent and fishery-independent assessments of abalone fisheries |  |  |  |  |  |  | ✓ |
| 2001/076 | Assessing survey methods for greenlip abalone in South Australia | ✓ |  |  |  |  |  |  |
| 2002/014 | Developing a new method of evaluating catch rates of spatially mobile and aggregating prawn resources | ✓ |  |  |  |  |  |  |
| 2002/056 | Innovative stock assessment and effort mapping using VMS and electronic logbooks | ✓ |  |  |  |  |  |  |
| 2002/057 | Sustainability of small-scale, data-poor commercial fisheries: developing assessments, performance indicators and monitoring strategies for temperate reef species | ✓ |  |  |  |  |  |  |
| 2002/059 | Developing fishery-independent surveys for the adaptive management of NSW’s estuarine fisheries | ✓ |  |  |  |  |  |  |
| 2002/072 | Assessing the feasibility of an industry-based fishery-independent survey of the SEF | ✓ |  |  |  |  |  |  |
| 2002/083 | Towards an industry-based abalone fishery monitoring program | ✓ |  |  |  |  |  |  |
| 2003/017 | Juvenile scallop trashing rates and bed dynamics: testing the management rules for scallops in Bass Strait | ✓ |  |  |  |  |  |  |
| 2003/044 | Development of a sustainable industry-based observation system for blue grenadier at the primary spawning sites | ✓ |  |  |  |  |  |  |
| 2003/047 | Evaluation of methods of obtaining annual catch estimates for individual Victorian bay and inlet recreational fisheries |  | ✓ |  |  |  |  |  |
| 2003/052 | Spatial scales of exploitation among populations of demersal scalefish: implications for wetline management | ✓ |  |  |  |  |  |  |
| 2003/222 | Innovative Solutions for Aquaculture: spatial impacts and carrying capacity - further developing, refining and validating existing models of environmental effects of finfish farming |  |  |  |  | ✓ |  |  |
| 2003/223 | Innovative solutions for aquaculture planning and management – Project 5, Environmental audit of marine aquaculture developments in South Australia |  |  |  |  | ✓ |  |  |
| 2004/006 | ESD Reporting and Assessment Subprogram: strategic planning, project management and adoption |  | ✓ |  |  |  |  |  |
| 2004/008 | Improving demonstrated environmental accountability in the Northern Territory fishing industry |  |  |  | ✓ |  |  |  |
| 2004/019 | Towards optimising the spatial scale of abalone fishery management | ✓ |  |  |  |  |  |  |
| 2004/020 | Validation and extension of acoustic reef habitat mapping methodologies in the western abalone zone, Victoria | ✓ |  |  |  |  |  |  |
| 2004/096 | The development and production of EMS template documents for the salmonid, oyster and abalone aquaculture sectors in Tasmania |  |  |  |  | ✓ |  |  |
| 2004/101 | ESD Reporting and Assessment Subprogram: review of the scope, assessment methods and management responses for fisheries ESD and EBFM in Australia |  | ✓ | ✓ | ✓ |  |  |  |
| 2005/004 | Determination of effective longline effort in the Eastern Tuna and Billfish Fishery | ✓ |  |  |  |  |  |  |
| 2005/011 | Development of Field Implemented Fillet Identification (FIFI) for coral reef fin fish |  |  |  |  |  |  | ✓ |
| 2005/031 | Establishing ecosystem-based management for the South Australian sardine fishery: developing ecological performance indicators and reference points to assess the need for ecological allocations |  |  |  | ✓ |  |  | ✓ |
| 2005/035 | The development, adoption and evaluation of environmental management systems in Western Australian commercial fisheries | ✓ |  |  | ✓ | ✓ |  |  |
| 2005/038 | Space-time analysis of western king prawns, brown tiger prawns and saucer scallops in Shark Bay for improved fisheries management | ✓ |  |  |  |  |  |  |
| 2005/044 | Development of the scientific requirements of an Environmental Management System (EMS) for the pearling (Pinctada maxima) industry |  |  |  |  | ✓ |  |  |
| 2005/047 | Utilisation of GIS spatial statistical methods to assist in the development of ecosystem based fishery management strategies using the Northern Territory demersal and Timor Reef fisheries as case studies | ✓ |  |  |  |  |  |  |
| 2005/238 | ASIC/NAC environmental labelling |  | ✓ |  | ✓ | ✓ |  |  |
| 2006/008 | Assessing data poor resources: developing a management strategy for byproduct species in the Northern Prawn Fishery | ✓ |  | ✓ |  |  |  |  |
| 2006/024 | Harvest strategy evaluation to optimise the sustainability and value of the Queensland scallop fishery |  |  |  |  |  |  | ✓ |
| 2006/036 | Supporting sustainable fishery development in the GAB with interpreted multi-scale seabed maps based on fishing industry knowledge and scientific survey data | ✓ |  |  |  |  |  |  |
| 2006/057 | Development of a national environmental management and accreditation system for business/public recreational fishing competitions |  | ✓ |  | ✓ |  |  |  |
| 2007/010 | Integration of socio economic sustainability criteria into a reporting framework for the Australian aquaculture industry |  |  |  |  | ✓ |  |  |
| 2007/013 | A comprehensive ESD analysis of a fishery: the incorporation of regulatory, ecological, economic and sociological aspects |  | ✓ |  |  |  |  |  |
| 2007/014 | Developing innovative and cost-effective tools for monitoring recreational fishing in Commonwealth fisheries |  | ✓ |  |  |  |  |  |
| 2007/016 | Development of national guidelines to improve the application of risk-based methods in the scope, implementation and interpretation of stock assessments for data-poor species |  | ✓ |  |  |  |  |  |
| 2007/017 | Integrated evaluation of management strategies for tropical multi-species long-line fisheries | ✓ |  |  |  |  |  |  |
| 2007/018 | Developing techniques to estimate total allowable catches for the NPF major prawn species | ✓ |  | ✓ |  |  |  |  |
| 2007/048 | Towards evaluating the socio-economic impacts of changes to Queensland’s inshore fishery management | ✓ |  |  |  |  |  | ✓ |
| 2007/055 | Independent environmental certification for Australia's Northern Prawn fishery marine stewardship council pre-assessment | ✓ |  | ✓ | ✓ |  |  |  |
| 2007/061 | The progression of abalone fishery performance indicators | ✓ |  |  |  |  | ✓ |  |
| 2007/064 | Tactical Research Fund: Developing an analytical module for large-scale recreational fishery data based on phone/diary survey methodology |  | ✓ |  |  |  |  |  |
| 2007/066 | Tactical Research Fund: Rapid response to abalone virus depletion in western Victoria: information acquisition and reefcode assessment models | ✓ |  |  |  |  |  |  |
| 2008/064 | Tactical Research Fund: Management Strategy Evaluation (MSE) of the harvest strategy for the Small Pelagic Fishery | ✓ |  |  |  |  |  |  |
| 2008/075 | Tactical research fund: Industry based size-monitoring and data collection program for albacore tuna in the ETBF | ✓ |  | ✓ |  |  |  |  |
| 2008/097 | Tactical Research Fund: Developing the use of existing technology in cost-effective and reliable Industry-based structured fishing surveys to urgently replace more costly methods and advise finer-scale management of abalone populations | ✓ |  | ✓ |  |  |  |  |
| 2008/215 | Tactical Response Fund: Implementation of the NEATFish environmental standard for recreational fishing tournaments |  | ✓ |  | ✓ |  |  |  |
| 2009/031 | Taking female mud crabs (Scylla serrata): assessment of risks and benefits |  |  |  |  |  |  | ✓ |
|  | Total | 28 | 10 | 7 | 8 | 7 | 1 | 7 |

**Summary of Benefits**

Table 7 provides a triple bottom line framework summary of the principal types of benefits associated with the outcomes of the investment.

Table 7: Summary of Benefits in a Triple Bottom Line Framework

|  |  |  |
| --- | --- | --- |
| **Industry** | **Environmental** | **Social** |
| 1. Increased sustainability of the wild catch fishing resource 2. Increased access to resources (or avoided reduced access) by both wild catch and the aquaculture industry 3. Reduced costs and or increased incomes 4. Improved research resource allocation 5. Increased industry/scientific capacity | 1. Maintenance or improvement in ecosystems and/or reduced biodiversity decline 2. Improved natural resource management by aquaculture industries | 1. Improved research resource allocation/public policy and governance 2. Increased scientific capacity |

The benefits identified above (1 to 9) have been classified into beneficiary categories and a subjective estimate of their magnitude is presented in Table 8.

Table 8: Magnitude of Beneficiary Types

|  |  |  |
| --- | --- | --- |
| **Fishing industry** | **Other industries** | **Public** |
| 1. \*\*\*  2. \*\*  3. \*  4. \*  5. \* |  | 6. \*\*\*  7. \*  8. \*  9. \* |

\*\*\* Major contribution \*\* Some contribution \* Minor contribution

**Public versus Private Benefits**

The investment will result in both public and private benefits. On the basis of the nine benefits as listed in Table 7, and equal weighting for each benefit, it could be concluded that public benefits to Australia could make up 44% of the total Australian benefits. If the subjective weightings are taken into account (Table 8), the public benefits would still make up 43% of the total Australian benefits.

**Distribution of Benefits Along the Supply Chain**

The majority of private benefits and any added costs from improved sustainability of wild catch fisheries and aquaculture sustainability could be captured initially by fishers but some projects may deliver initial benefits further down the supply chain (e,g. environmental branding). However, all costs and benefits will most likely ultimately be shared along the supply chains, including seafood consumers.

**Benefits to Other Industries**

It is likely that most industry benefits will be confined to the seafood industry, including recreational fishers and consumers.

**Benefits Overseas**

It is likely that there may be only some small spillover benefits to overseas interests, mainly in the form of scientific information and methods.

**Additionality and Marginality**

The investment in the projects in this cluster has been categorised as of high priority. FRDC contributed 47% of total funding for the whole cluster but this varied considerably between individual projects.

If FRDC had not received funding from government, some of these investments would probably still have been supported by FRDC. Some investments may have been funded from other sources if FRDC had not contributed. Further detail is provided in Table 9.

Table 9: Potential Response to Reduced Public Funding to FRDC

|  |  |
| --- | --- |
| What priority were the projects in this cluster when funded? | High |
| Would FRDC have funded this cluster if only half of public funding of FRDC had been available? | Yes, but with a lesser total investment (<50%) of actual total investment. |
| Would the cluster have been funded if no public funding for FRDC had been available? | Yes, but with a lesser total investment (<25%) of actual total investment |

**Match with National Priorities**

The Australian Government’s National and Rural R&D priorities are reproduced in Table 10

Table 10: National and Rural R&D Priorities

|  |  |
| --- | --- |
| **Australian Government** | |
| **National Research Priorities** | **Rural Research Priorities** |
| 1. An environmentally sustainable Australia  2. Promoting and maintaining good health  3. Frontier technologies for building and transforming Australian industries  4. Safeguarding Australia | 1. Productivity and adding value  2. Supply chain and markets  3. Natural resource management  4.Climate variability and climate change  5. Biosecurity  *Supporting the priorities:*  Innovation skills  Technology |

The cluster projects contribute directly to National Research Priorities 1 and 3. The cluster investment was strongly associated with Rural Research Priorities 1, 3, and to a lesser extent 5, and indirectly to Rural Research Priority 2. The cluster projects contributed to both supporting priorities.

**Quantification of Benefits**

**Benefits Valued**

Four benefits were valued. The first benefit valued is the increased economic sustainability of the various wild catch fisheries addressed by the projects compared to the situation where the projects were not funded. In relation to Table 7, this is the first benefit that covers the economic sustainability contributions made by the relevant 28 projects to specific wild catch fisheries (see Table 6). The general contributions to sustainability (10 projects n Table 6) are assumed to apply to the specific 28 fisheries but any contributions from these general projects to fisheries external to the 28 are not valued.

The second benefit valued is the reduction in the risk of biodiversity decline in species and ecosystems due to the improved fisheries management. This benefit refers to the sixth benefit listed in Table 7.

The third benefit valued is associated with benefits 2 and 7 in Table 7, avoidance of reduced access to the resources and improved natural resource management associated with aquaculture industries.

The fourth benefit valued was from wild catch focused projects that would have assisted continued access to marine resources (benefit 2 in Table 7).

Benefits identified in Table 7 but not valued included some cost reductions associated with improved assessment methods and some net income increases for fishers due to potentially higher prices from some seafood due to increased export opportunities. The cost reductions due to new assessment methods could have been partly offset by assessment cost increases in other projects. The extent of increased exports that may have been stimulated by a few projects is assumed to be only minor. Another benefit not valued was improved research resource allocation in R&D but this benefit was strongly related only to one project. The industry/scientific capacity benefits listed in Table 7 were not valued due to valuation difficulties.

**Benefit 1: Increased Sustainability of Wild Catch Fisheries**

This benefit is valued by assuming a shift in the sustainability status of each fishery affected by the improved stock assessment methods and management improvements developed within a range of projects.

*Status Probabilities*

An assessment is made of the state of each fishery before the project finished. This assessment included the probabilities that the fishery will remain sustainable or become unsustainable. The estimates are based on the status assessments recently published in FRDC (2012a).

Given the contribution from the projects as indicated by their outcomes and benefits, the probabilities of each future state of each fishery are reassessed.

The estimates of the state probabilities with and without the research investment are shown in Table 11. Although the probability estimates are made independently for each fishery, many of the probability estimates are the same due to lack of knowledge of each fishery. Three groups are identified: those where considerable confidence is available as to their sustainability (0.80 probability of sustainable state/0.20 probability of an unsustainable state); those where some doubt has been expressed in the FRDC status report (0.40/0.60), and those that may lie somewhere in between (0.60/0.40).

Table 11: Assumptions for Sustainability State Probabilities of Fisheries With and Without the Investments

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Fishery** | **Without Investment** | | **With Investment** | |
| Sust. State | Unsust. State | Sust. State | Unsust. State |
| Giant Crab (WA, SA, Vic, TAS) | 0.80 | 0.20 | 0.85 | 0.15 |
| Abalone (TAS) | 0.60 | 0.40 | 0.65 | 0.35 |
| Abalone (SA) | 0.60 | 0.40 | 0.65 | 0.35 |
| Northern Prawn (COMM) | 0.80 | 0.20 | 0.85 | 0.15 |
| Qld Trawl (QLD) | 0.80 | 0.20 | 0.85 | 0.15 |
| Temperate Reef (TAS) | 0.60 | 0.40 | 0.65 | 0.35 |
| NSW Estuarine (NSW) | 0.80 | 0.20 | 0.85 | 0.15 |
| South East (COMM) (a) | 0.40 | 0.60 | 0.45 | 0.55 |
| Abalone (VIC) | 0.60 | 0.40 | 0.65 | 0.35 |
| Bass Strait Scallops (COMM) | 0.60 | 0.40 | 0.65 | 0.35 |
| Blue Grenadier (TAS) | 0.80 | 0.20 | 0.85 | 0.15 |
| Demersal Scalefish (WA) (b) | 0.40 | 0.60 | 0.45 | 0.55 |
| Eastern Tuna and Billfish (COMM) (c) | 0.40 | 0.60 | 0.45 | 0.55 |
| Coral Reef (QLD) | 0.80 | 0.20 | 0.85 | 0.15 |
| Sardine (SA) | 0.80 | 0.20 | 0.85 | 0.15 |
| South Coast Estuarine Fishery (WA) | 0.80 | 0.20 | 0.85 | 0.15 |
| Shark Bay (WA) | 0.80 | 0.20 | 0.85 | 0.15 |
| Timor Reef (NT) | 0.80 | 0.20 | 0.85 | 0.15 |
| Qld Inshore (QLD) | 0.60 | 0.40 | 0.65 | 0.35 |
| Abalone (SA, VIC, TAS, NSW) | 0.60 | 0.40 | 0.65 | 0.35 |
| Small Pelagic (COMM) | 0.80 | 0.20 | 0.85 | 0.15 |
| Abalone (NSW) | 0.60 | 0.40 | 0.65 | 0.35 |
| Mud Crab (QLD) | 0.80 | 0.20 | 0.85 | 0.15 |

1. School Shark issue
2. Pink Snapper issue
3. Southern Bluefin Tuna issue

*Fishery Value*

An estimate was made of the latest readily available gross value of each commercial fishery (Table 12); these commercial catch values were compiled from various sources. The total value of $668.4m is just over half of the total value of Australian wild catch fisheries.

Table 12: Gross Values for 22 Commercial Fisheries Affected ($m)

|  |  |  |
| --- | --- | --- |
| **Fishery** | **Commercial ($m)** | **Source** |
| Giant Crab (WA, SA, Vic , TAS) | 4.0 | (b) |
| Abalone (TAS) | 97.1 | (a) |
| Abalone (SA) | 28.0 | (a) |
| Northern Prawn (COMM) | 93.8 | (a) |
| Qld Trawl (QLD) | 55.8 | (a) |
| Temperate Reef (TAS) | 1.6 | (a) |
| NSW Estuarine (NSW) | 19.5 | (b) |
| South East (COMM) | 59.7 | (a) |
| Abalone (VIC) | 23.9 | (a) |
| Bass Strait Scallops (COMM) | 2.9 | (a) |
| Blue Grenadier (TAS) | 0.5 | (b) |
| Demersal Scalefish (WA) | 3.3 | (b) |
| Eastern Tuna and Billfish (COMM) | 30.9 | (a) |
| Coral Reef (QLD) | 32.6 | (a) |
| Sardine (SA) | 19.3 | (a) |
| South Coast Estuarine Fishery (WA) | 2.0 | (a) |
| Shark Bay (WA) | 28.0 | (b) |
| Timor Reef (NT) | 4.2 | (a) |
| Qld Inshore (QLD) | 28.0 | (d) |
| Small Pelagic (COMM) | 19.8 | (c) |
| Abalone (NSW) | 2.83 | (a) |
| Mud Crab (QLD) | 29.4 | (a) |

Sources: (a) ABARES (2012); (b) Various sources; (c) DAFF (2010); (d) QLD Govt (undated)

*Timing and Extent of Impact of Collapse*

Various assumptions were necessary regarding the extent and timing of impact and potential recovery if a fishery became unsustainable and fishing investment was withdrawn for stock recovery purposes to benefit the fishery both from an economic viewpoint as well as for biodiversity and ecosystem protection.

The year in which the first impact from the research investment would occur is assumed. This was assumed as two years after the research project was completed. This is the year when the probability status was assumed to change. Where two or more projects contributed to the sustainability of a fishery, the status change year was assumed to be after the later project.

In the event of a fishery collapse, the first year of the collapse is estimated as is the number of years it takes for the fishery to totally collapse (e.g. 2006 and 4 years to total collapse). The extent of total collapse (e.g. 50% of the original value of the fishery) is estimated. Other assumptions required were the number of years the fishery will remain in the collapsed state after which recovery commences. The number of years to recovery is estimated. Once recovery is complete, the fishery may not return to its original state and the percentage of the original fishery value after recovery is estimated. As the catch declines, the percentage of the displaced catch input resources that can be utilised in other fisheries activities is estimated. Assumptions are provided in Table 13.

Table 13: Assumptions for Timing and Extent of Impact of Fishery Collapse

|  |  |
| --- | --- |
| **Fishery** | **Assumption** |
| Year collapse commences (a) | 2010 |
| Period from year of first to final collapse (years) | 4 |
| Extent of commercial value in final collapse state (% original catch ) | 50 |
| Length of final collapse period (years) | 4 |
| Period of recovery (years) | 5 |
| Input Resources re-deployed (% original catch inputs) | 50 |
| Final recovery value (% original) | 80 |

1. As most projects were completed in the years ended June 2006 to 2010, a typical collapse year 2 years after the end of each project would have been 2010.

*Cash flow*

For each fishery, the expected gross income stream of commercial fishing for each of the two scenarios (sustainable and unsustainable) without the research investment was estimated. The value for the expected gross income stream was estimated by applying the probabilities for each scenario (Table 11) producing two expected income stream without the research, and the two income streams added.

The income streams for each sustainability scenario (sustainable and unsustainable) was then estimated also for the “with research” situation and the two income streams added. The expected gain in each year was estimated by subtracting the “without research income stream” from the “with research income stream”.

**Benefit 2: Reduced Risk of Biodiversity Decline**

This benefit is the greater security of species biodiversity due to a reduced probability of the status of some species declining in some ecosystems. This impact is valued as a decreased probability (20% to 15%) of a decline to extinction occurring for 10 marine species in Australian marine areas. This decreased risk is valued through a willingness to pay estimate by Australian households per species of $0.89 per species per annum (van Bueren and Bennett, 2004; Lai, 2011). This impact is assumed to commence in 2011.

**Benefit 3: Avoidance of Reduced Access to Marine Resources for Aquaculture Industries**

Seven projects were assessed as contributing to this benefit. The benefit valued relates to the contribution of projects to retaining access to marine resources, and therefore allowing expansion, or avoiding contraction, of aquaculture industries. This benefit was estimated for two aquaculture industries.

***Yellowtail Kingfish industry***

Without the research investment in this cluster, it is possible the size of the Yellowtail Kingfish industry could have been capped either artificially low or high, due to the absence of appropriate scientific data and reasoning. Projects 2003/222 and 2003/223 contributed knowledge relevant to improved management. If the size of the industry was restricted due to being too cautious, there would be significant lost income to Australia; if the industry was allowed to grow too large, there would be environmental, as well as long-term industry impacts due to poor water quality.

For the purposes of this analysis, it is assumed that the decision would have been made to expand the industry to a greater extent than otherwise due to the demonstration of sustainability supported by modelling. It is assumed that the current gross value of the industry is $25 m per annum and that 10% of this value was influenced by the projects. The added value gained due to the investment is assumed equal to 15% of the gross value influenced by the projects. The projects were attributed only 50% of the added production and value, as other initiatives were assumed to contribute to the expansion.

***Pearl industry***

Also, projects supporting EMS and risk assessment allowed appropriate decisions to be made regarding the sustainable level of expansion of aquaculture. The projects (2005/035, 2005/044 and 2007/010) are assumed to have provided some benefits to the pearl industry in Western Australia. Without the research, it is possible the size of the industry could have been capped artificially low due to community and government concerns regarding the potential impact of the industry on the marine environment. If the size of the industry was kept too small, there would be significant lost income.

Currently, the pearl farming industry in WA is valued at approximately $119 million per annum. The assumptions required to estimate the value of the contribution of the projects were the potential loss of gross value from restricted access, the associated profit at risk and an attribution to the specific projects. All of these assumptions are provided in Table 14.

**Benefit 4: Avoidance of Reduced Access to Marine Resources from Wild Catch Fisheries**

There were at least eight wild catch focused projects that would have assisted continued access to marine resources. Some of these project were associated with ESD and EMS, and others associated with certification and environmental labelling. The total value of wild catch fisheries in 2010/11 was $1.31 billion. It is assumed that 10% of this gross value has been exposed as at risk from loss of access and contraction of 5% in value. With profit estimated at 15 % of gross value, the benefit from avoiding this contraction would be $0.98m per annum. Table 14 provides further details.

**Summary of Assumptions**

A summary of the key assumptions made is shown in Table 14.

Table 14: Summary of Assumptions

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Assumption** | **Source** | |
| ***Benefit 1: Increased sustainability of wild catch fisheries*** | | | |
| Wild catch fisheries status improvements | Various | | See Table 11 |
| Gross values of wild catch fisheries | Various | | See Table 12 |
| Fishery collapse characteristics | Various | | See Table 13 |
| ***Benefit 2: Reduced risk of biodiversity decline*** | | | |
| Number of species assumed affected | 10 | | Agtrans Research |
| Probability of extinctions without improved management | 0.20 | | Agtrans Research |
| Probability of extinction with management improvement | 0.15 | | Agtrans Research |
| Willingness to pay per household to avoid one extinction | $0.89 per household per annum commencing in 2011 | | Derived from van Bueren and Bennett (2004) and Lai (2011) |
| Number of Australian households | 8.5 million in 2011 | | ABS (2012) |
| ***Benefit 3: Avoidance of reduced access to resource for aquaculture industries*** | | | |
| *Yellowtail Kingfish Industry* | | | |
| Estimate of current gross value of industry | $25 m | | Agtrans Research |
| Component partly due to FRDC projects | 10% | | Agtrans Research |
| Value of FRDC project component | $5 m per annum | | Agtrans Research |
| Proportion of value that is profit | 15% | | Agtrans Research |
| Year in which expansion component commenced | 2007/08 | |  |
| Attribution to projects | 50% | | Agtrans Research |
| *Cultured Pearl Industry* | | | |
| Value of industry | $99.1 m | | ABARES (2012) |
| Potential value at risk | 5% | | Agtrans Research |
| Profit foregone | 15% of loss of value | | Agtrans Research |
| Attribution to relevant projects | 10% | | Agtrans Research |
| Benefits to relevant projects | $0.07 m per annum | | 99.1\*5%\*15%\*10% |
| Years in which benefit applies | 2007/08 to 2013/14 | | Agtrans Research |
| ***Benefit 4: Avoidance of reduced access to wild catch fisheries*** | | | |
| Total gross value of wild catch | $1.31 billion | | ABARES (2012) |
| Proportion of gross value of wild catch potentially exposed to restricted access | 10% | | Agtrans Research |
| Contraction value avoided | 5% of gross value exposed | | Agtrans Research |
| Avoided loss of profit | 15% of contraction value | | Agtrans Research |
| Benefits to relevant projects | $1.31b x 10% x 5% x 15% | | Agtrans Research |
| Year in which benefit commences | 2010/2011 | | Agtrans Research |

**Results**

All past costs and benefits were expressed in 2013/14 dollar terms using the CPI. All benefits after 2013/14 were expressed in 2013/14 dollar terms. All costs and benefits were discounted to 2013/14 using a discount rate of 5%. The base run used the best estimates of each variable, notwithstanding a high level of uncertainty for many of the estimates. Investment criteria were estimated for both total investment and for the FRDC investment alone. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2010/11) to the final year of benefits assumed*.*

Tables 15 and 16 show the investment criteria for the different periods of benefits for both the total investment and the FRDC investment.

The analysis is based on total investment in the projects and associated benefits, not on the additional benefits due to the marginal investment by FRDC. The FRDC benefit is estimated from the total benefit by the proportion of total funding providing by FRDC.

Table 15: Investment Criteria for Total Investment

(discount rate 5%)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Investment Criteria** | **Years from last year of investment** | | | | | | |
| **0** | **5** | **10** | **15** | **20** | **25** | **30** |
| Present value of benefits ($m) | 28.68 | 84.27 | 114.60 | 135.06 | 151.10 | 163.67 | 173.51 |
| Present value of costs ($m) | 49.39 | 49.39 | 49.39 | 49.39 | 49.39 | 49.39 | 49.39 |
| Net present value ($m) | -20.71 | 34.88 | 65.21 | 85.68 | 101.72 | 114.28 | 124.13 |
| Benefit cost ratio | 0.58 | 1.71 | 2.32 | 2.73 | 3.06 | 3.31 | 3.51 |
| Internal rate of return (%) | negative | 12.3 | 15.0 | 15.8 | 16.2 | 16.3 | 16.4 |

Table 16: Investment Criteria for FRDC Investment

(discount rate 5%)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Investment Criteria** | **Years from last year of investment** | | | | | | |
| **0** | **5** | **10** | **15** | **20** | **25** | **30** |
| Present value of benefits ($m) | 13.81 | 40.59 | 55.20 | 65.06 | 72.78 | 78.84 | 83.58 |
| Present value of costs ($m) | 23.36 | 23.36 | 23.36 | 23.36 | 23.36 | 23.36 | 23.36 |
| Net present value ($m) | -9.54 | 17.23 | 31.84 | 41.70 | 49.43 | 55.48 | 60.22 |
| Benefit cost ratio | 0.59 | 1.74 | 2.36 | 2.79 | 3.12 | 3.38 | 3.58 |
| Internal rate of return (%) | negative | 13.0 | 15.7 | 16.5 | 16.8 | 17.0 | 17.0 |

The annual cash flow of undiscounted benefits is shown in Figure 1 for both the total investment and for the FRDC investment.

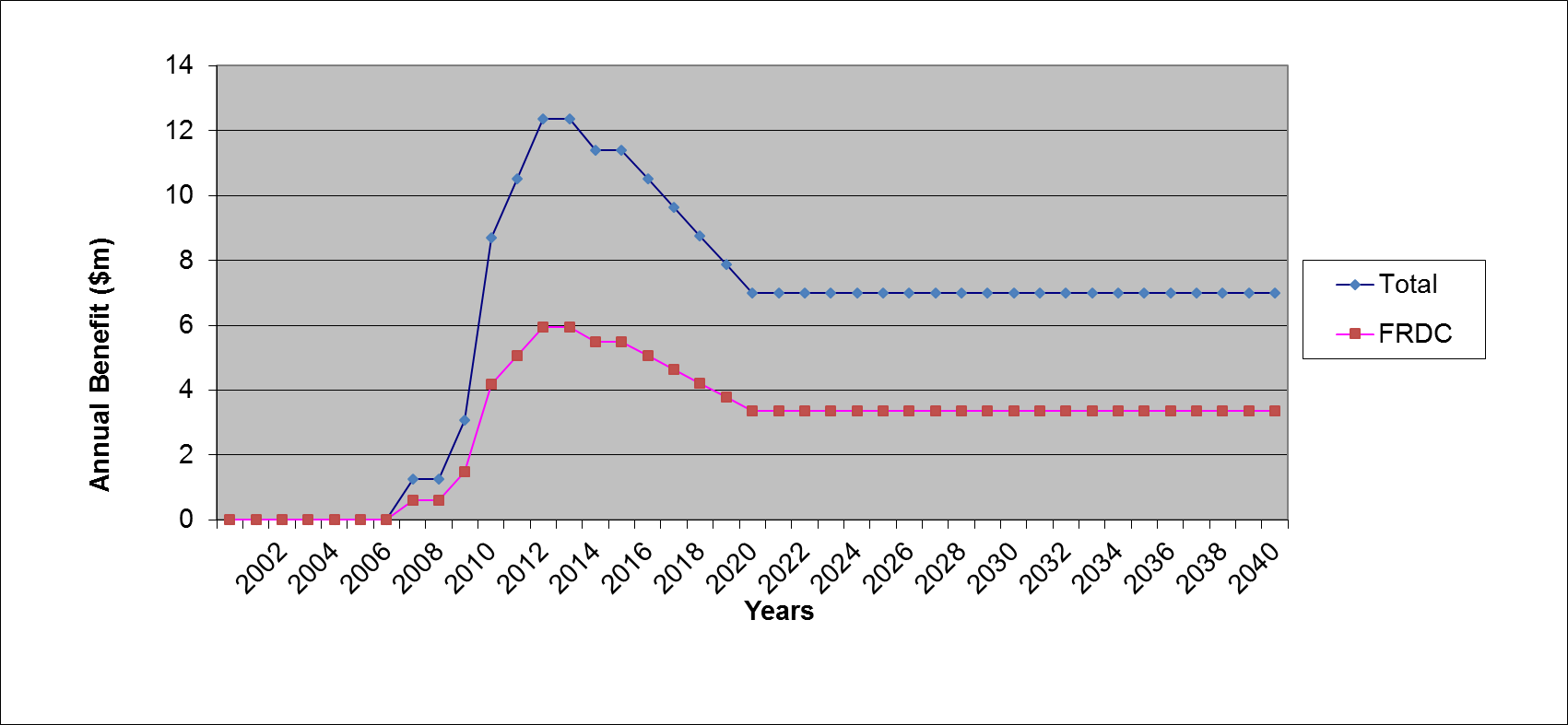


Figure 1: Annual Cash Flow of Benefits

The present value of benefits (PVB) from each source of benefits was estimated separately and then summed to provide an estimate of the total value of benefits. Table 17 shows the sources of benefits, expressed as the PVB and the percentage of total benefits.

Table 17: Source of Benefits (discount rate 5%, 30 year period)

|  |  |  |
| --- | --- | --- |
| **Benefit** | **PVB**  **($m)** | **% Total** |
| Increased Sustainability of Wild Catch Fisheries | 86.83 | 50.0 |
| Reduced Risk of Biodiversity Decline | 72.66 | 41.9 |
| Avoidance of Reduced Access to Marine Resources for Aquaculture Industries | 6.03 | 3.5 |
| Avoidance of Reduced Access to Marine Resources from Wild Catch Fisheries | 8.00 | 4.6 |
| Total | 173.51 | 100 |

Table 17 shows the economic benefit to fisheries and the reduced risk of biodiversity loss would each have covered the present value of total investment on their own.

Table 18 shows a subjective assessment of the different benefits against the rural research priorities. Bear in mind that this assessment refers only to those benefits that were valued.

Table 18: Benefits Valued and Rural Research Priorities

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Benefit** | **PVB**  **($m)** | **Productivity and Adding Value** | **Supply Chain and Markets** | **Natural Resource Management** | **Climate Variability and Climate Change** | **Biosecurity** |
| % subjective allocation to each priority | | | | |
| Increased Sustainability of Wild Catch Fisheries | 86.83 | 100 | 0 | 0 | 0 | 0 |
| Reduced Risk of Biodiversity Decline | 72.66 | 0 | 0 | 100 | 0 | 0 |
| Avoidance of Reduced Access to Marine Resources for Aquaculture Industries | 6.03 | 50 | 0 | 50 | 0 | 0 |
| Avoidance of Reduced Access to Marine Resources from Wild Catch Fisheries | 8.00 | 50 | 0 | 50 | 0 | 0 |
| Total ($m) | 173.51 | 93.84 | 0 | 79.67 | 0 | 0 |
| Total (%) | 100 | 54.1 | 0 | 45.9 | 0 | 0 |

**Sensitivity Analyses**

Sensitivity analyses were carried on some variables and the results for total investment are reported in Tables 19 and 20. All sensitivity analyses were performed with benefits taken over the life of the investment plus 30 years from the year of last investment. All other parameters were held at their base values.

The sensitivity analysis on the discount rate (Table 19) demonstrates that the investment criteria are not particularly sensitive to the discount rate over the range considered. This is because of the relatively short lag between the investment and accrual of benefits.

Table 19: Sensitivity to Discount Rate

(Total investment, 30 years)

|  |  |  |  |
| --- | --- | --- | --- |
| **Criterion** | **Discount Rate** | | |
| **0%** | **5%** | **10%** |
| Present value of benefits (m$) | 262.70 | 173.51 | 66.32 |
| Present value of costs (m$) | 33.01 | 49.39 | 34.09 |
| Net present value (m$) | 229.69 | 124.13 | 32.23 |
| Benefit cost ratio | 7.96 | 3.51 | 1.95 |

The sensitivities of the largest benefit (the economic benefit to fisheries) to the eventual recovery level (measured as a percentage of the existing gross value of the fishery) are provided in Table 20. As the recovery level assumed increases towards the value of the original fishery, the benefits logically decrease as the risk amelioration due to the improved management is held constant in this simple model.

Table 20: Sensitivity to Fishery Recovery Assumptions for the Economic Benefit from Improved Fishery Sustainability

(Total investment, 30 years)

|  |  |  |  |
| --- | --- | --- | --- |
| **Investment criteria** | **Recovery (% original fishery value)** | | |
| **60** | **80 (base)** | **100** |
| Present value of benefits (m$) | 120.23 | 86.83 | 53.42 |

**Confidence Rating**

The results produced are highly dependent on the assumptions made, many of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 21). The rating categories used are High, Medium and Low, where:

High: denotes a good coverage of benefits or reasonable confidence in the assumptions made

Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made

Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table 21: Confidence in Analysis of Management Cluster (Part C)

|  |  |
| --- | --- |
| **Coverage of Benefits** | **Confidence in Assumptions** |
| High | Medium |

**Observations for Future Investment and Evaluation**

1. The FRDC project management system was found valuable in being able to easily extract funding information by project by financial year across a range of individual R&D areas. However, an improvement would be if summary tables for each year by R&D area (e.g. by species in a time series) could be made available.

2. The proportion of total funding in this group of projects made by FRDC was 49%. This was well above the average percentage of 40% found for 18 clusters in 2009. This was not surprising due to the large public commitment to sustainable management of fisheries. The relevant percentages for each cluster are worth summarising as they may be important in assessing the FRDC current and prospective roles in different R&D areas and where public benefits are manifest but external funding may be difficult to attract. The percentage data may be useful also in developing changed leveraging targets for various themes and project groups.

3. While the ABARES statistics on production and value by species group and jurisdiction is extremely useful, one of the constraints faced by this analysis was finding data on the gross value of some fisheries and how this gross values may have varied year by year. It would be helpful if FRDC could facilitate improved summary data on the various fisheries such as annual gross values over time.

**Key Performance Indicators**

The four Theme 4 key performance indicators (KPI) are listed in Table 22.

Table 22: Key Performance Indicators for Theme 4

|  |  |  |
| --- | --- | --- |
| **KPI** | **Description** | **Number of projects contributing** |
| 1 | Development of mechanisms and technologies to collect economic, environmental and social data to inform management processes | 33 |
| 2 | Improvement of knowledge of the relationship between environmental processes and known biological processes | 4 |
| 3 | Development of techniques for incorporation of ecosystem based fisheries management in fisheries | 8 |
| 4 | Development of knowledge to help the industry to meet environmental standards | 13 |

Four of the 50 projects did not contribute to any of the KPIs as the projects did not produce any impacts except for building some scientific capacity. Of the 46 projects that did contribute, 33 contributed to KPI 1 and 13 to KPI 4. Some of the 46 projects contributed to more than one KPI.

**Conclusion**

Investment was made in a total of 50 projects within the cluster and FRDC contributed approximately 49% of the total nominal costs of investment.

Both industry and public benefits will be delivered by the investment. On the basis of the nine benefits as listed in Table 7, and equal weighting for each benefit, it could be concluded that public benefits to Australia could make up 44% of the total Australian benefits. If the subjective weightings are taken into account, the public benefits would still make up 43% of the total Australian benefits. On the basis of those benefits valued, the industry benefits contributed 54% of the total and the public benefits 46%.

Four impacts were valued from the investment in this group of projects. The two largest benefits in value terms were the industry economic benefits from improved sustainability of wild catch fisheries and the reduced risk of biodiversity decline; together these benefits contributed over 90% of the total benefits valued.

Four of the 50 projects were considered to be associated with no benefits except by building some industry or scientific capacity. One of these was highly innovative but its results could not be applied in a practical sense; another was innovative but required further investment that was not forthcoming. Two projects offered potential benefits to fisheries management but their findings were not adopted due to stakeholder considerations.

Overall, the investment criteria estimated for total investment in the project group of $49 million (present value of costs) were positive with a present value of benefits of $173 million, a net present value estimated at $124 million and a benefit-cost ratio of 3.5 to 1, all estimated using a discount rate of 5% (benefits estimated over 30 years from the final year of investment). A number of minor benefits identified were not valued, so the resulting investment criteria are likely to be a conservative estimate of total benefits.

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