**Economic Impact Assessment**

**Appendix 8:**

**An Economic Analysis of FRDC’s Investment in Theme 7: Profitability**

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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 8: An Economic Analysis of FRDC’s Investment in Theme 7: Profitability**

**Background**

The FRDC currently has five programs:

1. Environment

2. Industry

3. Communities

4. People development

5. Extension and adoption

Theme 7 is part of the FRDC’s Industry program, the main priorities of which are to promote the development of new and existing technologies, improve the productivity and profitability of existing industries while supporting the development of new ones, and to better understand and respond to domestic and international market and consumer requirements. Investment in the Profitability cluster aims to support the broad objective of Theme 7, which is to ‘increase the gross value of production, profit margins, productivity and opportunities throughout the fishing and aquaculture industry’ (FRDC, 2010).

Input costs, market prices, biomass levels, management arrangements and sustainability concerns all play a role in influencing profitability, both at an individual and sector level. This wide range of relevant factors means there is an ongoing need for research which targets key drivers of profitability, and identifies where investment may achieve the best outcomes in terms of improved profitability.

One key driver of profitability for wild-catch fishers is energy costs. This has led to great deal of interest in identifying ways to reduce the impact of rising fuel prices. Several projects worked to achieve this goal by identifying how energy usage could be monitored and improved, as well as investigating the possibility for the use of alternative fuels and propulsion systems.

Projects in this cluster targeted a wide variety of industry sectors, with some focussing on specific fisheries while others addressed broader issues relevant to the entire industry. Particular research areas included developing new techniques for value-adding waste products, assembling data for better-informed decision making, and developing methods for variable cost reduction.

**Summary of Projects**

There are 14 projects in the Profitability cluster. Table 1 gives a list of projects in the cluster and Table 2 provides a qualitative summary of each project.

Table 1: Projects Included in Theme 7: Profitability Cluster

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| **FRDC Project Number** | **Project Title** |
| 2002/250 | SEF Industry Development Subprogram: agricultural trials of a fish-based fertiliser (BioPhos) produced from Australian seafood processing wastes |
| 2003/206 | Antifouling solutions for the Australian pearling industry – coatings for shell and equipment |
| 2003/213 | Rock Lobster Enhancement and Aquaculture Subprogram: establishing post-pueruli growout data for Western Rock Lobsters to assess economic viability |
| 2005/217 | Rock Lobster Enhancement and Aquaculture Subprogram: the feasibility of translocating Rock Lobsters in Tasmania for increasing yield |
| 2005/239 | Fishing energy efficiency review for the FRDC |
| 2006/211 | Rock Lobster Post Harvest Subprogram: examination of green sustainable process technology for preparing chitin and associated derivatives from Rock Lobster waste |
| 2006/212 | Rock Lobster Post Harvest Subprogram: development of bait saving strategies for the Western Rock Lobster fishery |
| 2006/229 | Southern and Eastern Scalefish and Shark Fishery Industry Development Subprogram: development and implementation of an energy audit process for Australian fishing vessels |
| 2007/200 | SESSF Industry Development Subprogram: alternative fuels for fishing vessels |
| 2007/238 | Ornamental Fish Industry in Australia 2006/07 |
| 2007/241 | Feasibility study for the use of biofuel for the Western Rock Lobster industry |
| 2007/250 | Increased economic efficiency for the Western Rock Lobster Fishery through improved pot design |
| 2008/099 | Tactical Research Fund: Torres Strait Tropical Rock Lobster fishery 5 year business plan |
| 2009/221 | Tactical Research Fund: Improving the economic efficiency of the Southern Squid Jig Fishery |

Table 2: Description of the 14 Projects

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| **Project Number 2002/250: SEF Industry Development Subprogram: agricultural trials of a fish-based fertiliser (BioPhos) produced from Australian seafood processing wastes** | |
| Project details | Organisation: Department of Environment and Primary Industries Victoria  Period: January 2003 to September 2007  Principal Investigator: Aravind Surapaneni |
| Rationale | Disposal of fish waste is a problem of increasing concern to Australia’s seafood industry. Fish processing typically results in approximately 60% of the fish weight being discarded, generating a large amount of waste. These organic wastes contain nutrients that could be usefully recycled through agricultural systems.  Previous pilot studies had indicated that fish processing wastes can be combined with Reactive Phosphate Rock using proprietary technology to produce a phosphate fertiliser (BioPhos). It was thought that this fertiliser may comply with the requirements for use in organic farming systems. Although organic fertiliser products from fish wastes had been available in the market for some time, long-term field evaluations of these products had been scarce. This led to a need for further investigation into the opportunities for utilising fertiliser produced with Australian seafood processing wastes. |
| Objectives | 1. To compare the agronomic effectiveness of BioPhos with Superphosphate in tomato production. 2. To compare the agronomic effectiveness of BioPhos with Superphosphate and composite fertilisers (i.e. di-ammonium phosphate) in dryland crop production. 3. To compare the agronomic effectiveness of BioPhos with Superphosphate and composite fertilisers (i.e. based on mono-calcium phosphate) in the irrigated dairy industry. 4. To communicate outcomes of the trials to agricultural industries. |
| Outputs | * Experiments were conducted to compare the performance of the BioPhos fertiliser with more common agricultural fertilisers. Trials were conducted in intensive horticulture, dryland cropping, and irrigated pasture settings. * Experimentation indicated that there were no significant differences in agricultural production from the use of either BioPhos or alternative phosphorus (P) fertilisers such as Superphosphate. * Results suggested that in some cases, application of BioPhos may lead to lower concentrations of readily-available residual phosphorus in the soil. This suggests that BioPhos may be environmentally superior to highly water soluble P fertilisers, such as Superphosphate, where leaching can be an issue. * Recommendations were made for commercialisation of the BioPhos fertiliser. |
| Outcomes | * There is now more evidence available to support the use of fertilisers produced from fish processing wastes. * Incitec Pivot Limited indicated they were satisfied with project results and were ready to move on to commercialisation and marketing of the product. * The BioPhos fertiliser was produced by Incitec Pivot Limited until 2011, when production was ceased due to a number of technical, environmental and economic reasons. Production was resumed by a second commercial operator, however as of 2014, BioPhos fertiliser is no longer in production in Australia (Charlie Walker, pers. comm., 2014). * Diverting fish wastes from land fill to fertiliser production would reduce the environmental impact of seafood processing. * BioPhos has the potential to provide a more cost-effective fertiliser for adopting farmers, particularly those producing organic food products. |
| Benefits | * During the short time BioPhos was manufactured there may have been profit increases for fish processors due to value-adding opportunities and reduced waste disposal costs. * Potentially reduced environmental impacts in terms of both fisheries and agricultural production. * Increased scientific understanding regarding the production and utilisation of fertilisers using fish waste. |

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| **Project Number 2003/206: Antifouling solutions for the Australian pearling industry – coatings for shell and equipment** | |
| Project details | Organisation: James Cook University  Period: June 2003 to January 2008  Principal Investigator: Rocky de Nys |
| Rationale | The term ‘biofouling’ refers to the settlement and accumulation of organisms on immersed substrates. It impacts on all forms of aquaculture, including Pearl Oyster culture. Biofouling hinders growth through a reduction in water flow to Oysters, increases mortalities by impeding the opening and closing function of the shells, and damages equipment through increased long-line weight and drag on culture systems.  Traditional methods of dealing with the issue of biofouling relied on the periodic removal of fouling organisms rather than prevention. Doing so imposed a substantial cost on the industry, generating a strong incentive for the development of a cost-effective technology capable of preventing biofouling from occurring on pearl shell and equipment.  Prior research efforts had developed antifouling coatings and demonstrated their potential to be of substantial benefit to the Australian pearl industry. This project was developed in order to continue the development and testing of antifouling coatings, and to develop integrated solutions for their application and maintenance. |
| Objectives | 1. To develop antifouling coatings and technologies for protecting Oysters and equipment against fouling for a minimum of six months throughout the year. 2. To develop methods suitable for routine application and cleaning of coatings on shell and equipment to facilitate the successful implementation of new technologies. 3. To identify any effects on Oyster growth, Oyster health and pearl (nacre) quality from the use of antifouling technologies. 4. To provide commercially available antifouling products for pearls and pearling equipment. |
| Outputs | * Field trials of antifouling coatings were performed at numerous sites across the geographic range of pearl farming in Australia. * A previously developed broad spectrum antifouling coating for pearl shell was further refined. The resultant product met the needs of the industry, providing a high level of antifouling protection without harming the Oysters. * Methods for the application and cleaning of the coating on Oysters and equipment were developed. These methods ranged from simple methods appropriate for small-scale operations, through to industrial-scale systems capable of handling thousands of Oysters per day. * Inability to develop a suitable coating for plastic equipment such as pearl panels led to the development of zinc galvanised steel mesh panels that effectively control biofouling. * The various technologies developed in this and related projects were combined to create a complete antifouling system. This integrated system further enhanced efficacy against biofouling, significantly reducing the requirement for intensive cleaning throughout the year at all trial sites. However, it also demonstrated flawed technologies such as the inability of the coating to withstand industry field conditions when applied to ropes and floats. * The industry partner, Wattyl Paints, withdrew from the research in 2007 due to commercial reasons external to the project. This led to removal of the 3rd project objective. |
| Outcomes | * There now exists an effective method of reducing the occurrence of biofouling on Australian Pearl Oyster aquaculture operations. * Use of the antifouling system means cleaning of pearl shells can be conducted less frequently, and in some cases avoided entirely. This will lead to lower operating costs, reduced Oyster stress, and potentially increased Pearl Oyster growth for adopting operators. * The coatings, while under production, were used by one producer in their Indonesian operations. Following cessation of production by Wattyl Paints there has been little uptake in the Australian Pearl Oyster industry (Rocky de Nys, pers. comm., 2014). * Improvement and production of the coatings has recently been undertaken by Australian company Ecozean. The company is developing and marketing the coatings to control fouling in finfish and prawn aquaculture (Tim Charlton, pers. comm., 2014). |
| Benefits | * Potential increase in profitability of the Australian pearl aquaculture industry, due to a decrease in costs associated with fouling management, and increased growth rates and health of Pearl Oysters. * Industry capacity for the development of antifouling coatings has been enhanced. |

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| **Project Number 2003/213: Rock Lobster Enhancement and Aquaculture Subprogram: establishing post-pueruli growout data for Western Rock Lobsters to assess economic viability** | |
| Project details | Organisation: Department of Fisheries Western Australia  Period: December 2003 to March 2008  Principal Investigator: Roy Melville Smith |
| Rationale | As a high value product, Western Rock Lobster presented an attractive prospect for aquaculture production. Plans for development of the industry were built around the notion of capturing pueruli from the wild, then growing those to marketable size in a cultured environment. Given the large amount of investment that would be required to develop such an industry, detailed research needed to be conducted before Rock Lobster aquaculture could become a commercial reality.  Previous efforts had established biologically neutral methods for capturing large quantities of pueruli. The next step was to undertake experimental pueruli growout trials and obtain preliminary figures on the viability of this potential new industry. |
| Objectives | 1. To determine optimal flow rates for pueruli and juvenile Western Rock Lobsters held at high densities in flow through tanks.  2a. To evaluate growth rates and survival of post-pueruli, year 1 and year 2 Western Rock Lobsters (*Panulirus cygnus*) under two levels of biomass and two shelter types.  2b. To evaluate growth rates and survival of post-pueruli, year 1 and year 2 Western Rock Lobsters (*Panulirus cygnus*) at two temperatures (ambient and 23°C) and under two feeding regimes.  3. To estimate the expected survival rate and period required to produce a marketable sized animal from post-puerulus.  4. To provide biological data to assist in assessing the economic potential for growing out Western Rock Lobsters from post-pueruli to marketable size.  5. To compare the biochemical profiles of three Western Rock Lobster year classes subjected to different treatments under aquaculture conditions, with corresponding year classes caught in the wild. |
| Outputs | * Experiments were conducted to determine the conditions that would maximise growth and survival of three size classes of Western Rock Lobster (post-pueruli, year 1 and year 2 juveniles) in flow-through onshore tank systems. Data were gathered on the following key factors:   + Flow rate   + Stocking density   + Shelter type   + Water temperature   + Feed type and frequency   + Biochemical profiles * The experiments provide much of the basic data on growth and survival under a range of culture conditions. * Based on project results, it was concluded that Western Rock Lobsters have many biological attributes that are consistent with their suitability for aquaculture, in particular the ability for juveniles to be stocked at very high densities without adverse effects on growth, and the ability of cultured lobsters to reach legal size over 60% faster than wild lobsters. * A number of areas for further research were identified, including diet design, tank specifications, mortality rates and economic viability. |
| Outcomes | * A solid foundation of biological data and recommendations for culture parameters is now available for production of Western Rock Lobster post-pueruli and juveniles in commercial culture operations. * Data produced in this project will remain relevant if in future it becomes possible to produce Rock Lobster pueruli in hatcheries. * Despite substantial initial interest, currently it appears unlikely that *P. cygnus* culture will become a commercial reality in Australia. This is primarily due to strong opposition from wild-catch fishers concerned about the impact of pueruli harvesting on fishery recruitment and catch rates, combined with a long life-cycle compared to other Rock Lobster species (Danielle Johnston, pers. comm., 2014). * Much of the general information gained in this project is relevant to the ongoing research in aquaculture of other Rock Lobster species (Danielle Johnston, pers. comm., 2014). |
| Benefits | * Scientific understanding of the requirements for Rock Lobster culture has been advanced. |

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| **Project Number 2005/217: Rock Lobster Enhancement and Aquaculture Subprogram: the feasibility of translocating Rock Lobsters in Tasmania for increasing yield** | |
| Project details | Organisation: University of Tasmania  Period: March 2005 to December 2006  Principal Investigator: Caleb Gardner |
| Rationale | The Tasmanian lobster resource has been characterised by large spatial differences in growth and reproduction parameters. Despite this spatial variability, the same management rules have historically been applied across the fishery. Fleet dynamics were uneven with effort increasingly targeting depleted inshore areas where high value, hard-shelled red lobsters are located while populations of slow-growing, lower value white-shelled lobsters in deeper waters remained abundant. Effects of fishing on egg production/recruitment and ecology also appeared to be poorly managed, with high levels of depletion in some areas while other areas were virtually unfished.  Translocation was identified as one method of dealing with these issues. In essence, translocation involves moving lobsters from places where they are slow growing and abundant to places where they are fast growing and depleted (Gardner et. al., 2014). Prior experimentation had indicated translocation could lead to improved growth and colour change, and thus warranted further investigation. Driven by strong industry support, this project was conducted in order to provide preliminary desktop modelling on the feasibility of a translocation scheme. |
| Objectives | 1. To determine the costs associated with translocating lobsters. 2. To model the economic outcomes of translocation based on available biological data. 3. To combine the cost and economic outcomes into a bio-economic model. 4. To model the economic viability of large-scale translocation operations to achieve yield increases. 5. To identify crucial input data that impact on the economic viability of translocation. 6. To identify further data requirements from field-experiments. 7. To evaluate cost recovery options for a long-term operational system for translocation. |
| Outputs | * Biological and economic models were developed and used to simulate the translocation of Rock Lobsters from four original sites to four release sites with differing growth rates. * Results suggested that translocation has the potential to provide an economically feasible option for increasing catch and profitability of fishers, with most scenarios leading to increases in yield at least double the status-quo. * Scenarios in which the gains from translocation would be highest were identified, along with those where doing so would not be economically viable. * Management and cost-recovery options for a potential translocation scheme were developed through port meetings. * Information shortcomings and biological parameters with the greatest influences on translocation outcomes were identified as targets for further research. |
| Outcomes | * Implementation of translocation in the Tasmanian Rock Lobster fishery has the potential to lead to increases in: * catch rate * exploitable biomass * egg production * economic yield * By demonstrating the economic viability of lobster translocation, this project provided justification for further development of the concept. * Translocation research was continued in Seafood CRC projects 2006/220 and 2011/744. These projects further demonstrated the practical and economic feasibility of the concept through pilot and commercial scale trials. These projects also developed a system for ongoing management of translocations by the Tasmanian Rock Lobster Fishermen’s Association (Green et al. n.d., Gardner et. al., 2014). * As a result of these efforts, the industry voted to continue commercial scale translocation operations for three years from 2014. Collection of funds and management of operations is conducted through an industry committee, and translocation has been incorporated into the annual process for setting the total allowable commercial catch (Gardner et. al., 2014). * The majority of members of the Tasmanian Rock Lobster fishery are in support of translocation, and it appears likely to continue past 2017 (Caleb Gardner, pers. comm., 2014). |
| Benefits | * Increased profitability of the fishery through higher catches and more high-value red lobsters. * By supplementing lobster populations in overfished areas, sustainability of the fishery may be increased. |

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| **Project Number 2005/239: Fishing energy efficiency review for the FRDC** | |
| Project details | Organisation: DJ Sterling Trawl Gear Services  Period: November 2005 to January 2007  Principal Investigator: David Sterling |
| Rationale | Fuel is a key input for Australian commercial fishers and aquaculture producers. Price increases in the mid-2000s had placed substantial pressure on the profitability of many operators. This situation led to a great deal of interest and debate regarding potential mitigation measures.  Australia is fortunate in having access to potentially large sources of alternative fuels and new sources of conventional fuels. However, there was a shortage of information on the suitability of these products for use in fishing vessels.  The FRDC Board had discussed where it could invest in the short term to address the rising costs of fishing. It was agreed to fund an initiative to review potential developments in energy efficient fishing practices. The intent was to develop a guide that can inform the industry on existing and new developments in this area, and identify where the greatest potential for fuel efficiencies lies. The review was also intended to provide an analysis of potential R&D that could assist industry in developing and adopting energy efficient fishing practices. |
| Objectives | 1. To examine the degree to which rising fuel costs have impacted on different fisheries. 2. To examine new and existing technologies developed both within and outside of Australia in the field of increased fishing efficiency through reduced energy usage and innovation. 3. To examine opportunities for applying innovative solutions and developments which are most likely to produce the best return for the Australian fishing industry. 4. To develop a publication that scopes potential innovations, whether they be existing or have the potential for development, that reduce energy usage. 5. To provide advice on potential R&D that could assist industry in reducing energy usage. |
| Outputs | * The impact of rising fuel costs on different fisheries was investigated. A key finding was that the proportion of revenue paid for fuel rose from 25% to 50% in some fuel-intensive sectors, even after businesses had taken immediate action to reduce fuel costs (such as selecting fishing grounds closer to port, and travelling at a reduced engine speed). * Many new and existing technologies suitable for fisheries with the potential to improve energy efficiency or reduce the cost of fuel inputs were explored. The analysis covered alternative fuels, energy transformation technology, energy efficient vessel and gear design, and operating efficiency. * A four part report was produced, describing existing and new developments in the area of fishing efficiency that can assist industry in reducing energy requirements and flag potential R&D gaps and priorities. * For some technologies considered, experts did not universally accept the claims of improved energy efficiency made by suppliers. In these cases, the various arguments were presented and a balanced conclusion was attempted. * There were no commercially available technologies identified as having a clear benefit for fishers and therefore strongly recommended for adoption. This arose mainly because of the shortage of credible public information related to the evaluation of new and existing technologies designed to improve fishing performance. * A number of opportunities for further research, investment, and development of industry capacity were identified. * Project findings were extended through participation in workshops, publication of research papers, and articles in industry news publications. * A framework and professional network for addressing energy related issues in Australian fisheries was developed. |
| Outcomes | * Well-grounded information on the prospects of utilising cheaper alternative fuels and efficiency issues associated with engines and boats is now available. This has helped guide industry thinking along realistic themes and suppressed the propagation of suspect claims in relation to many dubious, highly-priced “efficiency” products. * Because of the framework and the professional network formed by the project, work is continuing with volunteer professional input and a small amount of industry funding to progress higher-level outcomes in other important areas; like propulsion devices, refrigeration, and fishing gear (principally trawl gear). * In response to the project forming a list of prioritised initiatives towards improving the economics of fishing, a range of related research projects were developed. Among these were the development of an energy audit process (FRDC Project 2006/229), and further investigation of alternative fuel inputs (FRDC Project 2007/200). |
| Benefits | * Reduction in energy costs for wild-catch fishers due to use of cheaper or more efficient practices and technology. * Potential reduction in greenhouse gas emissions of the fishing sector due to reduced fossil fuel consumption. * Enhanced industry research capacity in the areas of energy efficiency and alternative fuels. |

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| **Project Number 2006/211: Rock Lobster Post Harvest Subprogram: examination of green sustainable process technology for preparing chitin and associated derivatives from Rock Lobster waste** | |
| Project details | Organisation: University of Western Australia  Period: September 2006 to July 2008  Principal Investigator: Colin Raston |
| Rationale | Chitin is a naturally occurring polymer with a range of industrial, medical, and pharmaceutical applications. Demand for the material and related products such as chitosan and glucosamine has been on the rise with markets either already established or emerging with strong growth potential.  One source of this valuable material is the head and shell of crustaceans such as the Western Rock Lobster. The substantial amount of shell waste produced in the Western Rock Lobster fishery (WRLF) is typically dumped in landfill or sold on the wholesale market at a low price. The redirection of these shell wastes to chitin processing represents an excellent opportunity for increasing the revenue of the industry.  The traditional approach of isolating chitin from fishing waste involves the use of strong acids and bases, generating other wastes which must be disposed of at great cost. It was proposed that developing a new ‘green’ approach would be of great interest to lobster industries, both in Australia and the rest of the world. Previous research had developed ‘green’ extraction technology capable of isolating small quantities in a laboratory setting. Following on from this, the next step was to optimise and scale-up the process. |
| Objectives | 1. To characterise and optimise the laboratory synthesis of various chitosans and glucosamine produced using novel benign chemistry techniques, beyond preliminary results that demonstrate the feasibility of the project. 2. To bench mark the quality of the chitosans and glucosamine produced, against international standards recognised by the Therapeutic Goods Administration (TGA), as premium grade products. 3. To scope out a laboratory scale-up process suitable for processing multi-tonne quantities of Rock Lobster waste, in association with a commercial partner. |
| Outputs | * A previously developed ‘green’ process of extracting chitin from Rock Lobster waste products was refined and scaled-up in a laboratory setting. This method was demonstrated to be a technically feasible means of producing high purity chitin, chitosans and glucosamine. * The technology developed is also applicable to crabs, prawns, and other lobster species. * The project provided an outline of global chitin markets, and their relevance to the potential Australian market. * Recommendations on the steps needed to be taken by researchers, industry and government to further develop the technology were made. * Project findings were publicised through media interviews and industry news publications. * The intellectual property developed was protected through the lodgement of a patent (Colin Raston, pers. comm., 2014). |
| Outcomes | * While the project achieved all its objectives, it was recognised that additional research and market development would be needed before commercial-scale production could be achieved. * Technical and production limitations have impeded the uptake of the technology by industry (Colin Raston, pers. comm., 2014). * The technology developed in this project has since been superseded by more recent innovations (Colin Raston, pers. comm., 2014). |
| Benefits | * Scientific understanding of chitin isolation techniques has been advanced. |

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| **Project Number 2006/212: Rock Lobster Post Harvest Subprogram: development of bait saving strategies for the Western Rock Lobster fishery** | |
| Project details | Organisation: Murdoch University  Period: October 2006 to December 2007  Principal Investigator: Howard Gill |
| Rationale | Bait expenses represent a significant cost to the Western Rock Lobster industry. One factor affecting bait usage is the presence of non-target species, which can consume bait in lobster traps prior to lobsters being attracted. To combat this loss of bait, fishermen were forcing as much bait as possible into their bait boxes. However, it was indicated that doing so does not result in larger amounts of bait remaining after 24 hours and has no impact on catch rates unless pots are competing with other nearby pots.  The development of devices that exclude non-target species from entering the bait box has the potential to reduce the amounts of bait used by commercial fishermen. While baitsaving devices were commercially available, fishers had been hesitant to use them as no in-depth studies had been undertaken regarding their efficacy. This project was developed to address this issue by testing the efficacy of such devices in a commercial environment. |
| Objectives | 1. To reduce bait usage in the Western Rock Lobster fishery without reducing catches. |
| Outputs | * A baitsaver device was developed based on previous designs and information gained during this project. * It was initially intended to trial the baitsaver device over two years using baitsavers in both baskets, a combination of baitsavers in one basket and the other packed the traditional way, and controls using both bait baskets packed with the traditional method. * However, due to the poor season in 2005/6, five of the six trial participants withdrew from the trials, with the sixth continuing only with the combination method. * In 2006/7 all six participants trialled the combination method. Trial results suggested that the use of the baitsaver in at least one bait box could result in significant savings to fishers during the red shell phase of the season. * Project results were discussed informally with fishers, as well as presented formally in all zones of the fishery. |
| Outcomes | * Adoption of the devices has the potential to reduce the amount of bait required, thus increasing profit for adopting operators in the Western Rock Lobster fishery. * Despite the promising results of this project, continued discussion with fishers has shown they are hesitant to use baitsaver devices at a time when catches were low, possibly due to the fact that the cost of extra bait is minor compared to the perceived revenues generated from increased catches. However, catches have stabilised in recent years and the fishery is now under quota. |
| Benefits | * Potential for increased profitability of the Western Rock Lobster Fishery through the adoption of baitsaving devices. |

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| **Project Number 2006/229: Southern and Eastern Scalefish and Shark Fishery Industry Development Subprogram: development and implementation of an energy audit process for Australian fishing vessels** | |
| Project details | Organisation: Australian Maritime College  Period: May 2007 to September 2008  Principal Investigator: John Wakeford |
| Rationale | The Australian fishing industry uses a considerable amount of fuel in the harvest of fishery resources, and rising fuel prices had led to a desire to implement more efficient harvest strategies and gears. A 2005 workshop identified the introduction of an appropriately configured energy audit process as a logical step towards achieving this goal.  Energy audits provide a description of energy usage patterns, potential energy saving measures together with an expected payback period, and measures of performance against recognised energy audit parameters. This provides a clear idea of how energy is used in a business, and can subsequently identify how energy consumption and associated costs may be reduced. In addition to monitoring one’s own performance over time, this benchmark data can also be used for analysing performance across a fishery or between fisheries, both at a domestic and international level. Such information is useful to fishing companies, researchers, and governments.  While general methodology for conducting energy audits already existed in other industries, little work had been done in regards to fisheries. This led to a need to develop an energy audit process suitable for fishing vessels. |
| Objectives | 1. To adapt an existing land-based-infrastructure energy-audit process to suit certain types of fishing vessel. 2. To undertake a trial energy audit (Level 1 and possibly Level 2) of up to six different fishing vessels. 3. To present the tailored audit process, the audit findings, the energy management matrixes for each vessel type, and also provide recommendations for future work. |
| Outputs | * An energy audit process for individual fishing vessels was developed based on an adaptation of the existing Energy Audit Standard (AUS/NZ Standard 3598:2000). * This audit process was subsequently trialled on seven vessels in various Australian fisheries. The process proved satisfactory, although difficulties were encountered when it came to assembling the necessary historical data (fish landings, revenue from fish sales, quantities of fuel used and the associated expense, fishing time and/or engine running hours). * Results confirmed that passive fishing gears are less energy intensive than active forms of fishing, and that these methods are less susceptible to rising diesel prices. * The vessels which gained the most from the audit process were those that were more fastidious with their record/book keeping, as this permitted a more in-depth analysis to be performed. * A number of recommendations were made on how to improve and further apply the energy audit process, as well as general recommendations for steps which could be taken to reduce the impact of rising fuel costs on Australian fisheries. * A deficiency was identified in the number of appropriately qualified industry personnel able to provide technical guidance on fuel-energy saving measures for fishing activities, as well as a shortage of technical knowledge available to such people. * It was revealed that most fishing companies are not properly prepared for undertaking energy audits, simply due to a lack of records containing the required data. * The project provided a set of recognised energy-audit benchmarks that can be used for monitoring progress in this field. |
| Outcomes | * Data generated from the energy audit process will be of use to a range of parties interested in energy efficient fishing, namely fishing companies, fishery managers, state and federal government organisations associated with fisheries, and non-government organisations. * The project has given training institutions/providers an opportunity to include project results in their Marine Engine Driver (Level 2 and 3) syllabus. This will prepare new marine-engine drivers to assist fishing companies to contend with rising fuel-energy prices. * By demonstrating the processes and outcomes of energy audits, this project may instigate more audit activity in the future. * An additional energy audit was conducted on a Danish Seine vessel in Lakes Entrance by one of the project co-investigators. * Introduction of several substantial fuel-saving measures occurred on a MG Kailis fish-trawler as a result of an energy audit in 2008/9. * As the pool of energy audit information on Australian fishing vessels grows it should be possible to identify in what areas research and development is most needed, and embark on a long-term program to build up the necessary pool of technical expertise. * Project activity was also instrumental in drawing relevant technical expertise together in a number of publications, activities, and related projects (including FRDC Project 2007/200). |
| Benefits | * Increased profitability of fishers due to more efficient energy usage. * Enhanced industry capacity for analysing and improving energy efficiency. * Potential reduction in greenhouse gases through more efficient fishing practices. |

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| **Project Number 2007/200: SESSF Industry Development Subprogram: alternative fuels for fishing vessels** | |
| Project details | Organisation: University of Tasmania  Period: May 2007 to October 2008  Principal Investigator: Laurie Goldsworthy |
| Rationale | Rising fuel costs were of great concern to Australian fishers, and the industry was seeking input on where to best direct its efforts towards addressing this issue. Previous research (Project 2005/239) had identified a number of possible alternative fuels which could possibly supplement or replace diesel in Australian fisheries. Following on from this, there was a need to assess the technical, economic, and environmental feasibility of a number of specific alternatives to traditional fossil fuels. |
| Objectives | 1. To evaluate alternative fuelling options for the Australian fishing fleet, primarily to reduce costs. 2. To provide greater fuel security to the fishing industry. 3. To improve sustainability by reducing greenhouse gas emissions. |
| Outputs | * A detailed assessment was conducted on a number of alternative fuels, covering availability, cost, suitability for fishing vessel engines, on-board storage and handling, warranty implications, and exhaust emissions. * Specific fuels assessed were:   + Low Quality Distillate (Marine Gas Oil/Marine Diesel Oil)   + Fish oil   + Liquid Petroleum Gas (LPG)   + Ethanol   + Biodiesel   + Natural gas (Liquefied Natural Gas & Compressed Natural Gas)   + Hydrogen * Engine testing was conducted with LPG, ethanol and biodiesel, with results submitted for publication in technical journals (Laurie Goldsworthy, pers. comm., 2014). * The general conclusion reached was that no alternative fuel offers a straightforward solution to high fuel costs. Of the options evaluated, all had drawbacks which reduced their attractiveness in the short term. Common barriers identified were cost (initial and ongoing), safety, on-board storage, and availability. * A workshop was held at the Seafood Directions Conference in Hobart in 2007, where the views of fishing vessel operators were canvassed. * An article was published in Fishing Today, which provided a summary of the status of the project up to mid-2008. * Project staff have often been the first point of contact for numerous operators, dealing with numerous enquiries on alternative fuelling options such as on-board hydrogen electrolysis, the use of various fuel catalysts, and LPG installations. |
| Outcomes | * Fishing vessel operators have more information with which to make better- informed decisions on fuelling. * Governments and research organisations are now able to make better-informed decisions regarding potential further investment in alternative fuels. * Based on knowledge gained from the workshop, combined with findings of the project, it became obvious that, while fuel prices are taking their toll on some operators, most would find making significant changes to their current fuelling regime challenging. * As of 2014 there has been no significant adoption of alternative fuels in Australian fisheries. This is likely due to prohibitively large capital requirements, and a stabilisation of diesel prices which reduced the economic attractiveness of alternative fuels (Ian Knuckey, pers. comm., 2014). * Realistic evaluation of alternative fuels will lead to a reduced likelihood of wasteful investment in fuels which are not likely to be viable. |
| Benefits | * Reduction in the amount of investment in alternative fuels which do not produce significant benefits. |

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| **Project Number 2007/238: The Ornamental Fish Industry in Australia 2006/07** | |
| Project details | Organisation: DosAqua  Period: May 2007 to March 2008  Principal Investigator: David O’Sullivan |
| Rationale | The breeding and keeping of ornamental fish is an activity with close linkages to aquaculture. Many believe there is excellent potential for growth in the Australian ornamental fish industry. Prior to this project, there was a shortage of detailed and current information on the industry. This issue needed to be addressed in order to identify priority areas for research and development. |
| Objectives | 1. To determine an estimate of the overall structure, size and value of the ornamental fish industry in Australia. 2. To determine an estimate of the overall structure, size and value of ornamental fish industry activities. 3. Determine the level of recreational ornamental fish ownership and the types of owners – based upon level of seriousness (irregular, moderate and serious). 4. To compile a list of the commercially important species traded in Australia categorised by value, source, production method, etc. 5. To develop a method to estimate the Gross Value of Production (GVP) of the industry on an annual basis. 6. To identify potential areas for industry growth. |
| Outputs | * Detailed research was conducted in order to gain data on the Australian ornamental fish industry. This included 97 face-to-face interviews with businesses and individuals involved in the industry across Australia, as well as a review of scientific literature and government statistical information. * This information was used to prepare a report covering:   + Range of products and species traded   + Market segments   + Distribution methods   + Human capital   + Unregulated & illegal trade   + Implications of regulation   + Imports and exports   + Industry challenges and growth opportunities * A series of recommendations was prepared, highlighting opportunities for supporting the future growth of the ornamental fish industry. Existing and potential barriers to growth were also documented. * The manner in which the project methodology could be used to estimate the GVP of the industry on an annual basis was explained. * A database with over 300 industry contacts was collated and provided to the FRDC. |
| Outcomes | * The GVP information and overall industry trends collated as a part of the project will allow all industry sectors to better understand the current status of the industry and to understand their options for expanding production, sales and profitability. * The methodology and professional networks established in this project will enable the status of the industry to be monitored more effectively in the future. * A better understanding of industry dynamics amongst stakeholders will assist with the industry’s development. * The findings of this project have been disseminated in the public domain. |
| Benefits | * Potential increase in profits due to improved investment decisions. |

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| **Project Number 2007/241: Feasibility study for the use of biofuel for the Western rocklobster industry** | |
| Project details | Organisation: Kondinin Group  Period: October 2007 to August 2008  Principal Investigator: William Ryan |
| Rationale | With fuel costs rising rapidly, the Western Rock Lobster Council (WRLC) sought to examine a number of avenues to keep the industry profitable. Given that there were no presently viable alternatives to diesel fuels in marine engines, there was an interest in investigating the feasibility of biodiesel as an alternative to traditional petroleum diesel. Recognising the developments in biofuels in recent years and given the existence of agricultural industries nearby to the lobster boat anchorages, the WRLC decided to seek an analysis of the potential for biofuels for the WA Rock Lobster industry. |
| Objectives | 1. To analyse fuel use by the Western Rock Lobster industry including distribution, infrastructure and logistics. 2. To analyse biofuel production possibilities for the Western Rock Lobster industry including sources of raw materials, by-product opportunities and logistics of manufacture, storage and distribution. 3. Technical and economic advantages and disadvantages for biofuel for the industry including appropriate fuel standards and engine warranty issues. 4. Potential business cases, possible business structures and sources of capital for the development of a biofuel industry serving the Western Rock Lobster industry. |
| Outputs | * A detailed investigation was conducted into the feasibility of using biodiesel to supplement or replace regular diesel in the Western Rock Lobster fishery. * Three business models were investigated: individual boat owners making their own biodiesel, consortia of several boat owners meeting the fuel demands of the group, and large regional manufacturing facilities meeting the fuel requirements of the whole industry. * Within and between season supply and demand issues for fuel and raw material supplies affecting the viability of a biofuels business were examined. * Of the potential raw materials investigated, canola was identified as the most likely material as it is produced in close proximity to ports used by the Rock Lobster industry. * It was concluded that the economic benefits of biodiesel are dependent on the relationship between the prices of conventional diesel and canola. Fluctuations in these prices could potentially lead to a situation where biodiesel was a competitive option. * Other areas covered in the analysis included environmental concerns, OH&S issues, and the impact of government regulations and assistance. |
| Outcomes | * The project provided a detailed framework that will enable the Western Rock Lobster industry to continually assess the feasibility of substituting biodiesel for mineral diesel into the future. * The Western Rock Lobster industry is now individually and collectively able to make informed decisions on the viability of using biodiesel. * As of 2014 there is little evidence to suggest any significant uptake of biodiesel in the Western Rock Lobster fishery. |
| Benefits | * Increased industry capacity for the adoption of biofuels should they become economically viable in future. |

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| **Project Number 2007/250: Increased economic efficiency for the Western Rock Lobster Fishery through improved pot design** | |
| Project details | Organisation: Western Rock Lobster Council  Period: October 2007 to July 2009  Principal Investigator: Andrew Winzer |
| Rationale | A major driver for input costs in the Western Rock Lobster fishery (WRLF) is the number of pot lifts, with a greater number of pot lifts corresponding to increases in fuel, bait, gear, and labour expenses. The use of more efficient lobster pots was considered to offer a means of reducing these costs. This would require a design which enabled boats to fish with a smaller number of more efficient pots while still producing the same catch. |
| Objectives | 1. To provide industry with the blueprint(s) of one or many pots that catch target size Western Rock Lobster in a more efficient manner. 2. To provide industry with estimates of the cost savings that would be achieved in the WRLF through the adoption of a more efficient pot. 3. To optimise the economic efficiency of industry stakeholders without adversely affecting the exploitation rate. |
| Outputs | * A discussion paper was produced on the relative merits of redesigning the pot of the catch unit in the fishery. * A literature review was conducted relating to gear technology used in decapod crustacean fisheries worldwide. * Preliminary trials were conducted in the 2007/08 season with eight commercial operators spread across three zones. These trials compared the performance of a newly designed alternative pot against that of the traditional batten pot. * Initially the newly designed pot was found to catch significantly less lobster over a one day soak time whilst no significant difference in catch rates was found over a two day soak. Various modifications were made to the new design pot over the remainder of the season without success. * One fisherman decided to source and subsequently trial a larger 48 inch trap successfully used in the 1980s. When deployed during the final two months of the 2007/8 season over two day soaks, this trap was found to land significantly more lobster than the traditional batten pot. |
| Outcomes | * Further trials of the 48 inch pot were conducted in 2008/9 season in FRDC Project 2008/900. In these trials, the 48 inch pot was less successful in catching lobsters than the standard batten pot. * Changes in the fishery, particularly the move from input to output controls, reduced the incentives to adopt the alternative pot designs trialled in this and subsequent projects. As such, alternative pot designs have generally not been adopted by the industry (Simon De Lestang, pers. comm., 2014). |
| Benefits | * Potential for increased fishery profits if conditions lead to adoption of alternative pot designs. |

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| **Project Number 2008/099: Tactical Research Fund: Torres Strait Tropical Rock Lobster fishery 5 year business plan** | |
| Project details | Organisation: Department of Agriculture, Fisheries and Forestry  Period: May 2009 to November 2009  Principal Investigator: Paul Pak Poy |
| Rationale | Ongoing negotiations between Indigenous and non-Indigenous commercial fishers over the introduction of a management plan into the Tropical Rock Lobster fishery had stalled due to differences in opinion regarding the future operating environment between sectors. A suggestion agreed upon by both groups to overcome this stalemate was to develop a business plan as a medium term strategic plan to explore each sector’s goals, consolidated into a compromise solution with options on how this could be achieved. |
| Objectives | 1. To prepare a report presenting an approach agreed to by the Indigenous and non-Indigenous commercial sectors for the development of the Torres Strait Tropical Rock Lobster fishery in the coming five years. 2. To present the report to the Protected Zone Joint Authority to assist in the development of strategic policies and facilitate the implementation of the management plan. |
| Outputs | * Extensive stakeholder consultation was completed based on a series of seven workshops. * A report was produced which explored how each sector’s desires could be met in an innovative and cooperative fashion. Factors covered included:   + Optimum utilisation of resources   + Product development   + Market access opportunities   + Sustainability of the fishery * Several recommendations were made including:   + Development of financial, economic and social criteria for assessing new infrastructure investments and then using these to identify a number of potential projects to implement based on those criteria.   + Development of a schedule of training modules; and identifying key reforms to improve the efficiency of the onshore infrastructure operations.   + Bio-economic modelling, reviewing the need for a flexible harvest strategy, reviewing the nature of marketing businesses, and a review of the Indigenous commercial sector motives for fishing would be useful work that could be progressed by Protected Zone Joint Authority agencies.   + A Torres Strait Fisheries Reform Taskforce could be established to oversee the implementation of the business plan and the above work program. * The report also discusses the need for a strategic approach to capacity building and presents some options in relation to capacity building. These observations are based around a classification system introduced by the report that classifies Indigenous commercial fishers according to the amount of fishing they are likely to do and the level of capital investment they might make. * A draft of the report was provided to the Protected Zone Joint Authority to assist in deliberations on potential strategies for the Rock Lobster fishery. |
| Outcomes | * There is not unanimous support for all recommendations in the report but it is a useful document that all stakeholders can accept as a basis for ongoing discussion. * The Protected Zone Joint Authority agencies have considered all the recommendations and provided advice to the Protected Zone Joint Authority of the efficacy of conducting future work in the context of a broad strategy for the fishery. * The Torres Strait Regional Authority Board agreed to the formation of a Fisheries Development unit that used the report as a major input to the development and implementation of an Indigenous fisheries capacity building program over three years to 2012-13. * The report produced in this project has informed ongoing policy development by the Protected Zone Joint Authority and contributed to the development of a new Torres Strait Regional Authority fisheries development program, which used the report, and other sources of information to devise and implement a program to increase economic opportunities and capacity building for Indigenous fishers. |
| Benefits | * Potential increase in economic returns of the fishery, due to more efficient allocation between sectors. * Potential improvements in sustainability of the fishery through improved management arrangements. * Reduced conflict between sectors leading to social benefits for affected communities. |

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| **Project Number 2009/221: Tactical Research Fund: Improving the economic efficiency of the Southern Squid Jig Fishery** | |
| Project details | Organisation: McKinna *et al*  Period: April 2010 to September 2010  Principal Investigator: David McKinna |
| Rationale | The Southern Squid Jig Fishery (SSJF) was facing a number of challenges. While the industry had tackled issues of sustainability, it had not yet dealt with the economic and marketing issues that were impinging on its profitability and growth. The intention of this project was to investigate the causes of the economic drivers of poor performance, and to develop a range of potential solutions for improving profitability by either driving costs out of the supply chain or increasing value. |
| Objectives | 1. To assess the range of factors affecting the economic viability of the SSJF for Arrow Squid in southern Australia. 2. To canvass a broad range of practical solutions that will increase both the profitability and efficiency of the industry. These solutions should be in areas where the SSJF industry can focus efforts to improve profitability, as distinct from factors endemic to the wider fishing industry and other sectors of the economy. |
| Outputs | * An assessment of the Southern Squid Jig Fishery, and in particular the challenges facing the future development of this sustainable fishery, was developed in the following stages:   + Familiarisation and briefing   + Cost analysis   + Supply chain review   + Global trade analysis   + Domestic market review   + Industry development strategy * A number of recommendations for improving the profitability of the fishery via the three broad mechanisms:   + Increasing the value of the catch   + Improving the size and consistency of the catch   + Reducing costs * Specific areas targeted included:   + Value adding   + Quality assurance and grading   + Branding   + Labelling reform   + Fish tracking models   + Collaborative fishing methods   + Replacing incandescent bulbs with LED lights   + Improved boat design   + Reducing labour costs through automation   + Increased boat size   + Management of licences * Improving cost-efficiency and increasing catch yield were identified as areas which would yield the greatest profitability improvements. Two potential means of achieving this were identified as the adoption of satellite tracking technology, and collective fishing models. In the case of the former, the technology has had limited trials and the effectiveness is not proven. As for the latter, adoption of cooperative or collective fishing models requires a high degree of cooperation which is not a characteristic of the SSJF. * It was concluded that the only currently feasible opportunity to directly reduce costs is by adopting LED lighting technology. However, LED technology is unproven in the SSJF. * The assessment led to the acknowledgment that the SSJF is in a generally difficult position due to a number of factors which are beyond the control of the industry. Particularly, the SSJF’s competitors have a greater opportunity to invest in industry development, and to reduce costs (therefore providing a product on the market at a lower price than the domestic product). * A seven step roadmap for improving the future of the SSJF was developed to help guide the future direction of the fishery. |
| Outcomes | * Fishers, researchers, and government now have access to detailed information on the range of factors affecting the economic viability of the SSJF, as well as an assessment of the possible solutions for addressing these factors. * There has been progress by some industry members to develop a representative body but this has not yet been formally established. The industry members behind this initiative have been active in their efforts to develop new markets that offer a higher price for squid. These markets demand higher quality squid and some fishers have invested in a new boat with freezing capacity to meet the quality standards required (David Power, pers. comm., 2014). * This project assisted industry with identifying how they can increase the value of their products. However, finding squid in a cost effective way remains a substantial challenge for the fishery (David Power, pers. comm., 2014). |
| Benefits | * Potential profit increases through cost reduction and/or increased demand. |

**Project Investment**

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

Table 3: Investment by FRDC by Project for Years Ending June 2003 to June 2011 (nominal $)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Project** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **Total** |
| 2002/250 | 0 | 166,023 | 210,335 | 29,807 | 41,845 | 47,887 | 47,887 | 0 | 0 | **543,784** |
| 2003/206 | 0 | 61,918 | 69,830 | 0 | 0 | 168525 | 50,000 | 0 | 0 | **350,273** |
| 2003/213 | 0 | 0 | 172,188 | 385,004 | 50,164 | 0 | 151,839 | 0 | 0 | **759,195** |
| 2005/217 | 0 | 0 | 0 | 3,970 | 11,909 | 3,861 | 0 | 0 | 0 | **19,739** |
| 2005/239 | 0 | 0 | 0 | 15,966 | 3,991.50 | 0 | 0 | 6,652.50 | 0 | **26,610** |
| 2006/211 | 0 | 0 | 0 | 0 | 56,958 | 43,190 | 0 | 10,698 | 0 | **110,846** |
| 2006/212 | 0 | 0 | 0 | 0 | 0 | 37,790 | 0 | 7,998 | 0 | **45,788** |
| 2006/229 | 0 | 0 | 0 | 0 | 12,000 | 0 | 0 | 0 | 48,000 | **60,000** |
| 2007/200 | 0 | 0 | 0 | 0 | 27,460 | 28,080 | 68,030 | 13,721.91 | 0 | **137,292** |
| 2007/238 | 0 | 0 | 0 | 0 | 30,000 | 40,106 | 0 | 0 | 0 | **70,106** |
| 2007/241 | 0 | 0 | 0 | 0 | 0 | 35,000 | 28,000 | 7,000 | 0 | **70,000** |
| 2007/250 | 0 | 0 | 0 | 0 | 0 | 80,645 | 41,732 | 13,077 | 0 | **135,454** |
| 2008/099 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 55,000 | 20,000 | **75,000** |
| 2009/221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20,000 | 55,000 | **75,000** |
| **Total** | **0** | **227,941** | **452,353** | **434,746** | **234,327** | **485,084** | **387,489** | **134,147** | **123,000** | **2,479,087** |

Table 4: Investment by Researchers & Others by Project for Years Ending June 2003 to June 2011 (nominal $)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Project** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **Total** |
| 2002/250 | 42,470 | 54,642 | 56,763 | 8,490 | 0 | 0 | 0 | 0 | 0 | **162,365** |
| 2003/206 | 0 | 145846 | 207181 | 152,182 | 76,081 | 0 | 0 | 0 | 0 | **581,290** |
| 2003/213 | 0 | 96,799 | 92,309 | 75,938 | 0 | 0 | 0 | 0 | 0 | **265,046** |
| 2005/217 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 2005/239 | 0 | 0 | 0 | 34825 | 0 | 0 | 0 | 0 | 0 | **34,825** |
| 2006/211 | 0 | 0 | 0 | 0 | 104210 | 0 | 0 | 0 | 0 | **104,210** |
| 2006/212 | 0 | 0 | 0 | 0 | 57328 | 0 | 0 | 0 | 0 | **57,328** |
| 2006/229 | 0 | 0 | 0 | 0 | 242600 | 0 | 0 | 0 | 0 | **242,600** |
| 2007/200 | 0 | 0 | 0 | 0 | 0 | 29,050 | 0 | 0 | 0 | **29,050** |
| 2007/238 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 2007/241 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 2007/250 | 0 | 0 | 0 | 0 | 0 | 2,283.33 | 14250 | 0 | 0 | **16,533** |
| 2008/099 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 2009/221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| **Total** | **42,470** | **297,287** | **356,253** | **271,435** | **480,219** | **31,333** | **14,250** | **0** | **0** | **1,493,247** |

Table 5: Annual Investment in Cluster (nominal $)

|  |  |  |  |
| --- | --- | --- | --- |
| **Year ending June** | **FRDC** | **Researchers and Others** | **Total** |
| 2003 | 0 | 42,470 | 42,470 |
| 2004 | 227,941 | 297,287 | 525,228 |
| 2005 | 452,353 | 356,253 | 808,606 |
| 2006 | 434,746 | 271,435 | 706,181 |
| 2007 | 234,327 | 480,219 | 714,546 |
| 2008 | 485,084 | 31,333 | 516,417 |
| 2009 | 387,489 | 14,250 | 401,739 |
| 2010 | 134,147 | 0 | 134,147 |
| 2011 | 123,000 | 0 | 123,000 |
| **Total** | **2,479,087** | **1,493,247** | **3,972,334** |

**Benefits**

The various projects included in this cluster have helped generate a number of actual and potential economic, environmental and social benefits. These can be broadly separated into the following categories:

* Increased profitability of wild-catch fisheries
* Increased industry and scientific capacity
* Decreased environmental impacts of fisheries production

Table 6 summarises the major actual and potential benefits by category for each of the projects.

Table 6: Type of Benefit Delivered by Project

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Project Number** | **Project Title** | **Type of Benefit** | | |
| Increased profitability of fisheries | Increased industry and/or scientific capacity | Decreased environmental impacts of fisheries production |
| 2002/250 | SEF Industry Development Subprogram: agricultural trials of a fish-based fertiliser (BioPhos) produced from Australian seafood processing wastes | 🗸 | 🗸 | 🗸 |
| 2003/206 | Antifouling solutions for the Australian pearling industry – coatings for shell and equipment | 🗸 | 🗸 |  |
| 2003/213 | Rock Lobster Enhancement and Aquaculture Subprogram: establishing post-pueruli growout data for Western Rock Lobsters to assess economic viability |  | 🗸 |  |
| 2005/217 | Rock Lobster Enhancement and Aquaculture Subprogram: the feasibility of translocating Rock Lobsters in Tasmania for increasing yield | 🗸 | 🗸 | 🗸 |
| 2005/239 | Fishing energy efficiency review for the FRDC | 🗸 | 🗸 | 🗸 |
| 2006/211 | Rock Lobster Post Harvest Subprogram: examination of green sustainable process technology for preparing chitin and associated derivatives from Rock Lobster waste |  | 🗸 |  |
| 2006/212 | Rock Lobster Post Harvest Subprogram: development of bait saving strategies for the Western Rock Lobster fishery | 🗸 |  |  |
| 2006/229 | Southern and Eastern Scalefish and Shark Fishery Industry Development Subprogram: development and implementation of an energy audit process for Australian fishing vessels | 🗸 | 🗸 | 🗸 |
| 2007/200 | SESSF Industry Development Subprogram: alternative fuels for fishing vessels | 🗸 |  |  |
| 2007/238 | Ornamental Fish Industry in Australia 2006/07 | 🗸 |  |  |
| 2007/241 | Feasibility study for the use of biofuel for the Western rocklobster industry |  | 🗸 |  |
| 2007/250 | Increased economic efficiency for the Western Rock Lobster Fishery through improved pot design | 🗸 |  |  |
| 2008/099 | Tactical Research Fund: Torres Strait Tropical Rock Lobster fishery 5 year business plan | 🗸 | 🗸 | 🗸 |
| 2009/221 | Tactical Research Fund: Improving the economic efficiency of the Southern Squid Jig Fishery | 🗸 |  |  |
| Frequency | | 11 | 9 | 5 |

Table 7 provides in a triple bottom line framework a 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 profitability of fisheries 2. Improved industry and scientific capacity | 1. Reduced environmental impact of production | 1. Improved scientific capacity |

The benefits identified in Table 7 above have been classified into subjective beneficiary categories and a subjective estimate of their magnitudes is provided in Table 8. Benefit numbers in Table 8 refer to the benefit numbers in Table 7.

Table 8: Categories of Benefits from the Investment

|  |  |  |
| --- | --- | --- |
| **Fishing industry** | **Spillovers** | |
| **Other industries** | **Public** |
| 1. \*\*\*  2. \*\* |  | 3. \*  4. \* |

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

**Public versus Private Benefits**

The investment will result in both public and private benefits to Australia. On the basis of the 4 benefits listed in Table 7, and an equal weighting for each benefit, it could be concluded that the public benefits could make up 50% of the total benefits. If the subjective weightings are taken into account (Table 8), the public benefits could make up 29% of total benefits.

**Distribution of Benefits along the Supply Chain**

The majority of private benefits will be captured initially by fishers and aquaculture producers. Some benefits (and costs) may be shared along the supply chain, including to consumers of seafood products.

**Benefits to other Industries**

The projects in this cluster had the potential to benefit producers of a range of products including organic foods, fertilisers, pharmaceuticals, and alternative fuels. However, for the most part such benefits have not been realised. As such actual benefits to other industries are expected to be minor.

**Benefits Overseas**

The majority of projects were focused on specific Australian fisheries, or analysed generic issues in an Australian context. There may be some minor benefits to overseas parties from projects such as 2003/206; however these benefits are not expected to be significant.

**Additionality and Marginality**

The investment in the projects in this cluster has been categorised as medium-high priority due to the fact some projects were of a very high priority while others were of lower priority.. FRDC contributed 61% of total funding for the 14 projects (in real terms), but this percentage varied greatly across individual projects. If the FRDC had not received funding from government, some of these investments would probably still have been supported by the FRDC but to a lesser extent. Some of the investment may have been funded through other sources if the 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? | Medium-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, perhaps 50% to 75% of actual total investment made. |
| Would the cluster have been funded if no public funding for FRDC had been available? | Yes, but with lesser total investment, perhaps 25% to 50% 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 Research Priorities

|  |  |
| --- | --- |
| **Australian Government** | |
| **Strategic Research Priorities (est. 2013)** | **Rural Research Priorities (est. 2007)** |
| 1. Living in a changing environment 2. Promoting population health and wellbeing 3. Managing our food and water assets 4. Securing Australia’s place in a changing world 5. Lifting productivity and economic growth | 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 |

Source: DAFF (2014) & ARComm (2013)

The cluster substantially contributes to Strategic Research Priorities 3 and 5. The cluster investment was also strongly associated with Rural Research Priorities 1, 3 and 4, as well as both supporting priorities.

**Quantification of Benefits**

**Benefits Valued**

The main benefit valued in this analysis is the improved profitability of wild-catch fisheries. This was achieved via two main pathways: increased catch through translocation, and lower operating costs through improved energy efficiency.

Benefits which were identified but not valued include:

* Increased industry and scientific capacity
* Reduced environmental impact of fisheries production

These two benefits were not valued due to difficulties in valuation or because the benefits were perceived to be minor in comparison to those valued.

***Rock lobster translocation***

By providing initial justification for further investment, Project 2005/217 has made a significant contribution towards the establishment of commercial scale translocation in the Tasmanian Rock Lobster fishery. This movement of lobsters from lightly fished deep water regions to more heavily fished inshore regions has led to an increase in catches in the fishery and a maintenance of quota levels in the fishery. This has in turn led to increased profits for fishers.

The benefits and costs associated with a translocation scheme have been determined in seafood CRC Projects 2006/220 and 2011/744. Translocation efforts in the 2011/12 and 2012/13 seasons generated an additional 100,000kg of catch over two years. This was valued at a lease price of $28/kg (Caleb Gardner, pers. comm., 2014).

This additional catch was generated at a cost to industry of approximately $2/kg (Gardner, 2014). It is expected that in the future costs to industry will be higher at $3/kg, due to the absence of external funding (Gardner et. al., 2014).

The Tasmanian Rock Lobster industry has voted to continue translocation for the 2013/14, 2014/15, and 2015/16 seasons, and this is estimated to generate an additional 50,000kg of catch each year. Given that support for translocation is not unanimous throughout the industry, the probability of efforts continuing at this scale post-2016 has been assumed to be 90%.

*Attribution to Project 2005/217*

Project 2005/217 was only one of several projects which led to the implementation of translocation, with FRDC Projects 2006/220 and 2011/744 also playing a key role. Information on the present value of costs of these three projects is presented in Table 11.

Table 11: Present Value of Total Investment in Translocation Research

|  |  |  |
| --- | --- | --- |
| **Project** | **Present Value of Costs ($)** | **Proportion of total investment (%)** |
| 2005/217 | 33,446 | 0.6 |
| 2006/220 | 4,599,785 | 89.1 |
| 2011/744 | 530,558 | 10.3 |
| Total | 5,163,789 | 100.0 |

Even though Project 2005/217 represented only a minor fraction of total investment required to generate impacts, an attribution factor of 2% was applied in recognition of the project’s critical role in providing the justification for further research.

***Energy efficiency***

A number of projects in this cluster addressed the issue of energy usage and efficiency in Australian wild-catch fisheries. Of these projects, three (Projects 2005/239, 2006/229 & 2007/200) have been valued for their contribution towards an improvement in energy efficiency in the industry.

*Estimating energy costs*

Comprehensive data on the costs associated with energy usage in Australian fisheries are not available, so some broad assumptions have been made regarding this variable. As fuel (predominately diesel) represents the primary energy source in Australian fisheries, a reduction in fuel costs was used as a means of valuing energy efficiency gains.

The first assumption made in estimating fuel costs was that these expenses represent approximately 10% of revenue for operators using passive fishing methods and 30% of revenue for active fishers. This reflects the differences in fishing methods; passive fishing techniques rely on fish being attracted to the fishing gear, whereas active fishing involves using fishing gear to pursue the fish. The key differences are summarised in Table 12.

Table 12: Fuel Costs by Fishing Method

|  |  |  |
| --- | --- | --- |
| **Category** | **Fuel cost as proportion of gross revenue** | **Examples** |
| Passive fishing | 10% | Rock Lobster fishing, abalone diving, trapping, long-lining |
| Active fishing | 30% | Trawl fisheries |

Source: Agtrans Research, based on Wakeford (n.d.) and discussions with industry personnel

Passive methods are generally used to target rocklobster, abalone, crabs, molluscs and crustaceans (excluding prawns), while active fishing is typically used for prawns. Finfish are assumed to be targeted by 50% passive and 50% active fishing in recognition of the range of techniques used. One exception is the case of the South Australian state fishery, where finfish fishing is assumed to be 100% active as the catch is predominantly sardines caught by active methods. Miscellaneous ‘other’ fishery products are assumed to be targeted by passive methods.

The next step in estimating fuel expenses was to determine the proportion of total Gross Value of Product (GVP) generated by different fishery products. This information is summarised in Table 13.

Table 13: Fishery Products in State Fisheries by Share of 2012 GVP

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **State Fishery** | **Catch Type** | | | | | |
| Finfish | Prawns | Rock Lobster, crabs & other crustaceans | Abalone & other molluscs | Other fishery products | Total |
| Share of GVP (%) | | | | | |
| New South Wales | 53.5 | 19.5 | 18 | 8 | 1 | 100 |
| Victoria | 20 | 0 | 35 | 45 | 0 | 100 |
| Queensland | 39 | 32 | 25 | 3 | 1 | 100 |
| South Australia | 18 | 14 | 49 | 19 |  | 100 |
| Western Australia | 16 | 12 | 66 | 6 | 0 | 100 |
| Tasmania | 2 | 0 | 42 | 56 | 0 | 100 |
| Northern Territory | 75 | 0 | 24 | 0 | 1 | 100 |

Source: Calculations using data contained in ABARES (2013)

Following on from this, fuel expenses for each fishery were calculated by multiplying these percentages by the average GVP for years 2002-2012. The following formula was used:

The results of these calculations are presented in Table 14.

Table 14: Fuel Costs for State Fisheries

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **State** | **Average GVP ($/annum)** | **Proportion of fishing activity by fishing method** | | **Estimated fuel expenses ($/annum)** |
| Passive | Active |
| New South Wales | 90,894,017 | 54% | 46% | 17,497,098 |
| Victoria | 74,470,826 | 90% | 10% | 8,936,499 |
| Queensland | 225,454,300 | 48.5% | 51.5% | 45,767,223 |
| South Australia | 211,710,823 | 68% | 32% | 34,720,575 |
| Western Australia | 373,888,081 | 80% | 20% | 52,344,331 |
| Tasmania | 178,405,580 | 99% | 1% | 18,197,369 |
| Northern Territory | 33,393,869 | 62.5% | 37.5% | 5,843,927 |
| **Total** |  | | | **183,307,023** |

Source: Agtrans Research, with GVP information sourced from ABARES (2013)

In the case of Commonwealth fisheries, it was assumed that each fishery used either 100% passive or 100% active methods, with the exception of ‘other fisheries’ which were assumed to be 50% of each type. These calculations are outlined in Table 15.

Table 15: Fuel Costs for Commonwealth Fisheries

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Fishery** | **Average GVP**  **($/annum)** | **Fishing method** | | **Estimated fuel expenses ($/annum)** |
| Passive | Active |
| Northern Prawn | 85,301,146 |  | 100% | 25,590,344 |
| Torres Strait | 28,779,367 | 100% |  | 2,877,937 |
| SESSF Commonwealth Trawl Sector | 57,979,713 |  | 100% | 17,393,914 |
| SESSF Gillnet, Hook and Trap Sector | 25,563,061 | 100% |  | 2,556,306 |
| SESSF Great Australian Bight Trawl Sector | 12,997,360 |  | 100% | 3,899,208 |
| Eastern Tuna and Billfish | 43,860,496 | 100% |  | 4,386,050 |
| Southern Bluefin Tuna | 47,562,867 |  | 100% | 14,268,860 |
| Western Tuna and Billfish | 10,579,949 | 100% |  | 1,057,995 |
| Bass Strait Scallop | 1,532,949 |  | 100% | 459,885 |
| Southern Squid Jig | 1,163,882 | 100% |  | 116,388 |
| Other fisheries | 41,864,746 | 50% | 50% | 8,372,949 |
| **Total** |  | | | **80,979,835** |

Source: Agtrans Research, with GVP information sourced from ABARES (2013)

Based on these calculations, total fuel expenses for all Australian wild-catch fisheries were determined to be approximately $264 million per annum.

*Valuing efficiency gains*

Valuation of this impact is based on the assumption that adopting operators will achieve a 5% reduction in fuel expenses due to improved efficiency. Contact with industry personnel suggested that efficiency gains could be as high as 10-20%, however for this analysis a conservative figure was considered to be more appropriate. This 5% also takes into account:

* The avoidance of wasteful investment due to the suppression of inaccurate information on ineffective ‘efficiency’ investments.
* Any capital or other costs required for capturing the fuel efficiency gains.

Industry adoption has been estimated at 5%. This is intended to account for industry members not reached by the project, and those for whom the findings are not relevant. Furthermore, adoption is limited due to many fishers being hesitant to undertake the necessary capital investment in an uncertain environment, and operational factors which make implementing practice changes difficult (e.g. operators may not be able to operate at a lower speed due to a need to meet deadlines, match competitors, avoid bad weather etc.).

**Summary of Assumptions**

A summary of the key assumptions made is shown in Table 16.

Table 16: Summary of Assumptions

|  |  |  |
| --- | --- | --- |
| **Variable** | **Assumption** | **Source** |
| ***Translocation*** | | |
| *General assumptions* | | |
| Value of additional catch generated | 28 $/kg | Gardner, pers. comm., 2014 |
| Additional catch generated | 50,000 kg/year | Gardner et. al. (2011) |
| Attribution to Project 2005/217 | 2% | Table 11 and associated discussion |
| *2011/12 and 2012/13 seasons* | | |
| Cost of acquiring additional catch | 2 $/kg | Gardner et. al. (2011) |
| *2013/14 seasons onward* | | |
| Cost of acquiring additional catch | 3 $/kg | Gardner et. al. (2011) |
| Probability of outcome post 2015/16 | 90% | Gardner, pers. comm., 2014 |
| ***Energy Efficiency*** | | |
| Total fuel expenses for Australian fisheries | See Tables 14 & 15 | Agtrans Research, based on information contained in ABARES (2013) |
| Total fuel expenses in Australian wild-catch fisheries | $264 million per annum | Agtrans Research, using information from Wakeford (n.d) and ABARES (2013) |
| Reduction in fuel costs | 5% | Agtrans Research, based on discussions with David Sterling and John Wakeford |
| Maximum adoption | 5% | Agtrans Research |
| Year of first benefit | 2009 | Agtrans Research, based on the majority of contributing projects being completed in 2008 |
| Years to maximum adoption | 5 | 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 degree 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 17 and 18 show the investment criteria for the different periods of benefits for both the total investment and the FRDC investment.

Table 17: Investment Criteria for Total Investment

(discount rate 5%)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Years** | **Number of years from last year of investment** | | | | | | |
| **0** | **5** | **10** | **15** | **20** | **25** | **30** |
| Present value of benefits ($m) | 0.95 | 4.24 | 6.92 | 9.02 | 10.67 | 11.96 | 12.98 |
| Present value of costs ($m) | 7.05 | 7.05 | 7.05 | 7.05 | 7.05 | 7.05 | 7.05 |
| Net present value ($m) | -6.10 | -2.81 | -0.12 | 1.98 | 3.62 | 4.92 | 5.93 |
| Benefit-cost ratio | 0.13 | 0.60 | 0.98 | 1.28 | 1.51 | 1.70 | 1.84 |
| Internal rate of return (%) | negative | negative | 4.8 | 7.4 | 8.6 | 9.2 | 9.5 |

Table 18: Investment Criteria for FRDC Investment

(discount rate 5%)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Years** | **Number of years from last year of investment** | | | | | | |
| **0** | **5** | **10** | **15** | **20** | **25** | **30** |
| Present value of benefits ($m) | 0.58 | 2.61 | 4.25 | 5.55 | 6.56 | 7.35 | 7.97 |
| Present value of costs ($m) | 4.23 | 4.23 | 4.23 | 4.23 | 4.23 | 4.23 | 4.23 |
| Net present value ($m) | -3.64 | -1.62 | 0.03 | 1.32 | 2.33 | 3.12 | 3.75 |
| Benefit-cost ratio | 0.14 | 0.62 | 1.01 | 1.31 | 1.55 | 1.74 | 1.89 |
| Internal rate of return (%) | negative | negative | 5.1 | 7.8 | 9.0 | 9.6 | 9.9 |

One reason for the relatively modest investment criteria was that the first 3 projects made up over 70% of the total investment cost in the cluster (present value terms), yet did not lead to significant lasting commercial outcomes. While these projects and several others in the cluster achieved their objectives and produced useable outputs, the industry adoption or further investment required to generate benefits did not occur.

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) for each of the two benefits valued was estimated separately and then summed to provide an estimate of the total value of benefits. Table 19 shows each benefit expressed as the PVB and the percentage of total benefits.

Table 19: Source of Benefits (discount rate 5%, 30 year period)

|  |  |  |
| --- | --- | --- |
| **Benefit** | **PVB**  **($m)** | **% Total** |
| Lobster translocation | 0.42 | 3.2 |
| Energy efficiency | 12.56 | 96.8 |
| Total | 12.98 | 100.0 |

Table 20 shows a subjective assessment of total benefits against the rural research priorities. Bear in mind that this assessment refers only to the benefits that were valued.

Table 20: Benefits Valued and Rural Research Priorities

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Benefit** | **PVB**  **($m)** | **Productivity and Adding Value** | **Supply Chain and Markets** | **Natural Resource Management** | **Climate Variability and Climate Change** | **Biosecurity** |
| % subjective allocation to each priority | | | | |
| Lobster translocation | 0.42 | 90 | 0 | 10 | 0 | 0 |
| Energy efficiency | 12.56 | 85 | 0 | 0 | 15 | 0 |
| Total ($m) | 12.98 | 11.05 | 0 | 0.04 | 1.88 | 0 |
| Total (%) | 100.0 | 85.2 | 0 | 0.3 | 14.5 | 0 |

**Sensitivity Analyses**

The sensitivity analysis on the discount rate (Table 21) demonstrates that the investment criteria are highly sensitive to the discount rate over the range considered. This is likely due to the long duration of benefits assumed.

Table 21: Sensitivity to Discount Rate

(Total investment, 30 years)

|  |  |  |  |
| --- | --- | --- | --- |
| **Criterion** | **Discount Rate** | | |
| 0% | 5% | 10% |
| Present value of benefits ($m) | 21.17 | 12.98 | 9.55 |
| Present value of costs ($m) | 4.85 | 7.05 | 10.13 |
| Net present value ($m) | 16.32 | 5.93 | -0.58 |
| Benefit-cost ratio | 4.36 | 1.84 | 0.94 |

Table 22 demonstrates the sensitivity of the investment criteria to changes in the level of fuel cost savings assumed for Australian fisheries.

Table 22: Sensitivity to Assumed Extent of Fuel Cost Savings

(Total investment, 30 years)

|  |  |  |  |
| --- | --- | --- | --- |
| **Criterion** | **Fuel cost savings** | | |
| 2.5% (pessimistic) | 5% (base case) | 10% (optimistic) |
| Present value of benefits ($m) | 6.70 | 12.98 | 25.54 |
| Present value of costs ($m) | 7.05 | 7.05 | 7.05 |
| Net present value ($m) | -0.35 | 5.93 | 18.49 |
| Benefit-cost ratio | 0.95 | 1.84 | 3.62 |

**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 23). 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 23: Confidence in Analysis of Cluster

|  |  |
| --- | --- |
| **Coverage of Benefits** | **Confidence in Assumptions** |
| Medium | Medium (a) |

1. *Medium to high for translocation, low for fuel efficiency*

**Observations for Future Investment and Evaluation**

1. A number of projects evaluated had been completed a long time ago, with many years having passed since project completion. In the case of some of these projects researchers had moved into other research areas and had not kept track of their research after its completion.
2. The 14 projects included in this cluster spanned a wide variety of industries and issues, and in many respects most did not seem to have much in common except that they concerned profitability. Projects ranged from scientific trials of new technologies, through to desktop feasibility studies and information gathering exercises. Such a grouping can be seen as working against one of the purposes of clustering. The disparate nature of the projects not only contributes to greater difficulties in impact valuation, but also potentially decreases the value of the analysis in providing useful input for strategies regarding future investment priorities.

**Key Performance Indicators**

The Theme 7 key performance indicators are described in Table 24.

Table 24: Key Performance Indicators for Theme 7

|  |  |  |
| --- | --- | --- |
| **KPI** | **Description** | **Number of projects contributing** |
| 1 | Development of knowledge, processes and technologies to improve productivity and profitability of the commercial sectors. | 9 |
| 2 | Development of knowledge and technologies in the areas of domestication and breeding genetics to support growth of the aquaculture sector. | 1 |

Of the projects in this cluster, 10 were deemed to be directly contributing towards the theme’s Key Performance Indicators. The four which did not make a direct contribution provided information which could be used as a basis for further research and policy-making, and as such may have contributed in an indirect manner.

**Conclusions**

FRDC investment in the Profitability cluster produced a range of mainly productivity and capacity building benefits. These benefits were primarily economic in nature, although some social and environmental benefits were delivered via an increase in scientific capacity and a reduction of some environmental impacts. Three benefit categories were identified. Of the 14 projects in the population, only four contributed to the impacts that were valued, with three of these projects contributing to the principal benefit valued, that of fuel efficiency gains leading to increased profitability of wild-catch fisheries.

The fuel efficiency projects were commenced amid unprecedented rises in fuel costs. Fuel prices have since backed off somewhat, leading to a reduction in enthusiasm for research in that area. However when the next cyclical price rise/price shock occurs, interest may resurface.

The majority of projects in this cluster produced usable outputs, however in some cases there was a failure to translate research outputs to lasting outcomes and benefits. Common reasons for this included a change in market conditions, opposition from certain industry sectors, emergence of superior technology, and other unforeseen factors which reduced the attractiveness of the usefulness of research outputs.

Overall, the investment criteria estimated for total investment in the cluster of $7.05 million (present value of costs) were positive with a present value of benefits of $12.98 million, a net present value estimated at $5.93 million and a benefit-cost ratio of 1.84 to 1, all estimated using a discount rate of 5% and with benefits estimated over 30 years from the final year of investment.

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