Fisheries Research and Development Corporation

Economic Evaluation of FRDC Funding Submissions

BDA Group eSYS

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CONTENTS

EVALUATION SUMMARY

What we did?

- eSYS Development and BDA Group were contracted by the FRDC to carry out an economic evaluation of the 2001/200-240 series projects submitted for funding consideration.

- Benefit cost analysis was used to estimate the expected economic pay off on all submitted projects – as measured by a project's net present value (the difference between project benefits and costs over a 20 year period) and benefit cost ratio (the ratio of all project benefits to all project costs).

How we did it?

- Individual economic evaluations required future benefits and costs to be estimated.

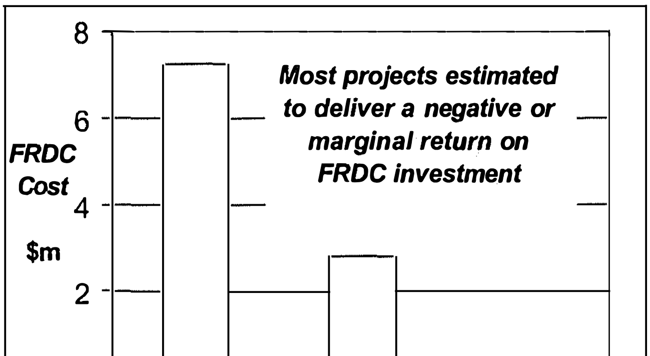
- Project benefits were determined in consultation with Principal Investigators and a number of people from industry. FRDC staff also provided feedback on evaluation assumptions. Project costs were obtained from project submissions and consultant estimates of possible additional R&D expenditure required for commercial development.

- In estimating project benefits, an assessment was first made on what the R&D would produce and what additional investment would be required to produce a commercial outcome or technology (product, process or information).

- Industry benefits considered included lower production costs, increased consumer demand (which leads to higher prices), higher quality production, disease and health risks and industry development.

- A one page summary of each evaluation was prepared and is included in this report. Each summary makes explicit assumptions regarding industry outcomes, benefits to individual technology users, technology adoption through time and risk or chance of achieving a successful outcome.

What we found?



- 37 projects were assessed with a potential FRDC investment totaling $10.2m

- Only 2 projects, with a combined FRDC investment of $0.2m, had a high expected pay off (more than $2 of benefit for every $1 invested).

- Majority of projects had either marginal industry benefits for the level of project risk or had excessive costs.

IDENTIFIED EVALUATION ISSUES

This is the first time that projects submitted to the FRDC for funding consideration have been subject to an economic evaluation prior to funding decisions being made. Although the main purpose of the consultancy was to provide a rapid and robust economic assessment of submitted projects, we thought that there could be value in highlighting a number of issues that may be relevant for the future.

✓ Generally, the link between R&D output and commercial outcome was not clear in the application or after discussions with principal investigators. Project needs and planned outcomes (section B3 and B6 in application) tend to address general issues facing the industry rather than specific industry benefits that can be attributed to the project.

✓ Although some assessment is made in project applications about the degree of risk faced, risk is largely considered in terms of the technical aspects associated with each project. In many cases there will be considerable downstream risks in commercialising technologies, including scale-up, marketing and distribution.

✓ Cost-benefit evaluation results have been adjusted to reflect both technical and commercial risks. While this is a reasonable approach when considering the relative attractiveness of projects, it is largely inadequate when trying to build a portfolio of investments. In this case, the risk / reward trade off should be made explicit so that an appropriate balance can be achieved. This would require an assessment of FRDC's current portfolio and the value that could be generated from different combinations of new investments

✓ Some projects are not designed to deliver a commercial outcome – many just contribute to knowledge, and further R&D is typically needed before a commercial outcome is achieved. Again, these projects should be assessed from a portfolio perspective.

✓ Economic evaluations were carried out on submitted projects, and hence serve only to provide an indicator of relative "value for money". Prospective evaluations of this type also have value when used in an iterative process to focus project design, cost and output.

✓ In many situations R&D would still be undertaken either domestically or overseas without FRDC financial support. The competitive advantage of FRDC's investment in realising industry benefits sooner than would otherwise occur – or to a greater extent, should be considered.

✓ It was not possible to derive monetary estimates for potential environmental impacts within this consultancy time frame. Potential environmental threats to the fishing industry should, however, be quantified and individual projects assessed on the basis of their contribution to reducing any environmental risks or consequences. In the absence of this data, it is extremely difficult to determine the magnitude of environmental benefits that could be attributed to individual projects.

✓ Making evaluation assumptions explicit enables debate to focus on key drivers of industry benefit. The evaluation framework developed under this consultancy could be successfully applied to other areas of FRDC's investment portfolio.

PROJECT RANKING BASED ON ECONOMIC PAYOFF (BENEFIT COST RATIO)

Project ID	Project Title	FRDC Cost ($)	Payoff (BCR)
234	Rock Lobster Post Harvest Subprogram: a code of practice for handling rock lobster	97,617	25.0
210	Development of a farm-level HACCP plan for the NSW prawn farm industry for identifying and reducing disease risks to spawners, postlarvae and growout prawns from viruses such as White Spot Virus, Gill Associated Virus and Spawner-isolated Mortality Virus	98,400	13.8
205	Atlantic Salmon Aquaculture Subprogram: management and control of amoebic gill disease of Atlantic salmon	1,159,500	1.8
201	Southern Bluefin Tuna Aquaculture Subprogram: commercialisation trials for a manufactured tuna feed	450,001	1.6
214	Development of a disease zoning policy for marteiliosis to support sustainable production, health certification and trade in the Sydney rock oyster	380,066	1.4
240	Optimising at-sea post-harvest handling procedures for the pilchard (Sardinops sagax)	139,106	1.2
230	Design and assessment of innovative harvesting equipment for glass eels in high water flows	34,593	1.1
235	Rock Lobster Post Harvest Subprogram: striking a balance between melanosis and weight recoveries in western rock lobster (Panulirus cygnus)	247,193	1.1
204	Atlantic Salmon Aquaculture Subprogram: system wide environment issues for sustainable salmonid aquaculture	194,175	1.1
215	Design and evaluation of sub tidal production systems for Pacific oyster (Crassostrea gigas)	202,320	1.0
208	Aquaculture Nutrition Subprogram: increasing the profitability of snapper farming by improving hatchery practices and diets	594,116	1.0
212	Increasing production of premium-size marron: an investigation to promote growth and minimise moult deaths in larger market-size marron	254,631	0.9
239	Aquaculture Nutrition Subprogram: commercialisation trials using value-added seafood waste for aquafeed utilisation	197,311	0.9

Project Ranking

Project ID	Project Title	FRDC Cost ($)	Payoff (BCR)
202&3	Captive reproduction of yellowfin (and bigeye) tuna & Feasibility study of yellowfin and bigeye tuna fingerling production and growout	371,468	0.8
223	Applications of insulin-like growth factor-I (IGF-I) assays in finfish aquaculture	210,927	0.7
206	Improving growth and survival of cultured marine fish larvae: striped trumpeter, Latris lineata, a test case for Tasmania	403,774	0.6
200	Southern Bluefin Tuna Aquaculture Subprogram: tuna cell line development and their application to tuna aquaculture health surveillance	299,233	0.6
218	Copepod culture for finfish larviculture	524,673	0.6
236	Nutritional and species characterisation of the marketing groups escolar and rudderfish	189,788	0.6
207	Selection for faster growing black bream Acanthopagrus butcheri	107,808	0.4
209	Diagnosis, distribution and disease triggers of gill-associated virus (GAV) infections in Australian black tiger prawns (P monodon)	346,184	0.4
219	Scaling-up marine zooplankton culture in outdoor tanks for larval finfish rearing	253,500	0.4
222	National vibrio reference laboratory for aquaculture & fisheries	470,155	0.4
231	Upgrade of national fisheries database to include images and common names of Australian fishes	238,896	0.3
232	Developing domestic and international seafood markets for undervalued and under-utilised seafood products (DDISM)	486,320	0.3
217	Aquaculture Nutrition Subprogram: nutritional strategies for reducing waste outputs of barramundi aquaculture	355,232	0.2
220	Aquaculture Nutrition Subprogram: development of marine fish larval diets to replace Artemia	523,903	0.2
224	Moulting regulation in high value crustacean aquaculture species	345,240	0.1
221	Microalgae for Australian aquaculture: production of a CD-ROM database	112,731	0
225	Development of sponge (Spongia Spp.) farming as a viable commercial enterprise for remote aboriginal communities and outstations	45,017	0
226	National chemical registration framework	164,090	0
228	Social impact assessment of fisheries: measuring the consequences of alternative management actions	526,291	0

Project Ranking

Project ID	Project Title	FRDC Cost ($)	Payoff (BCR)
229	Use of the National Recreational Fishery Survey data to estimate the value of recreationally caught fish	64,260	0
233	Seafood Services Australia: pilot project to determine the effectiveness of FoodSafe Plus as a tool in meeting ANZFA food safety standards	55,000	0
237	The current public health status of ciguatera poisoning in north Queensland and an Investigation of a ciguatoxin-binding protein in tropical fish species and its potential for application in the development of a rapid assay for ciguatoxin in tropical fish	92,964	0
Total	⇨	**$10.2m**	**1.1**
Top 5	⇨	**$2.2m**	**3.3**
Projects with a positive payoff	⇨	**$3.5m**	**2.5**

Note: Benefit cost ratio was calculated on all project costs (which include FRDC and partner contributions). FRDC costs are reported separately to make explicit the potential FRDC commitment to individual projects.

ECONOMIC EVALUATION OF INDIVIDUAL PROJECTS

In this section economic evaluation parameters for individual projects submitted to the FRDC for funding consideration are reported. Each evaluation has been reported in a consistent manner with key assumptions made explicit. The format used is described in some detail in the box below.

BOX 1: REPORTING FORMAT FOR INDIVIDUAL EVALUATIONS

R&D Output:

- What will be produced at the completion of the FRDC supported project?
- Output will typically be a technology – be it a product, process or information.

***Industry Outcome*:**

- What further steps will be required before the technology has a commercial application across the fishing industry?
- When will the technology be commercially available?
- What type of gain or benefit will be realised by the industry?

***Benefit in Use*:**

- For the typical technology user, what is the estimated benefit in dollar terms?
- Derivation of monetary benefits is shown.

Benefits through time

The distribution of estimated benefits over a 20 year period is shown graphically.

***Adoption*:**

- Size of market
  How large is the target market where the technology could potentially be used?
- Max adoption (as % of market)
  What is the anticipated level of take-up or adoption within the target market?
- Rate of adoption %
  Over what period of time will the technology be taken up within the target market?

***Risk*:** Risk level: (likelihood that industry outcome achieved)

- Is the commercial outcome guaranteed or is there an element of risk?
- What are the major determinants of project risk?

***Conclusion*:**

- Is the project attractive from an economic perspective?
- What is key driver of pay off and at what point would the project break even?

Tuna cell line development (2001/200)

R&D Output:

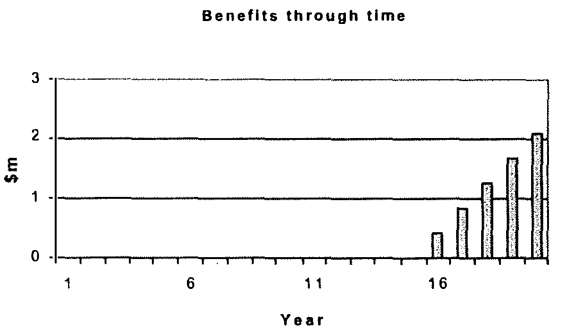
- Tuna cell line at AAHL
- Diagnostic tools that can be used to outside of AAHL to identify disease status in farmed tuba stocks and potential broodstock
- Surveillance process in tuna that is similar to salmon farming

Industry Outcome:

- Main impact will be for captive tuna production
- Identification of disease-free tuna that can be used in captive tuna production
- Identification of low level disease incidence in farmed tuna populations – this will entail implementation of a surveillance program across hatcheries and grow out enterprises.

Benefit in Use:

- Main benefit will be for enterprises that breed and rear juvenile tuna for subsequent growing out.
- Captive reproduction of tuna is still some way off – perhaps 10 to 20 years.
- In these enterprises the risk and loss associated with potential disease outbreaks will be minimised
- At a reduction in mortality of 5% for a 20 kg tuna at $10 kg value, saving would be, on average, $10 per fish or 50c per kg tuna sold for grow out.



Adoption:

- Size of market
  Within 15 years farmed tuna could be sourced from reared juveniles – some 4.2 kt annually
- Max adoption as %
  If captive production economical all grown out tuna would be from reared juveniles
- Rate of adoption %
  Taken up fully by year 20

Risk: High risk (25% chance of success) because:

- Successful application of techniques in salmon industry but juveniles not currently available
- Some risk as susceptibility of tuna to marine fish viruses not known at this stage.
- Success will depend on development of captive tuna production & grow out industry

Conclusion:

- Investment not attractive with NPV = -$0.4m and BCR = 0.6
- Main driver of value will be development of an industry to breed and rear juvenile tuna for subsequent grow out. Investment would be more attractive if made when captive tuna industry closer to commercial reality.

R&D Output:

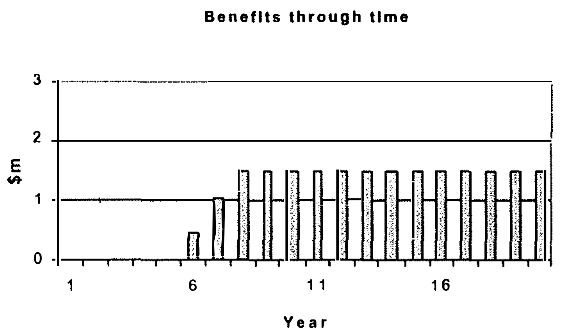
- Commercial feed pellet that can be used in SBT grow out instead of frozen fish (pilchards).

Industry Outcome:

- Commercial availability of tuna feed from Pivot (Tasmanian plant) by 2006
- Pellet feed to achieve a feed conversion ratio (FCR) of 8:1
- Longer term goal to produce pellet that does not need cold storage

Benefit in Use:

- Feed replacement greatest gain to industry
- For grow out of a 20 kg fish to 32 kg
  - Pilchard cost now at FCR of 15:1 and $0.80 kg = $144 or $4.50 per kg final weight
  - Pellet cost with FCR of 8:1 and $1.35 kg = $130 per fish or $4.06 per kg final weight.
- Total feed cost saving = $0.44 kg final weight
- Annual total benefit across whole industry (6.7kt) = $2.9m



Adoption:

- Size of market – 75% of industry
  Target replacement of pilchard imports
- Max adoption - 50%
  Limited to some extent by need for additional capital costs
- Rate of adoption
  Uptake should be rapid if cost saving achieved – 3 years

Risk: Medium risk (50% chance of success) because:

- Achieving target FCR of 8:1 will require re-formulation of pellet specifications by Pivot. Project is currently focused on a break even with FCR of 10:1
- Financial risk greatest to Pivot (discounted pellet cost and supply if FCR exceeds 12:1). Sepencer Gulf Fish Farms could incur additional feed costs if pellets do not perform to grow out targets. Total cost risk $0.5m year 1

Conclusion:

- Investment attractive with NPV = $1.8m and BCR = 1.6. (only at risk and fixed capital included with FRDC contribution)
- Likely that, if project successful, pellets used with pilchards to get more consistent product rather than cost saving (similar level of benefit).
- Largest gain will be to Pivot (80% share of feed market) from increased production of pellet feed. This incentive will be more relevant to further commercialisation of pellets than that available to the farmed tuna industry.
- Real long-term industry value may be in reducing risk of exotic disease outbreaks (through less reliance on imported pilchards) and reduced environmental discharges.

R&D Output:

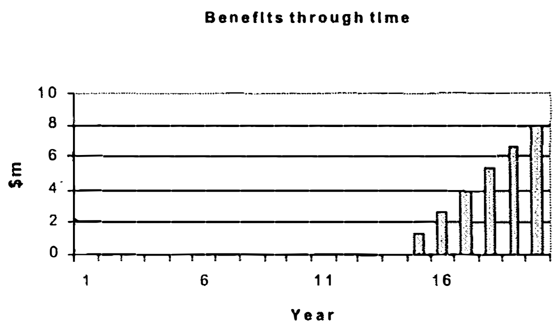
- Information (scientific papers) on the capture and breeding of yellowfin tuna to 5 kg to 10 kg.
- Information on the growing out of reared yellowfin tuna to 20 kg to 25 kg final weight
- Economic feasibility analysis of tuna fingerling production and grow out on the east coast of Australia.

Industry Outcome:

- Information will largely contribute to general R&D in tuna fingerling production. Most R&D worldwide is in bluefin tuna and there may be some synergies with this work. Further invetsment of $3m required.
- Considerable follow-on investment will be required in the development of a yellowfin hatchery industry and subsequent grow-out, neither which exist today. This is unlikely to occur within 15 years. An understanding of captive production will be one element in the investment decision and grow out may only be viable if fingerling cost is considerably less than wild harvest.

Benefit in Use:

- Main benefit will be the future development of a captive yellowfin tuna fishery on the east coast of Australia. Projected GVP of captive production around $200m of which $20m would be profit.



Adoption:

- Size of market
  At prices of around $10 kg implied market volume is 20 kt annually
- Max adoption
  Possible to achieve market volume as not dependent on wild harvest
- Rate of adoption
  Considerable investment required in new product / market hence likely to be slow – over 15 years.

Risk: High risk (25% chance of success) because:

- Little progress to date on captive production of tuna and so far largely contained to bluefin
- Substantial product risk as no industry currently exists. Market risk may also be high if significant volumes are targeted at Japanese market.

Conclusion:

- Investment not attractive with NPV = -$0.7m and BCR = 0.8
- Scope to minimise FRDC financial exposure by building on world-wide R&D in captive bluefin tuna.
- Risk too high for level of ultimate benefit
- Significant longer term benefits may be realised when application is transferred to bluefin tuna.

R&D Output:

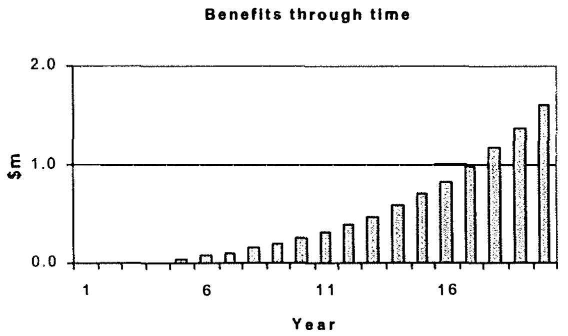
- The stock of information relating to physical, chemical and biological characteristics of the Huon Estuary and D'Entrecasteaux Channel will be enhanced through surveys and measurement of water quality parameters
- Data will be incorporated in a hydrodynamic-ecological model that will be used to determine the effects of salmon farming practices on surrounding waters.

Industry Outcome:

- Development of the model may help develop practices and farm designs that more cost-effectively meet environmental benchmarks.
- All stakeholders in target estuaries may benefit from the preservation of water quality
- A follow-on project of two years, @$200,000 per year would be required to package modeling outputs into farm environmental management guidelines

Benefit in Use:

- Administration and miscellaneous items were estimated to cost salmon farmers $55,000 per annum within a 40,000 smolt system - $491 per tonne of salmon produced.
- If improved environmental management guidelines derived from the project (eg. possibly more cost-effective monitoring practices) could decrease these costs by 15%, a $74 t saving would be realised
- Assume 50% of the Tasmanian salmon industry reaps this cost saving



Adoption:

- Tasmanian salmon industry (9,196 tonnes) – expanding at 10% per annum
- 50% of the industry is assumed to capture benefits reduced environmental compliance measures.
- Results of project would first be adopted by industry in Year 5. Adoption rate – 5% per annum

Risk: Medium risk (35% chance of success) because:

- Research strategic in nature, with limited scope to transfer recommendations to industry

Conclusion:

- Marginal investment with NPV = $0.1 m and BCR = 1.1
- The availability of scientific information relating to the off-site impact of aquaculture may help to facilitate industry expansion otherwise retarded as a result of environmental concerns. Ecosystem pollutant load tolerances need to be determined.
- Low probability of research translating into practical farm benefits constrains project attractiveness - research appears to be strategic in nature

R&D Output:

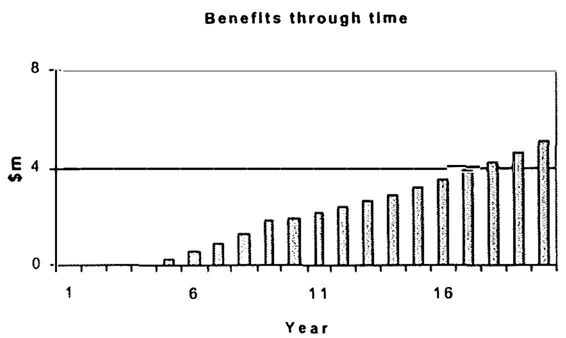
- Develop improved (Amoebic Gill Disease) AGD treatment methods possibly based on vaccines, novel therapeutics and/or marker assisted genetic selection
- Increase in the amount of fundamental knowledge about host-pathogen interactions – particularly focusing on the validation of infection-challenge systems, confirmation of acquired immunity and development of AGD in-vitro techniques
- Determination of AGD distribution and development of disease-risk forecasting models.

Industry Outcome:

- Reduced Atlantic Salmon (AGD) mortality and/or reduced costs of disease prevention and treatment. Current practice of freshwater bathing becomes expensive when fresh water supplies are low and less effective when estuary salinity is high.

Benefit in Use:

- Hired labour and medicine estimated to cost $1,133 t salmon/yr, which could be reduced by 2% under improved disease management regime. A cost saving benefit of $23t/yr would be apparent
- Average salmon farm productivity would be increased with the reduced incidence of AGD. Farm productivity would be increased by 2% per year with improved AGD management.



Adoption:

- Atlantic salmon industry estimated to be 9,196 tonnes in 1999.
- Forecast to increase by 10% per annum.
- Max adoption as 50%. Small number of large commercial players
- Rate of adoption 10% per annum. Maximum adoption achieved within 5 years.
- Results first adopted in 5 years.

Risk: Medium-high - (30% chance of success) because:

- Largely a modeling and disease surveillance project, with limited attention to industry extension and technology transfer. Industry collaboration in the CRC for finfish aquaculture would help to facilitate transfer
- The development of complicated management recommendations may not be widely adopted by industry if they are difficult or labour intensive to adopt

Conclusion: Attractive Investment - with NPV = $2.3 m and BCR = 1.8. Despite a medium probability of project outcome, the investment is attractive due to the substantial impact of AGD infection on salmon production.

Improved Growth and Survival of Striped Trumpeter Larvae (2001/206)

R&D Output:

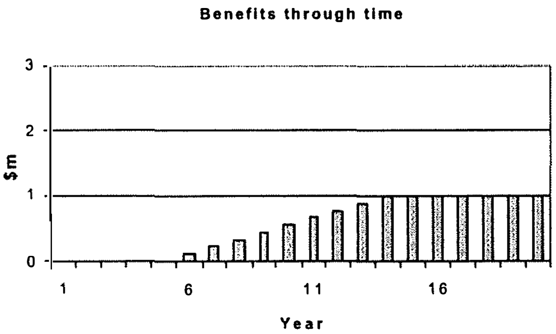
- Greater knowledge of lipid and vitamin requirements of striped trumpeter larvae
- Development of techniques for enrichment of live-feeds using PUFA-rich oils, bacteria, vitamins - along with use of copepods as a supplementary live-feed
- Transfer of striped trumpeter hatchery technology to commercial partner.

Industry Outcome:

- Reduced larval mortality and improved hatchery feeding technology would make commercial striped trumpeter a feasible proposition for finfish producers
- The availability of alternative finfish species would reduce monoculture risks (disease and possible price) faced by Australian salmon producers
- Enhanced hatchery technology would be of relevance to other finfish species and may reduce industry production costs in applicable industries.
- Follow-on research would be likely for commercial refinement of production technology. Assumed to be a further 3 years @$200,000 per year.

Benefit in Use:

- Currently there is no use of striped trumpeter in commercial aquaculture production.
- Annual value of industry benefits estimated to be $1.0 million ($10 kg received for final fish, 10% industry profit margin, 1,000 t produced in 2015)



Adoption:

- Size of market
  Assumed production capacity will increase from 0 t in 2001 to 1,000 t by 2015
- Max adoption is 100%. Project output required for industry development
  Rate of adoption – implicit in industry growth
- Results first adopted 6 years.

Risk: High - (25% chance of success) because:

- Possible technical difficulties associated with species larval mortality and extended growth "paper fish" phase

Conclusion:

- Investment not attractive - with NPV = $-0.7 m and BCR = 0.6
- Break even striped trumpeter production in 2015 would need to be 1,607 tonnes. Note: NPV of $0.5 m would be achieved with 2,000 tonne production by 2015.

R&D Output:

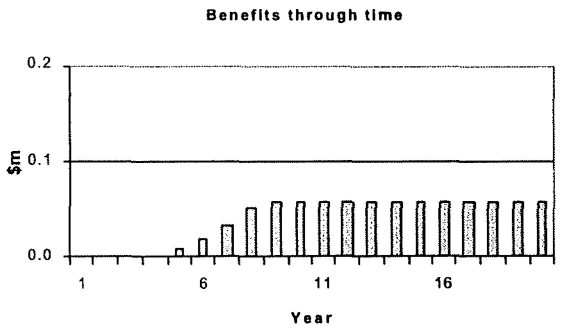
- Increase in the volume of information about weight gain in genetically different strains of black bream including data relating to genetic variance and heritability of faster growth rate;
- A prediction of the economic benefits from an improvement in the 300-day weight of black bream;
- Development of a program that will produce hatchery reared black bream capable of reaching 250 g in 12 months; and
- Production of farmer management guidelines that will allow fish to reach genetic potential.

Industry Outcome:

- Farmers, largely on salt-affected land - switching to black bream production, would benefit through higher fish growth rates.
- An increase in growth rate from 0.3-0.4 g/ per day is thought to be achievable. Improved black bream husbandry techniques will be extended to farmers;
- The fish farming tourist industry may also expand as a result of the adoption of faster growing fish; and
- Additional expertise in finfish genetic improvement programs would be gained, some of which, would be applicable to other finfish species and industries.

Benefit in Use:

- An increase in growth rate of 45 kg fish/ha would generate annual total benefits across all industry estimated at $0.1 m.
- Assumes – 500 ha of ponds, an average farm-gate price of $5.00/kg and variable production cost $1.81/kg



Adoption:

- Size of market
  Assumed production capacity of 500 ha by 2010
- Max adoption as 80%
  Most black bream produced within WA - likely to have access to extension services
- Rate of adoption 20% per annum
  Maximum adoption achieved within 4 years. Results first adopted 5 years.

Risk: High - (30% chace of success) because:

- Current low growth rates of black bream and possible low heritability of growth rate

Conclusion:

- Investment not attractive - with NPV = $-0.1 m and BCR = 0.4.
- Small market size limits economic attractiveness. Maybe spill-over benefits for salinity management

Increasing the Profitability of Snapper Farming (2001/208)

R&D Output:

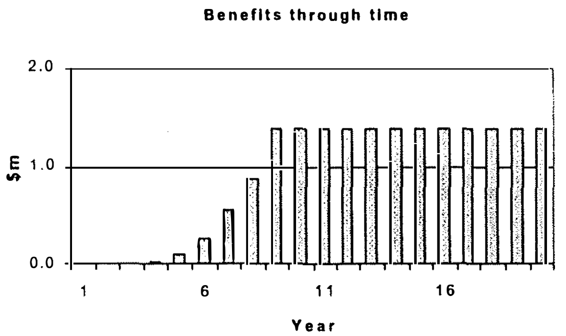
- Development of improved snapper fingerling production processes utilising fertilised pond rearing techniques, enhanced larval feeding strategies and reduced disease incidence strategies
- Provision of feeding practices to minimise overfeeding and diets that reduce pollution
- Development of strategies that improve farmed snapper skin colour by reducing melanisation.

Industry Outcome:

- Recommendations will help to develop viable hatcheries that produce fingerlings for 25 c. Currently, fingerlings sell for $1 each.
- Cost-effective high performance and low polluting diets will increase industry profitability through improved feed conversion and consistent supply of snapper with desired colour
- The development of low polluting diets would reduce environmental pressures on the industry,

Benefit in Use:

- Total snapper production was estimated to be 3,617 tonnes in 1998/99 and had a value of $16.4 million. Only a small proportion of this production is associated with aquaculture. Assumed to be 50 tonnes or 1%.
- Fingerlings and feed were estimated to cost $2,890 per tonne of snapper produced within a 100 t per year enterprise. A reduction in these costs by 30% per year, as a result of improved fingerling and feeding technology, would increase annual profitability by $867 per tonne of snapper
- Improved feed could reduce dark skin colouring – assumed to increase average price by $0.4 kg



Adoption:

- It is assumed that farmed production will increase to 2,000 t by 2010.
- Maximum adoption of 80% of total farmed production.
- Rate of adoption 20% per annum. Adoption would be rapid in relatively small industry
- Maximum adoption achieved within 4 years. Results first extended in 4 years.

Risk: High - (20% chance of success) because:

- There are some technical problems associated with egg and larvae supply and occurrence of diseases.
- Limited scope for industry expansion due to uncertainty about market fit for product – colour problems and also environmental issues

Conclusion:

- Investment not attractive- with NPV = $-0.1 m and BCR = 1.0.
- Small industry and expensive project.

GAV in black tiger prawns (2001/209)

R&D Output:

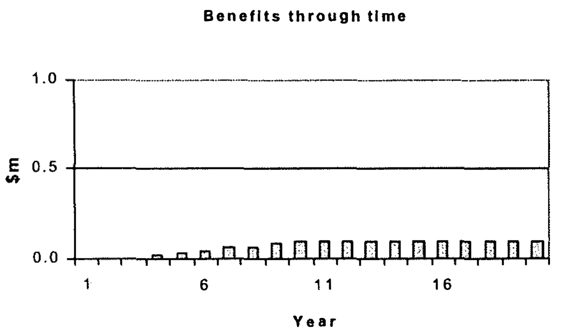
- Improved test (commercially available) for diagnosis of GAV on farms
- Information on how to manage GAV disease risk on farms
- Survey of prevalence of GAV and other pathogens in wild prawn populations.

Industry Outcome:

- There is no treatment to control or eradicate GAV (or other viruses). Disease risk and consequence can be minimised by maintaining high water quality and moderate stocking densities.
- PCR test for GAV and a number of other viruses is available. However, it is not recommended that routine testing for GAV be carried out on farms and hatcheries as prevalence is 95% or more across wild populations.
- Improved test and better understanding of GAV may enable farmers to delay harvest of diseased crops – and hence increase profits by monitoring the disease status on-farm. This could also be achieved if broodstock were sourced from disease free locations around Australia.
- Also, disease diagnosis will be important when the cycle is closed and seed broodstock screened for GAV – however PCR test available now.

Benefit in Use:

- Average profit margin (excluding capital) is 28% on GVP
- Reduction in production due to disease is 11% each year – includes less crops per year to maintain lower stocking densities.
- Contribution of GAV to all diseases 20% - so 3% production loss each year or $0.34m on total production of $44m.
- Farm level cost of test on total production = $50,000



Adoption:

- Size of market
  Production to reach 5 kt by 2005
- Max adoption 20%
  Limited – will need to keep stocking densities low anyway to protect from other diseases
- Rate of adoption 7 years
  Slow – PCR tests widely used overseas but not taken up widely in Australia.

Risk: Medium risk (50% chance of success) because:

- Considerable application of scientific techniques in this area world-wide
- Predicting optimal harvest times under different disease severity will be complex.

Conclusion:

- Investment not attractive with NPV = -$0.6m and BCR = 0.4
- Prawn farmers will need to manage whole range of diseases anyway and consequently production saving may not be realised.
- Break even if adoption reached 50% of production or if annual production loss avoided from GAV was 27% of total production.

R&D Output:

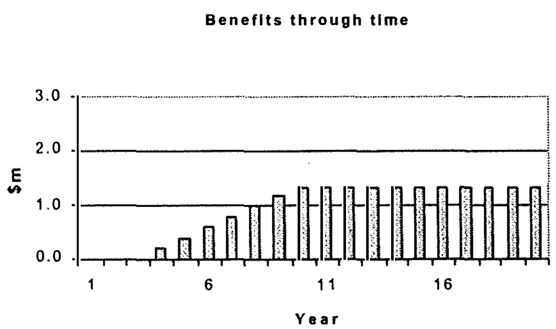
- Information on how to reduce the spread of viral disease on prawn farms in NSW
- Information on how a HACCP plan can be developed and implemented across the entire prawn farming industry.

Industry Outcome:

- While it is not necessarily an objective to progress down a detailed farm level HACCP plan for the industry, the outcome of the project will be to identify ways in which the disease risk can be managed by the industry.
- Diseases currently spread through the hatchery industry, and by encouraging prawn farmers to screen juveniles the likelihood of sourcing diseased juveniles will be reduced.
- Disease is currently managed through water quality and stocking rate management. A reduced risk of disease will increase production from existing and future farms.
- Industry outcomes should start to be realised in 2004.

Benefit in Use:

- Average profit margin (excluding capital) is 28% on GVP
- Reduction in production due to disease is 11% each year – includes less crops per year to maintain lower stocking densities.
- The current value of lost production due to disease is $1.4m annually on total production of 2.4 kt. Better risk management may reduce losses to 5%
- Farm level cost of screening juveniles on total production = $50,000. The potential saving is $260 tonne of prawn produced.



Adoption:

- Size of market
  Production to reach 5 kt by 2005
- Max adoption 100 %
  Adoption should be high as incentive will fall on hatcheries to source disease free broodstock (or with low prevalence of disease)
- Rate of adoption over 7 years
  Adoption will be slow as considerable resistance to the use of currently available diagnostic tests exists.

Risk: High risk (25% chance of success) because:

- Substantial industry resistance to taking up screening (although many PCR tests available) because of high incidence of disease in wild populations.
- Most limiting factor will be available sources of disease free broodstock around Australia.

Conclusion:

- Investment attractive with NPV = $2.1m and BCR = 13.8
- Break even uptake (maximum adoption) is only 5% of farms

Increasing production of premium size marron (2001/212)

R&D Output:

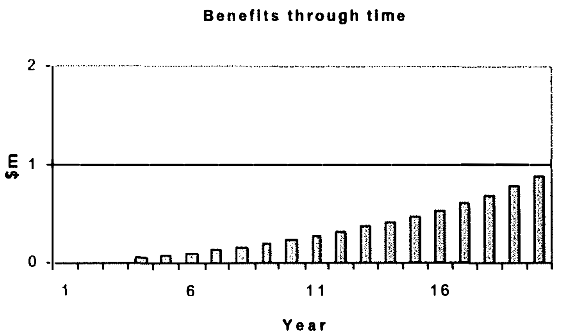
- Information on marron growth and mortality in the large (>120g) grade
- Determination of changes in farm practices that are required to manage larger marron stock
- A better understanding of the moult-cycle and optimal timing for avoiding pre or post-moult storage

Industry Outcome:

- Improved marron husbandry techniques will be extended to farmers via industry R&D groups, regular workshops, reports, 'best-practice guidelines' and publications
- The concept of 'relaying', a technique employed by USA crawfish farmers to produce larger stock, would be refined for Australian conditions, and allow Australian farmers to target the premium end of the market
- Techniques generated as part of the project would be used by marron farmers to achieve increases in pond productivity and enhanced product quality through increased harvest yields (> 120 g)

Benefit in Use:

- Operating parameters include - price for 220 g marron ($24/kg), cost of production ($10/kg) and profit margin ($14/kg).
- If an additional 251 tonnes of large marron could be produced partly as a result of project findings, annual industry benefits of $3.5 million would be generated. Assuming 25% of industry benefits attributed to this proposal, annual benefits of $1m are possible.



Adoption:

- Currently 49 tonnes of marron produced. Industry forecasting substantial growth over the next 10 years
- Assume a growth rate of 10% per annum resulting from increased profitability – with 25% of growth attributed to project
- Max adoption %. 100%
  Assume that industry growth partly results from successful development of large marron production techniques
- Results first adopted in Year 4

Risk: High (20% chance of success) because:

- High mortality rates have been observed in marron over 200 g
- Premium price for larger stock may be eroded with increased supply of product for this segment of the market and increase investment risk

Conclusion:

- Poor investment with NPV = $-0.1m and BCR =0.9.
- High risk reduces attractiveness of project.

R&D Output:

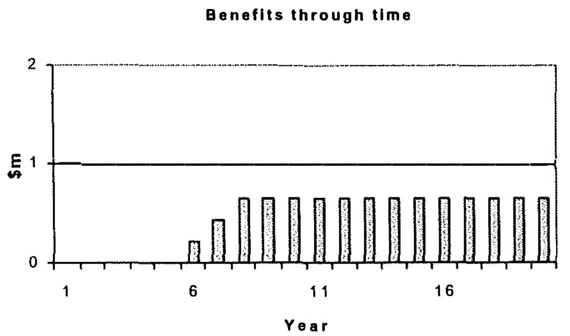
- Identification of marteiliosis (QX) endemic and disease-free areas using sampling and diagnostic techniques
- Determination of Marteilia spp. identities using ultra-structural and molecular diagnostics
- Prepare a zoning plan for QX based on disease sampling and identification,
- Extend results of the analysis through the internet, notices, journals and industry groups

Industry Outcome:

- Improved management of QX would reduce the probability of infected stock movement and protect the economic viability of disease-free segments on the industry
- Enhanced potential for international marketing of Australian Sydney rock oysters.
- Anticipate that a 3 year follow-on project @$100,000 per year required to implement zoning program

Benefit in Use:

- If an improved zoning program reduced the probability of QX spreading to 15% of the industry in 2010 by 5%
- A yield decline of 3,500 dozen/ha/year was incurred on QX infected farms
- Oysters prices of $4.50 per dozen oysters and variable production cost of $1.2 per dozen were apparent. Annual industry benefits of $0.5 m would be realised.



Adoption:

- The Sydney rock oyster industry was assumed to be stable at 5,387 ha, for the evaluation period.
- Zoning reduces the probability of QX spreading to 808 ha
- QX has traditionally been endemic in northern production areas, although it is now apparent in Georges River area.
- Probability of spread reduced by 5%. Low probably of reduced spread included due to possibility of 'carrier state' existence in numerous estuaries

Risk: Medium - (40% chance of success) because:

- Issues surrounding sensitivity of diagnostic techniques and sampling.
- Means of implementing the zoning program not clearly stated.

Conclusion:

- Investment attractive- with NPV = $0.3 m and BCR = 1.4.
- High project returns were calculated - despite a medium probability of success - due to large industry size.

R&D Output:

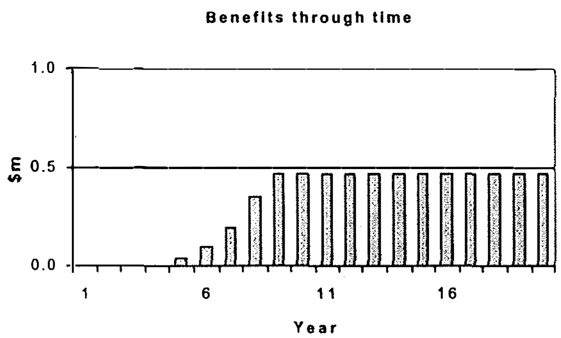
- Review of sub-tidal production technology in use around the world which will be stored in a web-hosted database
- Development of technical plans for sub-tidal oyster production based on experimentation and scientific examination
- Integration of information gained from project into marine engineering course materials

Industry Outcome:

- Enhancement of sub-tidal grow-out technology that addresses product quality and shell life differences with inter-tidal production systems
- Adoption of production guidelines will result in more efficient production of sub-tidal oysters
- Greater awareness of profitable sub-tidal production technologies and practices would facilitate increased industry investment in this production system
- Improve industry safety on exposed leases by reducing the probability of mechanical failure of system components

Benefit in Use:

- Adoption of improved sub-tidal production practices would improve oyster quality. It is assumed that average price increases by $0.18 per dozen as a result of enhanced shell and mussel quality
- Sub-tidal 'best practice' may involve additional farm capital expenditure – valued to be $0.05 per dozen.



Adoption:

- 50 ha of sub-tidal leases currently utilised in Tasmania. Assumed to increase to 450 ha (SA and TAS) by 2010
- Average production 10,000 doz/ha/yr
- Improved production techniques adopted by 80% of producers.
- Rate of adoption 20% per annum
- Maximum adoption achieved within 4 years.
- Results first adopted 5 years.

Risk: High - (20% chance of success) because:

- May not be able to overcome industry perception that sub-tidal systems produce poorer quality product - resulting in limited adoption
- Technical issues such as - dislodgment of systems and components of the system being prone to tangling and fouling difficult to overcome.

Conclusion:

- Marginal Investment - with NPV = $0.0 m and BCR = 1.0.
- Large industry that has been expanding considerably in the last decade. Payoff driven by rate at which industry expands.

R&D Output:

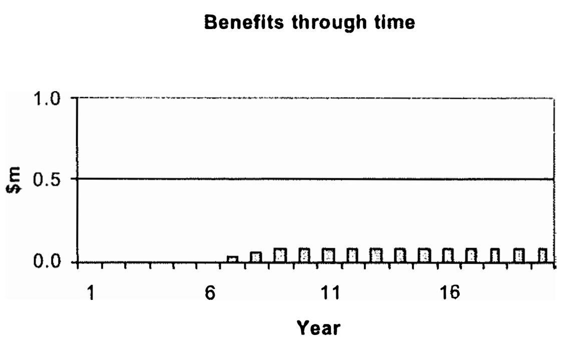
- Scientific information on the phosphorus requirements of barramundi
- Information on waste outputs (organic matter, phosphorus and nitrogen) from at least nine commercially used feeds.
- Development of new feed diets for barramundi that reduce waste outputs.

Industry Outcome:

- The EPBC Act (2000) will have little impact on feed diets used in the barramundi industry. However, general movement towards tighter environmental constraints at the State level will lead to higher production costs as a result of waste monitoring and compliance requirements. Project output unlikely to have any real impact on these costs.
- The main commercial impact of this project will be the development of new diets that are more cost effective due to less waste. New diets would need to be tested in a commercial environment and produced and marketed by feed producers to meet specifications demanded by farmers. A further 3 years would be required @ $200,000 per year.

Benefit in Use:

- Current feed cost is $1.60 kg barramundi produced.
- Cost saving around 15% or $0.24 kg production



Adoption:

- Size of market
  Total production around 800 tonnes with growth prospects – to 1,200 tonnes in 2010
- Max adoption
  Feed performance varies across locations and any one diet may achieve 30% of market.
- Rate of adoption
  Simple replacement of diet will promote quick uptake – over 3 years.

Risk: Medium risk (50% chance of success) because:

- Assessment and nutritional needs and waste output based on well established scientific methods – some risk with extrapolation of results.
- Considerable risk associated with development of "eco diets" that are commercial viable in both manufacture and use.

Conclusion:

- Investment not attractive with NPV = -$0.9m and BCR = 0.2
- Break even cost saving is $1.14 kg barramundi produced.

R&D Output:

- Technology developed for mass production of copepod for larval finfish feed and transferred to commercial partner (Bluewater Barramundi).
- Information on commercial performance of different fish species using developed copepod diet.

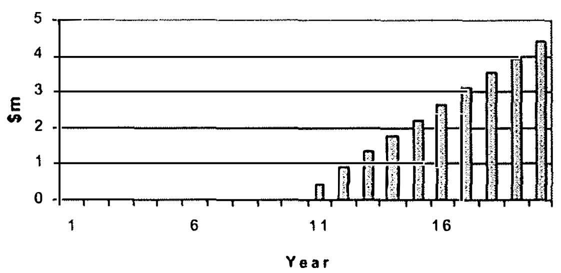
Industry Outcome:

- R&D targeted at reef finfish production for live market. QDPI expects that $14m of R&D required over 10 years to get industry going. Production forecast in 20 years is 2.5 kt.
- Expected increase in fish prices will limit the extent to which fingerling costs constrain production in the future.
- Mass production would commence when industry starts to develop – would require development of new facilities. Project will deliver a cost saving in fingerling cost.

Benefit in Use:

- Fingerling cost estimated at $2.79 kg final fish weight (factors in low survival and growth of juvenile production).
- Cost saving around 30% = $1 kg.

Benefits through time



Adoption:

- Size of market
  2.5 kt for live export market in 20 years
- Max adoption
  Industry will pick up available technology at the time
- Rate of adoption
  High prices for reef fish will drive development of the industry from 2010.

Risk: High risk (25% chance of success) because:

- New feed industry in new finfish market.
- Depends on development of industry – paucity of technical information on the technology of aquaculture for these species.
- Industry outcome will be difficult to demonstrate from planned R&D output.

Conclusion:

- Investment not attractive with NPV = -$0.6m and BCR = 0.6. Break even cost saving would need to be $1.80 kg
- Larval diet R&D expected to be completed within 4 years. More economic to wait until 2006 when reef finfish industry closer to commercial production. This would also increase likelihood of a commercially relevant outcome.

Scaling-up marine zooplankton for larval finfish rearing (2001/219)

R&D Output:

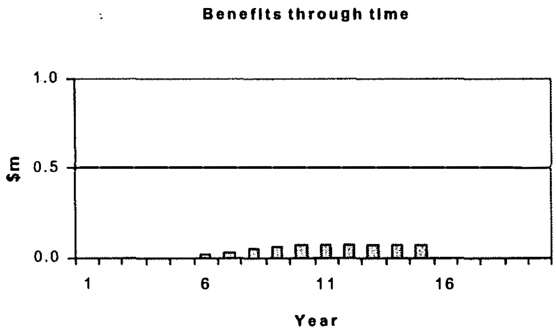
- Techniques for zooplankton production in outdoor tanks.
- Information on larval fish and fingerling production using tank reared zooplankton.
- Two PhD theses.

Industry Outcome:

- Research completed in 4 years and results tested in a commercial hatchery. No further development expected.
- Zooplankton expected to be produced at hatchery as add-on operation.
- Cost of fingerling production will decrease with a more cost effective alternative to artemia

Benefit in Use:

- Australian hatchery industry uses around 5 tonnes of artemia a year – insignificant volume compared to world hatchery demand.
- Artemia replacements available – but lower cost needs to be weighed against poorer performance. Many alternatives are non-economic.
- Total industry cost at AUS$100 kg (US$25 lb) around $0.5m a year.
- If economically viable alternatives available then would expect to reduce average annual cost by using alternatives when artemia prices are high. Assume saving is, on average, $50 kg a year.



Adoption:

- Size of market
  Current market around 5 t a year with some growth expected through time
- Max adoption high – to 40%
  Unlikely to be suitable for all species or used as part replacement
- Rate of adoption over 5 years
  Take-up rate moderate because of risk associated with trial of new feeds. Recommendations only valid for 10 years as new products become available.

Risk: Medium risk (50% chance of success) because:

- Natural marine zooplankton has been successfully cultured in outdoor tanks in other countries.
- Main risk will be application in commercial environment.
- Development of artemia replacements being developed elsewhere could put cost pressure on zooplankton diets.

Conclusion:

- Investment not attractive with NPV = -$0.3m and BCR = 0.4
- Break even saving in larval feed would need to be $137 kg

Development of marine fish larval diets to replace Artemia (2001/220)

R&D Output:

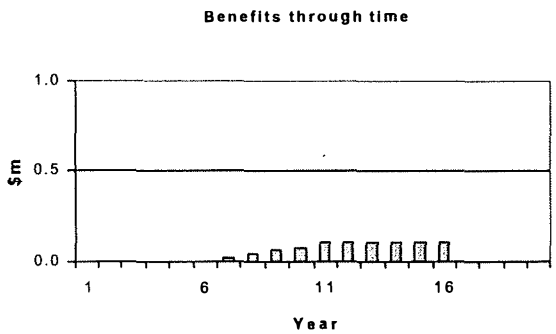
- Test results that measure the performance (growth and survival) of currently available artificial diets to replace artemia as a feed
- Measured performance of local artemia and enrichments
- Formulation of new or improved microparticulate diets

Industry Outcome:

- Results and recommendations will be distributed at the end of the project to the hatchery industry – further 3 years for industry to validate commercially.
- Information also to be used directly by feed suppliers
- Overall gain to the hatchery industry will be a cost saving in larval feed diets.

Benefit in Use:

- Australian hatchery industry uses around 5 tonnes of artemia a year – insignificant volume compared to world hatchery demand.
- Artemia replacements available – but lower cost needs to be weighed against poorer performance. Many alternatives are non-economic.
- Total industry cost at AUS$100 kg (US$25 lb) around $0.5m a year.
- If economically viable alternatives available then would expect to reduce average annual cost by using alternatives when artemia prices are high. Assume saving is, on average, $50 kg a year.



Adoption:

- Size of market
  Current market around 5 t a year with some growth expected through time
- Max adoption high – to 40%
  Unlikely to be suitable for all species or used as part replacement
- Rate of adoption over 5 years
  Take-up rate moderate because of risk associated with trial of new feeds. Recommendations only valid for 10 years as new products become available.

Risk: Medium risk (50% chance of success) because:

- Considerable work done internationally and economic viability of alternatives still not demonstrated.
- Recommendations will need to be tested in a commercial environment.

Conclusion:

- Investment not attractive with NPV = -$0.8m and BCR = 0.2
- Break even saving in larval feed would need to be $242 kg
- R&D cost economies may be achieved with better links to international feed suppliers.

R&D Output:

- Production of a cd-rom about microalgae – including physical and biochemical properties, culture characteristics and gaps in scientific knowledge. The cd-rom will include strains not currently marketed by the CSIRO.

Industry Outcome:

- The cd-rom will be marketed through CSIRO's microalgae supply service.
- The target audience will be hatcheries in Australia and R&D organisations.
- Information will contribute to other R&D work and not deliver an immediate benefit to industry. Industry gains may be achieved through reduced search times for information needed by R&D groups – but such savings are likely to be marginal.
- At a commercial level, the cd-rom will contribute to the delivery of CSIRO's microalgae supply service business.

Benefit in Use:

- The cd-rom production and distribution will be subsidised – market expectations are 100 – 200 units at a sale price of $100 each.
- Market valuation suggests cd-rom will be a loss-making venture – however could be justified if contributes to revenue stream from sale of products by Microalgae Supply Service.

Not relevant

Adoption:

- Size of market
  100 units – mainly R&D usage
- Max adoption
  Implicit in target market
- Rate of adoption
  Not relevant

Risk: Low risk because:

- Primarily a compilation of existing information
- Designed primarily to support further R&D efforts

Conclusion:

- Investment not attractive - Market valuation implies loss-making venture if a stand alone project.
- Cost should be absorbed within Microalgae business costs if cd-rom users do not value the product enough to pay a price that covers cost of production and distribution.

R&D Output:

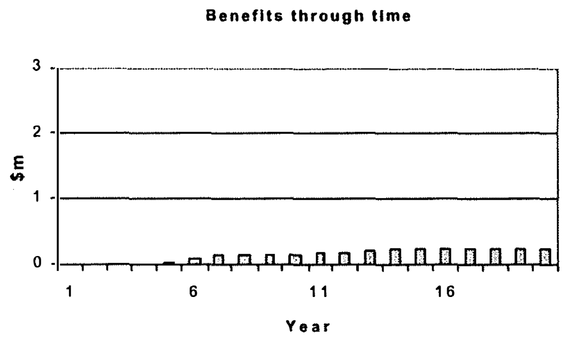
- A determination of the range of Vibrio spp. associated with finfish aquaculture, shellfish and crusacea in Australia – computer assisted identification software and PCF probes will be developed as part of this output
- Establishment of Vibrio reference identification service and implementation of national Vibrio reporting scheme
- Training, education and technology transfer to microbiologists in state veterinary laboratories.

Industry Outcome:

- Potentially reduced finfish, prawn, oyster and abalone mortality
- Reduced costs of Vibrio prevention and treatment.

Benefit in Use:

- Average salmon, Pacific oyster and Prawn farm profitability would be increased with the reduced incidence of Vibrio
- Assumed that the average cost of juveniles would be decreased by 2% as a result of reduced hatchery mortality.



Adoption: size of market:

- ⇒ Atlantic salmon industry estimated to be 9,196 t in 1999 - increase to 31,744 t by 2015
- ⇒ Pacific oyster - 4,909 t in 1996. increase to 5,500 t by 2015
- ⇒ Prawns – 2,413 t in 1999. increase to 3,500 t by 2015

- Max adoption 30%
- Rate of adoption 10% per annum
- Maximum adoption achieved within 3 years.
- Results first adopted 5 years.

Risk: Medium - (35% chance of success) because:

- Largely a disease identification and surveillance project
- Limited understanding of the nature of industry extension
- Practical value to industry needs to be better defined – for example could vaccine/novel therapeutics or disease zoning polices be developed and implemented as a result of proposed project.

Conclusion:

- Poor Investment - with NPV = \$-0.6m and BCR = 0.4.
- A low probability of a project outcome decreases the attractiveness of the project.
- Relatively large project cost

Application of IGF-I assays in finfish aquaculture (2001/223)

R&D Output:

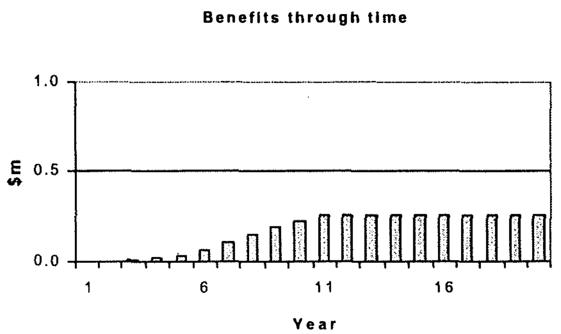
- This project seeks to examine the relationship of IGF-I to growth rates in finfish.
- Three areas are being examined to determine whether IGF-I concentrations can be used to predict long term growth rates in finfish, smolt status in salmon and heritability of high growth performance in salmon broodstock.

Industry Outcome:

- An assay is currently available and an industry outcome will be dependent on finding a relationship between growth and IGF-I that can be exploited commercially. This will be known at the end of the project.
- Outcomes could include
  - faster grow-out trials for new feeds and hence cost savings in feed costs
  - more predictable smolt status and hence less moralities in salmon
  - better growth performance in tilapia and hence shorter grow out cycle in salmon after further investigation (extra three years @ $50,000 pa)

Benefit in Use:

- Feed cost savings are likely to be marginal to other benefits given the relatively small size of feed market (greatest gain overseas).
- Failed smolt syndrome leads to moralities of around 15%, but can be managed to around 1% with better transport, handling and transfer. Better predictability may reduce a further 0.5% - benefit = $0.04m annually.
- Better growth performance reduces fixed costs as growing cycle is shortened. Average gain over last 10 year was 3% pa with breeding accounting for a third. A 0.3% (point) gain from project would give industry benefit of $0.02m with gains cumulative through time ($0.13m pa after 6 years).



Adoption:

- Size of market
  Market expected to grow to 14 kt by 2010
- Max adoption as 100%
  Market highly concentrated and outcomes relevant to all production
- Rate of adoption 5 years
  Moderate adoption as benefits to users are marginal

Risk: Medium to high risk (30% chance of success) because:

- Real driver of project benefits is breeding impact and application of IGF-I in this area has been limited to date.

Conclusion:

- Investment not attractive with NPV = -$0.2m and BCR = 0.7
- Break even rate for growth performance is 41% on top of what can be achieved now through breeding.

R&D Output:

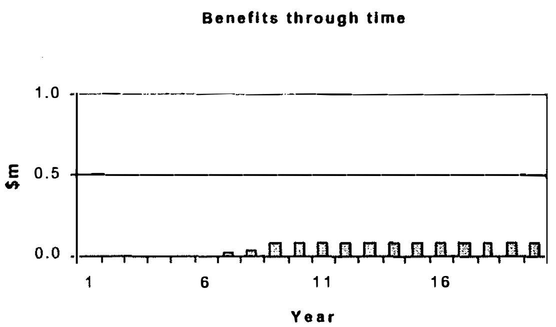
- Information on the impact of environmental factors on shell hardening and moulting
- Development of a technology that will enable farmers to control when moulting occurs in crabs

Industry Outcome:

- If the technology is successful it will need further validation and development in a commercial environment. This is likely to require an additional $200,000 a year for 3 years – available commercially in 2007.
- Main outcome will be in crab aquaculture in the first instance. Soft shelled crabs sell at a premium in the US (main market) of around 25% of hard shell crabs (main species is blue crab). Crabs are harvested by hand at moulting.
- In Australia around 6 kt of crabs harvested (wild) with very little farmed production. R&D has demonstrated that crabs can be bred and grown out to a marketable size. If industry develops then project outcomes would enable cost savings in the production of soft shell crabs. Forecast production some 100 tonnes in 2005.

Benefit in Use:

- Price around $6.30 kg with premium of $1.60 kg
- Cost saving potentially 80 cents kg if technology cost is trivial against hand collection.



Adoption:

- Size of market
  Market at 100 tonnes in 2005 to 200 tonnes by 2010.
- Max adoption
  Soft shell market 50% of total
- Rate of adoption 3 years
  Significant cost saving would promote rapid take-up if technology simple and compatible with industry practices

Risk: High risk (25% chance of success) because:

- Knock out gene technology (not transgenics) is quite novel in application to moulting.
- Market and product risks are high – most crab is consumed domestically but greatest opportunities in export markets.

Conclusion:

- Investment not attractive with NPV = -$1.3m and BCR = 0.1
- High cost / high risk project with inadequate benefit – break even cost saving is $10,000 tonne.
- Greatest application would be overseas

R&D Output:

- Suitable sponges for low technology commercial culture will be identified;
- Existing sponge production technology will be adapted for Northern Territory conditions;
- A market assessment for bath, cosmetic and industrial sponges will be conducted
- Financial and economic analysis of sponge farming will be conducted to determine the level of investment required.

Industry Outcome:

- The primary aim of this one year project is to identify a viable culturing system for sponges. Further development will be required to extend and refine commercial production systems.
- As a result of this and follow-on projects, commercial low technology sponge production would be established in remote Northern Territory communities

Benefit in Use:

- Currently no low technology sponge farming is carried out in Australia, although production occurs in the United States, the Mediterranean and in Micronesia
- Natural sponges retail for $7 each. In the future sponges could be used for a range of pharmaceutical products (e.g. antibiotics) and to 'soak-up' nutrients produced by marine cage aquaculture.
- Large scale retailers are averse to selling wild caught sponges due to the environmental damage caused when harvesting

Not relevant

Adoption:

- Max adoption high – to 100%
- All low-technology production would most likely flow from this project
- Recommendations valid for 20 years as low-technology practices would not become obsolete across evaluation time frame.
- Follow-on funding would be required to field test systems and extend 'best practice' recommendations.

Risk: High risk because:

- A good quality endemic sponge has not been found - with low foreign material, no spicules and asexual reproduction.
- The financial viability of remote production has yet to be ascertained

Conclusion:

- Investment not attractive – project largely pursues social objectives.

National Chemical Registration Framework (2001/226)

R&D Output:

- Establish a mechanism for chemical registration and maintenance
- Different models for the management of chemicals will be reviewed
- Consultation with key stakeholders will be undertaken to determine appropriate model to adopt

Industry Outcome:

- Increased efficiency of production as a greater range of chemical products would be registered for use in Australian wild catch and cultured fisheries industries.
- Reduced probability of residue issues constraining Australian seafood exports
- Reduced cost associated with registration as protocols would be established and communicated to industry and government stakeholders.

Benefit in Use:

- If chemical costs could be reduced in Salmon, Prawn and other fisheries industries as a result of having greater access to registered products, a national benefits would be realised.
- Currently producers have to register product under minor use permits which need to be renewed on a regular basis and involve the collation of data
- Australian authorities do not recognise registration-related data collected overseas for a number of products. The cost of assembling data is likely to be prohibitive for a number of chemicals under current process.

Not relevant

Adoption:

- Size of market (mainly affects aquaculture industries where antibiotics and other chemicals are used)
  - ⇒ Atlantic salmon industry estimated to be 9,195 t in 1999
  - ⇒ Farmed prawn output estimated to be 2,413 t in 1999
- Maximum adoption
  Would affect all industries once framework instituted
  Results first adopted 2 years

Risk: Medium risk because:

- Study largely desk-top and involving industry consultation.
- High probability that a framework will be developed as a result of the project being financed.
- Mechanism for extension not clearly defined

Conclusion:

- Investment not economically attractive. Largely a policy related outcome.

Social impact assessment of fisheries (2001/228)

R&D Output:

- Existing social impact methods used in Queensland fisheries will be applied to the NSW estuarine trawl and Victorian abalone fishery
- Development of spatial databases and profiles - incorporating financial and social information - about each fishery. The financial model utilised for the SA Rock Lobster industry will be used as a template for this analysis.
- The economic and social impact of reduced access to traditional fishery resources will be analysed.

Industry Outcome:

- The development of social impact tools and incorporation of social criteria into fisheries management plans will help policy makers make more holistic decisions, instead of focusing primarily on biological outcomes.
- Incorporation of social outcomes such as, regional community impacts, production values, employment and income levels and measures of community dependency networks, into fisheries management plans
- Utilisation of broader criteria may lead to optimal economic production of a fishery.

Benefit in Use:

- The case study NSW estuarine (prawn and general) trawl was comprised of 1,301 fishing licenses in 1999 and the Victorian abalone fishery accounted for 71 license holders
- Utilisation of social impact criteria may not necessarily lead to economic benefits, as the pursuit of social equity objectives may lead to a decrease in overall production of a fishery - analysis of regional employment impacts and other community dependency relationships could lead to decreased access to the fishery resources in the event that impacts are below expectation

Not relevant

Adoption:

- Target industries - NSW estuarine (prawn and general) trawl and the Victorian abalone fishery.
- Not clear how social analyses in Queensland industry and SA Rock Lobster fishery has been integrated into policy making and what positive/negative economic impact has transpired.

Risk: Medium-high risk because:

- Not clear how analysis will be integrated into policy making.
- Types of social benchmarks to be used in the analysis not clearly specified

Conclusion:

- Investment not economically attractive. Social equity benefits rather than economic benefits would be generated.

R&D Output:

- An increase in the stock of information relating to the value of recreational fish catch
- Enhancement of National Recreational Fishing Survey Data to include economic valuation – possibly based on travel cost, hedonic pricing or random utility modeling for two case studies
- Presentation of results to Recfish and conference papers

Industry Outcome:

- Results of the study will be used for industry policy making – particularly relating to resource distribution issues, collection of fees and levies, questions of damage and compensation, and allocation of funding for representation and research

Benefit in Use:

- Results of the study would be used to optimise resources between commercial and recreational fishery users
- There are not likely to be additional industry economic benefits generated from the project

Not relevant

Adoption:

- Target industries – NSW fisheries will form the basis of the case study valuations
- Not clear how analysis would be integrated into policy making

Risk: Medium risk because:

- The impact of travel cost and other valuation techniques on policy making not readily apparent

Conclusion:

- Investment not economically attractive. Enhanced policy making rather than economic benefits would result.
- The importance of recreational fishing management has, however, been recognised. A Ministerial Council set up a working group to address the shortfall in recreational fishing information. Specifically the group should consider that:
  - ⇒ 'Recreational fishing should be managed as part of the total fisheries resource,
  - ⇒ 'Recreational fishers are entitled to a fair and reasonable share' and....
  - ⇒ 'Fisheries management decisions should be based on sound information including fishing biology, fishing activity, catches and the economic and social values of recreational fishing'

Harvesting Equipment for Glass Eels in High Water Flows (2001/230)

R&D Output:

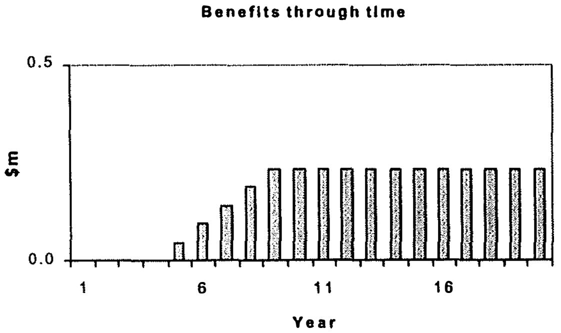
- Development of improved glass eel harvesting gear suitable for fishing within rivers of high flow – such as the Tamar in Tasmania
- Generate information about harvesting gear performance (by-catch levels, glass eel mortality)
- Construction and refinement of prototype eel harvesters based on literature review and design performance within flume tank and field experimentation.
- Design and plans for improved eel harvesting gear

Industry Outcome:

- Designs and guidelines will be disseminated to industry and other interested parties via reports, posters and videos
- Greater supplies of glass eels would result from the adoption of safe, species selective, high catching efficiency equipment
- Reduced pressure on Murray-Darling eel resources, along with reduced harvesting of adults.
- Follow-on project would be required to commericalise results - at $200,000 over 3 years

Benefit in Use:

- Tasmania has a large glass eel resource that is currently untapped due to an inability to harvest in high water flow. The Tamar could sustainably yield 400 kg of glass eels per year.
- Given a survival of 50% and production of 650 kg of adult eel per 1 kg of glass eel, annual production of eels could increase by 130 t per year.
- Assuming a profit margin of 30% and an eel price of $6.00 kg (finished), the industry would gain $0.2 m per year if the Tamar could be harvested.



Adoption:

- Size of market
  Currently, eels are not harvested in high water flow areas. The development of suitable gear would result in 130 t of production
- Maximum adoption 100%
- Rate of adoption 20% per annum

Risk: High - (20% chance of success) because:

- Harvesting gear maybe be ineffective at high flow rates and high eel mortality may still be a problem.
- Glass eel harvesting currently not extensive, and expansion in glass eel harvesting maybe constrained by concern over exhausting wild stock
- Possible availability of high-flow gear from overseas needs to be investigated

Conclusion:

- Marginal Investment - with NPV = $0.0 m and BCR = 1.1.
- Small project with potential industry benefits.

R&D Output:

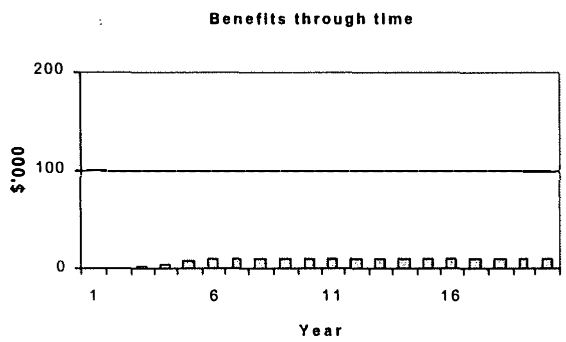
- Production of an industry approved common names list for Australian fish
- Development of a database of high quality digital images of Australian fish for product promotion
- Upgrade the fisheries code website to include common species names - which will be freely accessible to the industry

Industry Outcome:

- More than 40,000 celluloid images, comprising 3,000 species, form the basis of the photographic index of Australian fish. The replacement value of this collection was valued at $25 million
- The bulk of the collection is held in filing cabinets as transparencies, which limits accessibility. The transfer of these images into digital format and posting on internet sites, would make the collection more available - possibly helping with species identification and product promotion.
- CSIRO receive many requests (several per week) for images. If each request, say five per week, was associated with three hours of labour – then 780 hours of searching incurred per year.
- Valued @$19,500 assuming an hourly rate of $25 hr

Benefit in Use:

- Commercial benefits are not readily transparent and likely to be more public good in nature.



Adoption:

- If the annual image search time ($19,500) could be reduced by 75% - as a result of digitisation and web hosting and 80% of image seekers adopted, then an annual benefit of $11,700 would be apparent.
- Rate of adoption 20% per annum
- Maximum adoption achieved within 4 years.
- Results first adopted 3 years.

Risk: Low- (90% chance of success) because:

- Upgrade of images relatively straight forward procedure and should be undertaken without technical constraints

Conclusion:

- Poor Investment - with NPV = $-0.2m and BCR = 0.3.
- Economic benefits may be generated through a cost saving in digitisation of images now, rather than allowing them to deteriorate or a less cost-effective approach being adopted by industry to upgrade images.

Developing domestic and international seafood markets (2001/232)

R&D Output:

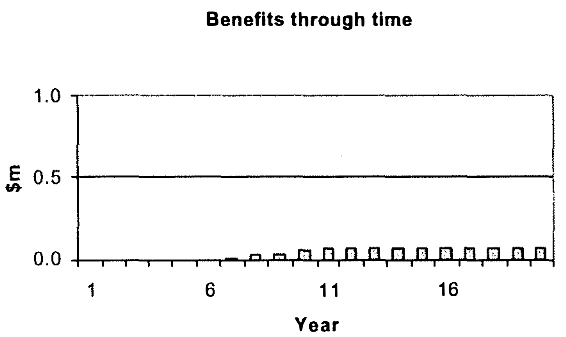
- Workshops to transfer marketing knowledge on export of undervalued species
- Domestic retailer and consumer awareness packages for chefs and point of sale
- Report on export market opportunities for selected species

Industry Outcome:

- Main outcome is to increase the consumer demand for selected fish species in both domestic and export markets.
- The project concludes after three years and would require a further three years for commercial opportunities to be realised – demand / supply matching and distribution. The costs of this would be absorbed in commercialisation activities of wholesalers.
- Current production of under utilised fish (such as ribbon fish) is minimal, but potential annual catches have been estimated at anywhere between 1 kt and 4kt. Increased consumer demand for these species will increase their average boat price – which may be up to $1 kg now.

Benefit in Use:

- Target market volume, both domestically and overseas, is assumed to be around 100 tonnes for two species. This increase represents new markets and not substitution of other Australian fish products.
- Increased demand of 100 tonnes would lead to an industry gain of $0.1m each year (prices would increase by 67%). Although niche markets will be pursued, product competition within these markets will ensure that consumers remain responsive to prices. (Elasticity of demand assumed to be –1.5 in both domestic and overseas markets)



Adoption:

- Size of market
  100 tonne target volume
- Max adoption
  100 tonnes – implicit in target volume
- Rate of adoption 20%
  Adoption expected to be quick, with target volumes achieved after 5 years.

Risk: Medium risk (50% chance of success) because:

- There has been success with similar ventures in the past, although this may need to be more objectively determined.
- Meeting consumer demand will involve supply capacity development

Conclusion:

- Investment not attractive with NPV = -$0.4m and BCR = 0.3
- Break even market volume is 330 tonnes per year.

R&D Output:

- Documentation that demonstrates the effectiveness of FoodSafe Plus as a means for small (and mainly mixed) seafood businesses to meet legislated food safety standards – as well as some standards that are not compulsory. This will involve an assessment of the costs and benefits to individual businesses.
- Two experienced environmental health practitioners in each State that can provide accreditation of seafood businesses to standards of FoodSafe Plus.

Industry Outcome:

- Food safety is an important issue for the seafood industry that ultimately impacts on consumer demand. Under Seafood Services Australia investment is made to support the seafood industry achieve targeted levels of food safety and standards.
- This project will assist the seafood industry to determine which food safety systems will meet their legislative requirements or deliver the greatest value to their business at least cost.
- This project will not directly impact on consumer demand. The attractiveness of this project needs to be determined on the basis of its cost effectiveness in assisting the industry reach desired food safety or standards targets. This would require examination of other options open to the FRDC through Seafood Services Australia or other State and Federal initiatives.

Benefit in Use:

Adoption:

Not relevant *Not relevant*

Risk: Not relevant unless compared with other options:

Conclusion:

- Can not be assessed using cost-benefit analysis. Needs assessment using cost-effectiveness analysis - which requires an examination of other options available to FRDC to achieve adoption of food safety systems by Australian seafood businesses.
- Cost benefit analysis needs to be carried out on this aspect of Seafood Services Australia's operations (if not already completed) to determine maximum investment in this area that could be justified.
- Consideration should also be given as to whether or not this project should be funded from R&D budgets or should be provided through commercial networks.

R&D Output:

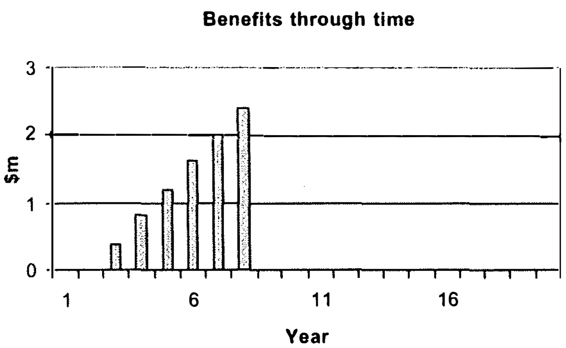
- A new code of practice for handling rock lobsters will be developed.
- Current code (developed in 1995 and in WA in 1998) is dated and only ever intended as a how to manual for deck hands. New code will be developed around current technology and incorporate recent research findings (technology transfer vehicle).

Industry Outcome:

- A manual and video will be made available and distributed to licence holders under this project.
- The code of practice will be used by fishers to increase the percentage of their harvest classed as "fit for live" thereby increasing recovery rates and prices received.
- Since the release of the previous code of practice the percentage of rock lobster meeting "fit for live" has increased from 70% to 90%.

Benefit in Use:

- Increased recovery rate from 90% fit for live to 91%.
- 1% extra yield each year is 170 tonnes – aim is to increase landed weight and not to increase volume sold as live.
- Value per kg is $23.55
- Annual total benefits if across all industry estimated at $4m



Adoption:

- Size of market
  Could be used generally across all catch – some 17 kt annually
- Max adoption
  Limited by marginality of benefit and concerns by some state associations – peak at 60%
- Rate of adoption
  Uptake should be similar to previous code – taken up over 5 year period but only relevant for 6 years

Risk: Medium risk (50% chance of success) because:

- Will need to find those operators currently adopting "best practice".
- Code of practice changes will be more technically based and harder to achieve.
- Research results may not translate to simple practice changes.

Conclusion:

- Investment attractive with NPV = $2.8m and BCR = 25.
- Real driver is extent that recovery can be increased as a result of fishers adopting "best practice". However, will only need to get an extra 7 tonnes of yield for the investment to break-even (or 0.04% of current production).

R&D Output:

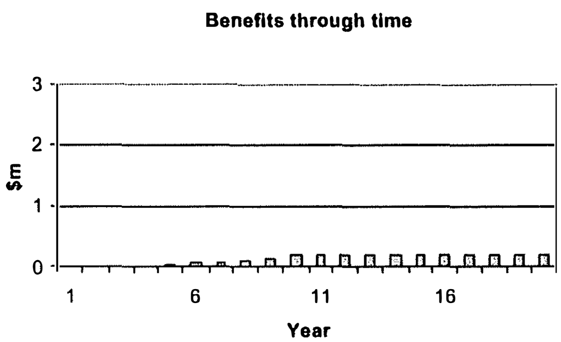
- Better understanding of cook times and commercial practices on weight recovery and melanosis formation.
- Recommendations that will enable processors to more accurately determine the appropriate endpoint of cooking in lobsters to prevent melanosis.

Industry Outcome:

- Recommendations will be available at the end of the project in 5 years.
- Guidelines will be developed and made available to industry. FRDC will be responsible for extension through the post-harvest subprogram.
- If recommendations are taken up it is anticipated that cooking times can be reduced without melanosis occurring. This will increase cooked weight recoveries that are currently around 95% of beach weight.

Benefit in Use:

- When melanosis is detected in cooked samples, processors increase cooking times.
- Incidence of melanosis is unknown – estimated as high at 20%.
- Subsequent loss of weight is 1% of beach weight.
- Production of cooked whole lobster in WA is around 5 kt annually with export value of $27.60 kg.
- Estimated annual industry loss is $0.3m



Adoption:

- Size of market
  Target is all whole cooked production
- Max adoption 75%
  If recommendations easy to implement will gradually become standard and hence expect widespread adoption
- Rate of adoption
  Take up slow because of marginal benefit

Risk: Medium risk (50% chance of success) because:

- Scientific techniques are widely used in the food industry, but this will be a novel application to a "whole animal" rather than pieces or cans.
- Validation of cooking times will be required in a commercial environment and the inherent variability in lobsters makes it difficult to standardise cooking times.

Conclusion:

- Investment marginally attractive with NPV = $30,000 and BCR = 1.1
- Impact of melanosis on cooking time likely to be marginal to weight loss compared to other factors and given that processors are likely to build some additional margin into cook times anyway for other reasons.

R&D Output:

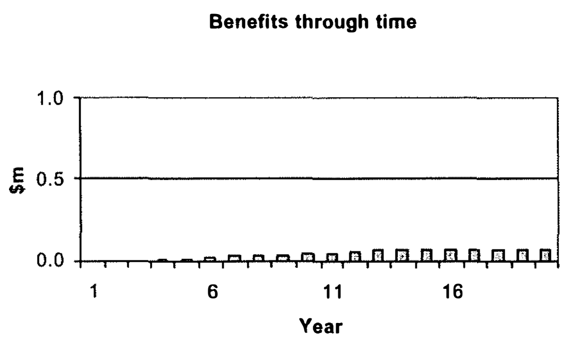
- A guide for use at wholesale for the identification of whole fish and fillets
- Information leaflets for consumers (at point of sale) on health risks and factors that may reduce health risks.

Industry Outcome:

- Publications available at end of year 2 with another year for distribution. Provision may need to be made for on-going production of consumer leaflets.
- Overall aim is to reduce health risks faced by consumers through inaccurate species identification. This health benefit was not included in the evaluation.
- Although consumers are generally unaware of the health risks form these fish species, it is reasonable to expect that overall demand for these species would be weaker than if no risk existed.

Benefit in Use:

- Current market is around 200 tonnes a year – with major catches from tuna fisheries.
- Demand increase of around 10% expected from awareness campaign. This translates to an annual benefit of $62,000.



Adoption:

- Size of market
  200 tonnes – aim is to build demand
- Max adoption
  200 tonnes – increase demand across total market
- Rate of adoption – over 10 years
  As consumers not aware of health risk adoption would be slow. Better identification at wholesale will be more rapid as more concentrated.

Risk: Medium risk (50% chance of success) because:

- Identification work relatively straight forward – some issue with how exhaustive study will be across all species and correlation to potential health risk.
- Changing consumer behaviour can be difficult with broad awareness campaigns that don't target specific consumer groups.

Conclusion:

- Investment not attractive with NPV = -$0.1m and BCR = 0.6
- Break even at around 17% increase in demand.
- Project viability largely based on perceived "duty of care" across these species compared to other risk areas in Australian fisheries.

R&D Output:

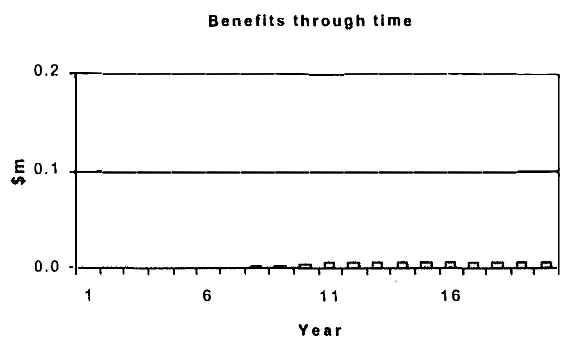
- Increased knowledge about the current public health risks associated with Ciguatera poisoning associated with consumption of tropical fish in Queensland
- Investigation of the potential for developing an assay for Ciguatera presence in edible species of fish based on a ciguatoxin binding protein

Industry Outcome:

- This project is strategic in nature and would develop the body of knowledge required for developing a toxin assay
- A follow-on project could be developed, if this project is successful, with the objective of formulating a commercially available assay based on the binding protein research
- Public health costs (2.5% people in Cairns survey had experienced intoxication) would be reduced if Ciguatera-infected fish were identified.
- It is assumed a $0.3 million project, over a 3 year project would be required in addition to this proposal.

Benefit in Use:

- Finfish production (excluding tuna) in Queensland valued to be $78 million in 1999. Currently a number of species are not exploited in Ciguatera areas due to the threat of poisoning
- The development of an assay, and assurance of toxin-free fish, may increase output of the Queensland fishery. If 20% of the industry could increase finfish production by 2%, an industry benefit ((@$100 t – profit margin) would generate benefits of $5,676 per annum



Adoption:

- Ciguatera is located in specific areas and affects different species of fish (assumed to affect 20% of the non-tuna finfish industry)
- Rate of adoption 5% per annum. Maximum adoption achieved within 4 years. Results first adopted 8 years.

Risk: Moderate- (40% chance of success) because:

- Research strategic in nature. A follow-on project would have to be successfully completed for development of an assay for point of sale or capture screening of fish.

Conclusion:

- Investment not attractive - with NPV = -$0.4m and BCR = 0 Logistics and cost of using assay to test fish is likely to preclude widespread adoption
- Even with an assay, it may not be economic to fish toxin areas as affected fish have to discarded.
- Public health benefits may be significant, but precise incidence of poisoning currently not known.

R&D Output:

- Information on how to manufacture aquafeed using local seafood waste
- Develop new diet formulations using local seafood waste
- Economic analysis of impact of new feed on the fishing industry and wider environment.

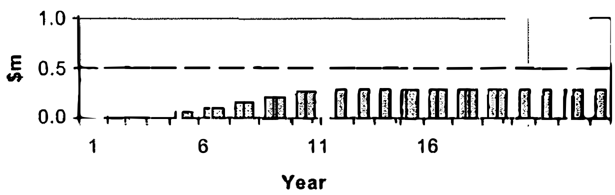
Industry Outcome:

- Further work will be required on commercialisation of feed manufacture in Australia. This could take a further two years before a commercially available product – with development expenditures up to $100,000 a year.
- Main industry benefit will be lower cost feed for aquaculture. This cost saving will largely be realised through the use of lower cost inputs (waste products) by feed manufacturers. Environmental benefits in Australia will be marginal in terms of reduced land-fill.

Benefit in Use:

- Current market around 12 kt of fishmeal annually
- Annual industry cost @$800 tonne = $12m
- Potential cost saving is 10% or $80 tonne.

Benefits through time



Adoption:

- Size of market
  12 kt of fishmeal used annually with increase to 18 kt by 2010.
- Max adoption 20%
  Source of cheap waste product will limit production as well as the likelihood that new diets will only be suitable in a number of species.
- Rate of adoption – 5 years
  If new diets can be fed with same ease as fishmeal, take-up will be rapid if significant cost saving achieved.

Risk: High risk (25% chance of success) because:

- Matching the nutritional value of waste products to specific specie requirements will be difficult.
- Commercial viability of producing and using new feed will need to be tested, and significant product risk exists in both the manufacture (in Australia) and use of developed feeds.

Conclusion:

- Investment not attractive with NPV = -$0.1 and BCR = 0.9
- Investment would break even if no development costs were incurred after two years or the cost saving was $900 tonne.
- Environmental benefits only realised if feed delivers cost saving to users – but magnitude of benefits unlikely to increase attractiveness to any significant extent.

R&D Output:

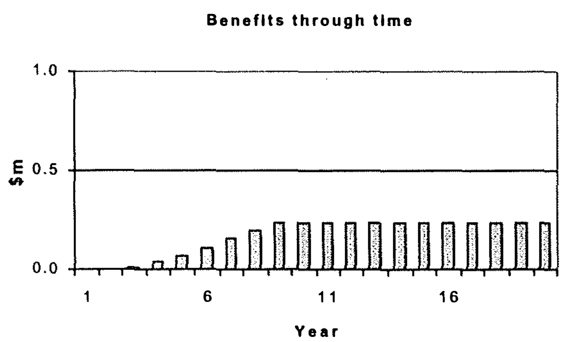
- The stock of information relating to biological and ecological factors that affect the rate of deterioration of pilchards will enhanced
- Optimal handling methods will be devised following the comparison of post-harvest management techniques as part of project-related trials.
- Recommended practices will be extended to fishers and industry. Laminated card will be developed to demonstrate whether pilchards contain plankton that causes rapid deterioration.

Industry Outcome:

- Improved quality of the catch will increase the average price fishers receive for pilchards
- The development of a canning industry will generate employment and export revenues for South Australia

Benefit in Use:

- Assume processing industry increases to 4,000 t by 2010
- Assumed that improved product handling recommendations stemming from FRDC #240 would be adopted by 20% of the processing industry suppliers
- Average price of pilchards received by fishers adopting improved practice would increase by $0.3 kg
- An annual industry benefit of $0.2 million would result from adoption of this magnitude



Adoption:

- Recommendations would be extended to industry quickly as the project is only of 2 year duration.
- Extension begins – Year 3
- 20% of processing industry suppliers would adopt the practice
- Recommendation would be taken up over 5 year period

Risk: High risk (20% chance of success) because:

- Pilchard fleet may not be able to adopt improved post-harvest practices due to lack of adequate post-harvest handling capacity
- Research proposal does not include plans to leverage off previously conducted Australian pilchard handling research.
- Project has a limited budget which may preclude widespread dissemination of findings

Conclusion:

- Marginal investment with NPV = $0.1 m and BCR = 1.2.
- A relatively small two-year project which would extend information to a relatively large industry.
- Break even increased pilchard price of $0.25 kg would be required

DETAILS OF EVALUATION METHOD - BENEFIT COSTS ANALYSIS

In this section the fundamentals of BCA are discussed to a level of detail that will enable readers to work through the individual evaluations of projects submitted to the FRDC for funding consideration.

There are two critical aspects in the benefit-cost assessment of a proposed research and development project. The first involves an assessment of what technology (be it a product, process or information) will ultimately be made available for commercial use in the industry. The second involves an assessment of how the technology will increase industry profits. The first part requires consideration of the technical aspects of a proposed project while the latter involves a costing of industry benefits once the likely industry outcome has been identified.

For any valid comparisons to be made between projects in which FRDC could invest, it is essential that there be consistency in the data used, assumptions made, approach taken to cost industry benefits and how the likely pay offs are evaluated. Without this consistency evaluations provide little value to decision makers.

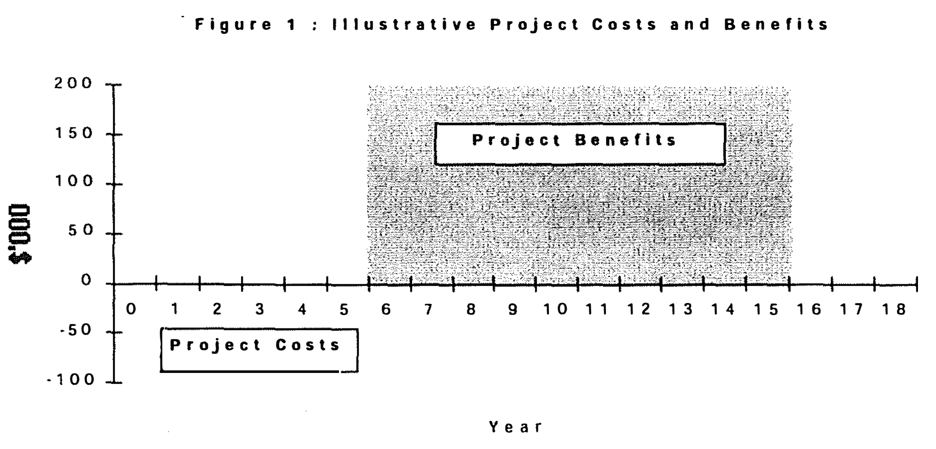
Two of the main strengths of using benefit cost analysis are that assumptions can be made explicit and evaluation results can be readily reproduced. Benefit cost analysis is a "tool" for research decision makers and the extent to which it is used and the detail given should be matched closely to the needs of individual decision makers. Although the degree of detail required may vary from project to project there will always remain a number of key factors that should be considered. These include: the likely specifics of the technology that would be produced through R&D and the associated cost; the strategy which would be followed to ensure that the technology is used commercially; how industry participants would use the technology; and what impact the technology will have on their profitability.

What is BCA?

Benefit-cost analysis is simply a comparison of project benefits against project costs that are realised or incurred through time. Project costs are the costs incurred in carrying out a given research project plus the costs involved in developing research outcomes for direct commercial application in fisheries industries. Project benefits are the gains realised by fishing industries and the Australian community at large from the commercial application of research and development outcomes.

In Figure 1 a representative stream of project costs and benefits through time is illustrated. In this example, annual project costs of $100,000 are planned for 5 years after which annual benefits of $200,000 are generated for a period of 10 years. In total, $500,000 is invested in the project for a return of $2 million. But, is the investment worthwhile?

Two measures of project pay off are used to answer this question. The first is the net value of the project, measured by the total value of benefits minus the total value of costs. In our example, the net value of the project is $1.5m, and as this sum is greater than zero the project would represent a profitable investment. However, because we are concerned with the relative attractiveness of projects, projects should be ranked on the basis of the benefit realised for every dollar invested.



The second measure reflects this and is called the benefit/cost ratio. It is calculated by dividing total project costs into total project benefits. In our example the benefit cost ratio is equal to 4. Hence, for every dollar invested in the project a return of $4 is realised.

An important consideration in BCA is the treatment of project costs and benefits that are incurred or generated at different points in time. Generally speaking, in a decision to have a dollar today or at some later date, individuals would show a preference for having the dollar today. In a commercial environment, the extent to which an individual would be prepared to postpone having the dollar is at least equal to the rate of interest that could possibly be earned from having the dollar today and investing it. In other words, if you could get an interest rate of 6% over a year so that after one year your dollar was worth $1.06, then, to compensate you for waiting one year to have your dollar, it would be necessary to offer you $1.06 after the year.

In BCA the extent to which individuals prefer a dollar today as opposed to a dollar in a later period is called the discount rate. The discount rate utilised for these benefit cost analyses is 6% each year, and reflects market interest rates (net of inflation) on borrowed capital.

Handling project benefits

The estimation of project benefits is usually the most difficult part of any BCA. Project benefits are the total net gains realised directly by users of R&D outcomes and indirectly by other participants in the industry or the community at large. To determine project benefits, a clear understanding of the anticipated direct industry impact is essential. In BCA there are three aspects which need to be considered when estimating project benefits. These are the size of the gain to individual users, the number of users realising the gain (target market and adoption), and the likelihood that R&D will be successful in delivering the anticipated commercial outcomes.

Estimating individual gains

The net gain to an individual user can be measured by the difference in profits that could be earned with and without the use of the developed technology (commercial R&D outcomes in the form of a product, process or information).

Technological improvement can increase profitability of a given business in several ways. It can:

(i) increase yields or the volume of output given existing resources.

(ii) enable higher prices to be realised on output sold.

(iii) decrease the unit cost of inputs used.

(iv) decrease the volume of inputs used.

In most cases, these impacts can be adequately expressed in terms of a given unit of production, for example, per kg of fish sold. Offsetting these impacts are the costs to the individual of purchasing and using the technology.

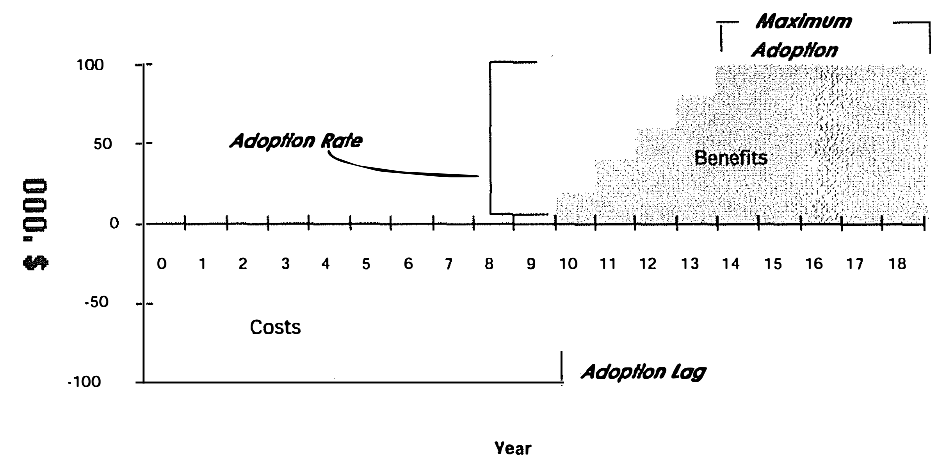
Adoption

To derive total net gains from the use of a developed technology it is necessary to estimate the net gain to all individuals that could potentially benefit from adoption and use of the technology, and then sum these gains. Obviously, this would not be practical, and instead, a representative business for the target group of potential beneficiaries should be selected and net gains estimated for this business alone. This group would therefore represent the potential users of the technology, and adoption would reflect the extent to which the technology would be taken up within this group.

The rate and level of adoption of a new technology in the derivation of total net gains is usually very understated in benefit cost analysis. The total net gain in any given year is simply the sum of individual net gains that are generated in that year. The effect of halving net individual gains or total net gains is the same as halving the anticipated rate of adoption of the new technology.

Technology adoption has three components critical to benefit cost evaluation. These components are illustrated in Figure 2.

Figure 2 : Impact of Adoption on Net Gains



1. Adoption Lag - the time lag between successful R&D and the first commercial use of a technology (adoption lag).

   Once the R&D project has been brought to a successful close the technology would then be ready for commercialisation and release into the market. During this phase the technology would be produced in commercial quantities, marketed and distributed. While the costs incurred during this phase are reflected in the price at which the technology is sold, the time taken from project commencement to the first commercial use of the technology is important because, as the realisation of benefits is delayed in time the attractiveness of the project declines.

2. Adoption Rate – the rate at which a technology is taken up within the target market.

   The rate of technology adoption is important because, like adoption lag, it influences the extent to which gains are realised in any one year. In practise, technology adoption tends to occur gradually at first, then quite rapid for a while before tapering off. In prospective evaluations a constant rate of adoption through time (linear) is a reasonable assumption to make in the absence of detailed market survey information. The main factors that will influence the rate of adoption through time are the size of the benefit realised by the user, the complexity of use of the technology, the ease with which the technology can be integrated into existing business practices, the degree of financial risk and the communicability of benefits between users.

3. Maximum Adoption – the ultimate level of technology take up within the total market.

   The final component is the maximum level of adoption within the target group. The factors described above that influence the rate of adoption also affect the adoption ceiling.

Probability of Project success

The final aspect in the estimation of total net gains is the likelihood that a R&D project will be successful in ultimately delivering the anticipated benefits to the fishing industry. For project success, the research, development and commercialisation phases must meet all their desired objectives. The probability of project success is therefore conditional on the success of each phase. As an example, if the probability of success for each phase was 50%, then the probability of project success would be 12.5%. Because of project risks, project benefits need to be weighted accordingly and expressed in terms of an expected benefit to the funds invested. This is done simply by multiplying annual project benefits by the probability of project success.

Dealing with project costs

Project costs are the planned expenditures in the research and development phase of a project – by all parties involved. In order to carry out a BCA, project costs need to be estimated on an annual basis over the anticipated life of the project. The end of the project will be when the research output has been fully developed and is ready for commercialisation.

Price Effects

Simplifying assumptions have been made on price effects as a result of increased industry profitability. Price impacts are important and should be considered. Such impacts determine the distribution of R&D benefits between different industry participants - including fishers, processors and consumers. Price effects also indicate the extent to which production increases following technology adoption that results in higher industry profitability or stimulates consumer demand.

Research Lead Time

Research lead time is a measure of the competitive advantage of FRDC's R&D investment. FRDC is one of many players in the R&D market, and their investment will enable industry benefits to be realised sooner than would otherwise be the case or to a greater extent through time.