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EX POST BENEFIT-COST ANALYSIS

PROJECT NO: 1999/128

Research to develop and manage the sea urchin fisheries of NSW and eastern Victoria

Prepared for the FRDC

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SUMMARY

The proposal for this project was developed in the context of rapidly growing catches of sea urchin in New South Wales (NSW) and to a lesser extent Victoria, the initial development of Australian sea urchin exports to Japan, investment in new sea urchin processing facilities, and significant changes in management arrangements in NSW that resulted in the sea urchin and turban shell (SUTS) fishery being established as a restricted fishery in its own right. Development prospects for the fishery appeared bright.

Total costs of the project were just over $1m, of which FRDC contributed around 35%.

A stratified survey program was undertaken to estimate sea urchin density, stock-structure, and roe quality in NSW, eastern Victoria and Port Phillip Bay.

In the case of red sea urchins, the results from the project on the estimated biomass (1195mt), likely productivity of the resource (between 1-5%), and the sustainability of current fishing levels, were provided to NSW TAC Setting and Review Committee in 2001. The Committee accepted advice, based on the project's findings, that the existing catches coming from regions 3 and 4 were not sustainable and used the regional abundance estimates from the project to recommend regional total allowable commercial catch (TACC) limits totalling 60mt/year across the state. These recommendations were implemented by the NSW Government and became effective from 1 January 2002.

In the absence of the project, it is assumed that the introduction of quotas by NSW Fisheries would have been delayed by several years, increasing the risk of more extensive and widespread depletion of the red sea urchin population.

The project also enabled NSW Fisheries to gain a better scientific understanding of the stock abundance, distribution and sustainable harvest levels for purple sea urchins, enabling the TAC Setting and Review Committee to decide that quotas were not warranted at the present time as the estimated sustainable yield was far greater than current catch levels.

There has been less interest in the sea urchin fishery in Victoria compared to NSW, such that the Victorian fishery continues to be managed as a developing fishery and quotas have not been considered necessary given the present low harvest levels.

The expected development of the sea urchin fishery anticipated at the time the project started has failed to materialise. The rapid initial growth in the industry was based on the harvesting and processing of red sea urchin. However, the surveys undertaken as part of the project demonstrated that the red urchin resource was simply insufficient to sustain the catch levels being taken at that time. The subsequent downturn in catch, together with problems in maintaining quality, adversely affected the export markets, such that most of the red sea urchin catch is now sold domestically. This in turn led to a glut of product on the domestic market, forcing prices down. Prices to fishers have dropped by almost 40%, from a high of around $5/kg in 2000 to their current level below $3/kg, further negating industry growth.

Development of the purple urchin sector of the industry has also failed to gain momentum. Roe from the purple urchins is considered to be bitter in taste and is not highly sought after by consumers, with prices to fishers being around $1/kg wholeweight (one third the price paid for reds). Profit margins in the harvesting/processing of purple urchins are currently too low to sustain a viable industry.

Of the 37 endorsements in the NSW SUTS fishery, only around 5 are currently active, most of whom have other sources of income, either from other fishing interests or from non-fishing sources, and sea urchin production in NSW is valued at only around $30,000/year.

The project found that the yield and colour of purple sea urchin roe can be improved by transplanting urchins from less productive barrens grounds to more productive fringe habitat areas. Discussions with sea urchin fishers indicated that some transplanting of urchins does occur though it is the reds, not the purples, that are transplanted, and that in any case such transplanting was occurring prior to the study. Given low profit margins on purple urchins, divers consider the potential gains insufficient to make transplanting of purples worthwhile.

To the extent that the project brought reality into future expectations regarding the sea urchin industry and discouraged any unsustainable investment, this can be considered as an economic benefit from the project. However, the main benefits from the project are environmental, in that the fisheries agencies of both NSW and Victoria now have the necessary scientific information on stock abundance, distribution and harvest levels to properly manage the future sustainable development of their respective sea urchin fisheries should it be possible to overcome the current marketing problems affecting the industry.

1. Introduction

This report describes an ex-post benefit-cost analysis undertaken on FRDC project 1999/128, 'Research to develop and manage the sea urchin fisheries of NSW and eastern Victoria'. The project was coordinated by the NSW Fisheries Research Institute with assistance from the Victorian Marine and Freshwater Resources Institute.

2. Background

The proposal for this project was developed during 1998/99, in the context of rapidly growing catches of sea urchin in New South Wales (NSW). As noted in the final project, there had been several attempts to develop sea urchin fisheries in NSW during the 1970s and 1980s but all were short-lived and relatively unsuccessful, and the NSW sea urchin catch averaged less than 2mt/year over the fifteen years prior to 1998 (Blount and Worthington 2003). By 1999, catches in NSW alone had increased to around 19mt/year, much of which was exported (in 1999, Australia exported around 3.5mt of sea urchin roe to Japan, valued at around $330,000 ($97/kg)), capital had been invested in processing facilities, and development prospects for the fishery appeared bright.

In the case of New South Wales, the timing of the proposal also coincided with a significant change in management arrangements for its sea urchin fishery. In March 1999 – three months before the project started – the sea urchin and turban shell fishery (SUTS) was separated from the abalone fishery and became a restricted fishery in its own right. Prior to this, sea urchin and turban shell was managed as part of the abalone fishery. Endorsements to the SUTS fishery were issued to all 37 abalone endorsement holders and such endorsements were fully tradeable, so making it more likely that operators might specialise in the sea urchin fishery, further supporting the expectation that the fishery might experience rapid development[1].

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[1] Prior to the separation of the endorsements, given the opportunity to fish either abalone, sea urchin or turban shell, the rational decision was to concentrate on the most profitable option – abalone – and devote little effort to the others. By creating separate tradeable endorsements for abalone and SUTS, it became possible for a fisher to hold only a SUTS endorsement, either by a new entrant purchasing the SUTS endorsement from an existing abalone operator or from an existing abalone operator choosing to sell the abalone endorsement but retain the SUTS endorsement. Given the very limited demand for turban shell, a SUTS-only endorsement holder would be likely to focus on sea urchin.

Being a sedentary species located in shallow water close to the coast, sea urchin is easily harvested and, in the absence of proper management arrangements, highly vulnerable to overfishing, as demonstrated by the depletion of urchin stocks in Japan and California. There was a clear need to develop appropriate management arrangements for the developing fishery, yet very little was known about the extent of the sea urchin stocks or what sort of harvest levels might be sustainable.

Sea urchin are harvested for their roe, found in the animal's gonads. Ideally, urchin are harvested immediately prior to spawning, when the gonads are said to be 'ripe', as this produces roe of the best quality and volume, and hence returns the best price to fishers. Processing the urchin involves cracking the shell, removing the roe and then cleaning, soaking, packing and grading based on the roe's colour, size, texture and taste.

Three species of sea urchin have been commercially harvested in Australia:

i) the purple sea urchin (*Centrostephanus rodgersii*), thought to be relatively abundant in NSW and eastern Victoria but producing roe of variable quality, particularly in terms of taste. Due to quality problems, purples are only harvested from December-June;

ii) the red sea urchin (*Heliocidaris tuberculata*), found mostly in New South Wales, thought to be less abundant than the purples, but generally producing roe of a higher quality, with less variability, and with a longer shelf life. Because of this more consistent quality, reds are harvested all year round; and

iii) the white or green sea urchin (*Heliocidaris erythrogramma*), found in Victoria, Tasmania and South Australia.

Sea urchins are found on two habitat types – fringe areas with high levels of micro-algae, and barrens, areas with relatively low levels of productivity. Preliminary results from an earlier FRDC study suggested that at any given time, a large proportion of the sea urchin population was likely to have poor quality roe, particularly those found on the barrens[2]. Given that the quality of the roe is not usually detected until after the urchin has been killed, such variability in quality adversely affects industry profitability through increased processing costs and the income foregone from not harvesting the urchin at a more

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[2] FRDC 1993/102, Interactions between the abalone fishery and sea urchins in NSW

appropriate time. It was considered that overcoming these quality problems would provide a big impetus to industry development.

A separate FRDC study had demonstrated the potential for improving the quality of sea urchin roe by increasing food availability in the wild[3]. This was achieved by transplanting sea urchins from areas of high density to areas of low density. Given the problems with poor quality roe in NSW, successful application of the results from the Tasmanian work could potentially improve yield and value of the NSW fishery and encourage the spreading of fishing effort onto the currently unfished barrens areas.

In addition, previous research had demonstrated that by reducing densities of purple sea urchins on the barrens, the barrens habitat could be modified to enhance the recruitment, survival and growth of abalone[1]. Accordingly, the controlled development of the sea urchin fishery might have a direct positive effect on abalone abundance and hence provide significant spill-over benefits for the abalone fishery.

3. Project Objectives

1. Develop and complete a process for stock assessment of sea urchins in NSW and eastern Victoria; and
2. Investigate techniques to enable the reliable harvesting of quality roe from coastal reefs, and determine their impact on associated species.

4. Research Findings

Stock assessments

A stratified survey program was undertaken to estimate sea urchin density, stock-structure, and roe quality in NSW, eastern Victoria and Port Phillip Bay.

NSW

Red sea urchin

Reds were found throughout the survey area, with greatest densities occurring between Ulladulla and Montague Island. Abundance was found to be highly variable, with large

[3] FRDC 1993/221, A pilot program to maximise Tasmania's sea urchin resource

accumulations of individuals at some sites whilst other nearby sites had few animals. The estimated biomass of red urchins throughout the state was 1195mt.

The research estimated the effects of fishing by monitoring changes in abundance at selected sites over time. The surveys indicated there had been a significant depletion of the biomass in those areas closest to the processing facilities (falls of 47% in the region from Currarong-Brush Island, and 82% in the region Brush Island-Montague Island). In some sites believed to have been targeted by commercial fishers, the biomass was estimated to have fallen to 12-15% of its pre-fished level.

Purple sea urchin

Purple sea urchins were found throughout the survey area, with no significant difference in density among the regions though significant variation was found among sites within each region. The biomass was estimated at around 52,000mt, with about 22,000mt in the fringe areas and 30,000mt in the barrens.

The density of purples in the barrens was found to be twice that of the fringe. Most individuals on the fringe had good-medium colour roe, while those on the barrens had medium-poor colour and were smaller in size.

Eastern Victoria

Both purple and white/green sea urchins were found at all survey sites, with the purple more abundant. Densities were estimated as being comparable to those found in NSW waters. Respective biomasses were estimated for purples (3300mt) and white/greens (1500mt). Basing estimates of maximum sustainable yield (MSY) as being between 1-5% of the unexploited biomass, and using current biomass estimates as the unexploited biomass, the research suggested sustainable annual catches of 30-150mt for purples and 15-75mt for white/greens. However, it was estimated that up to 25% of this catch may contain roe of poor quality.

Port Phillip Bay

The green or white sea urchin was found to be abundant wherever reefs occurred in the Bay. The biomass on the fringe areas was estimated at around 3000mt, from which it was suggested a maximum annual catch of 30-150mt could be sustained. Around 15% of this catch was considered likely to be of poor quality roe. The biomass on the bare reefs was estimated at around 4300mt, of which up to 45% was likely to be of poor quality.

Potential to improve the quality of harvested roe

Previous studies had identified the availability of food materials, and by implication, the level of competition among urchins, as being a major determinant of roe quality. Accordingly, the feasibility of two approaches to improve the quality of harvested roe by increasing food availability was examined:

i) reducing the density of individuals to increase the availability of food to those remaining; and

ii) transplanting individuals to areas of higher food availability.

Impact of reducing densities

Trials were undertaken to examine the impact of reducing the density of purple sea urchin from barrens areas on the yield and quality of roe of remaining urchins. Trials were conducted over three time frames - short term (3-6 months), medium term (2 years) and longer term (3 years), and varying degrees of reductions.

Results demonstrated that reducing the density of sea urchins does lead to an improvement in roe quality. Improvements were detected after just three months, with the greatest improvement – yield increasing by more than 200% and colour by more than 130% - occurring after 12 months and after having removed 66% of the initial sea urchins. However, despite these improvements, the quality of roe taken from animals on the barrens was still inferior to that of animals taken from the fringe.

Impact of transplanting individuals

Trials were undertaken to assess the impact on the yield and quality of roe of purple sea urchins transplanted from less productive barrens grounds to the more productive fringe areas. Trials were conducted on varying degrees of scale - small, medium and large - over varying timeframes – 6 weeks, 3 months and 12 months – and at varying densities on the fringe areas.

No improvements in either yield or colour were detected after 6 weeks of the small scale trial. However, improvements were detected after three and 12 months. Based on these results, the researchers concluded that transplanting was found to 'rapidly enhance the yield and colour' of the transplanted roe.

The researchers suggested that for best results, transplants should be made in the period October-January, and at densities no greater than those naturally occurring in the fringe areas.

5. Benefit-cost Analysis

There are two major components of net economic benefit in benefit-cost analysis - producer's surplus and consumer's surplus. In the context of this study, producer's surplus can be considered as being the net economic benefits generated in the sea urchin fishery and related sectors – such as the roe processing sector – as a result of the research project. Although somewhat simplified, producer's surplus can be thought of as the additional profits generated. In addition, if there is increased employment in the sea urchin fishery or the roe processing industry, then to the extent that previously unemployed labour is now utilised, the associated new wages would be treated as a benefit.

Consumer's surplus is a measure of net economic benefits realised by consumers. For example, if a project resulted in an increased supply that in turn results in a decrease in prices on the domestic market, then domestic consumers would be better off. Consumer surplus is a measure of this improvement in consumer well-being.

Benefit-cost analysis involves the calculation of the net economic benefits that are generated from the research investment, which are in turn compared to the initial research investment.

5.1: Project Costs

Total costs of the project were just over $1m, of which FRDC contributed around 35%.

Table 2: Costs of Research Investment for Project 1999/128

FRDC	Applicant	Other	Total
$346,613	$626,977	$43,706	$1,017,296

5.2: Potential Benefits

The project proposal stated that the direct benefits from the research would be 'to facilitate the development of a fishery for a significantly under exploited resource that has potential to be of enormous value'. The proposal referred to estimates of the current standing stock of

roe of up to 1000kg/hectare of reef, and to quality roe attracting prices of 'up to $200/kg in overseas markets and $100/kg in local markets'.

The proposal identified beneficiaries of the research as being 'commercial sea urchin processors and fishery endorsement holders' and noted that 'significant employment opportunities could also be possible'.

The proposal also referred to the results from previous FRDC-funded work proposing that the potential harvesting of sea urchins could have a direct positive effect on abalone populations. The proposal therefore suggested that the development of a sea urchin fishery 'could lead to significant benefits to the abalone fishery, particularly in NSW but also eastern Victoria'.

Potential economic benefits from the project can thus be summarised as:

i) increased profits accruing to sea urchin fishers in NSW and Victoria resulting from the more rapid development of the sea urchin fishery;

ii) increased profits accruing to the roe processing sector;

iii) increased employment in the sea urchin fishing or processing sectors; and

iv) increased profits/employment accruing to the abalone fisheries of NSW and Victoria as a result of increased abalone abundance resulting from greater harvesting of sea urchins.

From a social and environmental perspective, potential benefits from the research are:

v) the benefits to regional communities in New South Wales and Victoria resulting from the previously-mentioned economic benefits; and

vi) the benefits arising from the enhanced management of the sea urchin fisheries in NSW and Victoria.

5.3: Realised Economic Benefits

Development of the sea urchin fishery

The development of the sea urchin fishery, the prospects of which appeared so promising when the project commenced in 1999, has thus far failed to materialise (see Table 2).

Table 2: NSW Sea urchin production 1998-2004

		1998	1999	2000	2001	2002	2003
Reds	TACC	n/a	n/a	n/a	n/a	60	60
	Catch (mt)	<5	20	83	25	11	10
Purples	Catch (mt)		<10	36	negligible	negligible	negligible
Total	Catch (mt)		<30	119	~25	~11	~10

The rapid growth in catches in 1999/2000 was based on the harvesting and processing of red sea urchin. However, the surveys undertaken in this study identified rapid and widespread depletion of the red sea urchin stock by 2001, demonstrating that the reds resource was simply insufficient to sustain these higher catch levels.

The subsequent downturn in product volumes, together with problems in maintaining quality, adversely affected the exporting of the NSW product, such that most of the catch is now sold domestically. This in turn has led to a glut of product on the domestic market, forcing prices down. Prices to fishers have dropped by almost 40%, from a high of around $5/kg in 2000 to their current level below $3/kg, discouraging industry growth.

Domestic consumers of red sea urchin roe have benefited from the fall in price. However, the lower domestic prices are due to the problems that Australia producers experienced in maintaining export markets. These problems – and the subsequent glut of product on the domestic market – would have occurred irrespective of whether the FRDC project proceeded, such that the benefits enjoyed by domestic consumers can not be attributed to the project.

Development of the purple sector of the industry has also failed to gain momentum. The purples are considered to be bitter in taste, such that they are not highly sought after by consumers, with prices to fishers being around $1/kg whole weight (one third the price paid for reds). Market demand for the roe from purple urchins at the present time is simply inadequate, and profit margins in harvesting/processing too low, to sustain a viable industry.

Industry members advise that of the 37 endorsements in the NSW SUTS fishery, only 5 are currently active, and that virtually all sea urchin divers need to rely on other sources of income, either from other fishing interests or from non-fishing sources. Given that sea urchin production in NSW, based on current prices, is valued at around $30,000/year, the need for these other income sources is readily apparent.

Potentially, the project findings that there was scope to improve the yield and colour of purple sea urchin roe by transplanting urchins from less productive barrens grounds to more productive fringe areas could be used to increase industry profits. Discussions with sea urchin fishers indicated that some transplanting of urchins does take place, though it is the reds, not the purples studied in the project, that are transplanted. Given the low demand – and hence price ($1/kg) – for purples, divers consider the potential gains insufficient to make transplanting purples worthwhile.

The information produced in the project regarding the improvements in roe yield from transplanted purple urchins may have positively impacted on fishers expectations regarding the viability of transplanting red urchins from less to more productive grounds. However, discussions with fishers indicated that transplanting of reds was occurring prior to the study, such that fishers were already aware of these potential benefits. While the project may have reinforced fishers views and given fishers greater confidence that transplanting of reds was worthwhile, fishers would have come to these same conclusions soon enough in the absence of the study.

With the lack of industry development and the transplanting of purples taken-up by industry, none of the potential economic benefits from the project – in terms of increased profits accruing to sea urchin fishers resulting from the more rapid development of the sea urchin fishery, increased profits accruing to the roe processing sector and increased employment in the sea urchin fishing or processing sectors – are likely to have been realised. Similarly, given that the project has not boosted harvest levels, there will not have been any flow-on benefits to the NSW/Victorian abalone fisheries.

Conceivably, there may have been prospective investors who, in the absence of the information produced in this study demonstrating the limited nature of the red urchin population, may have been attracted to investing in the roe processing sector. Clearly, any such investment would not have been viable and would have incurred costs to the economy as a whole, these being the benefits foregone had the capital been invested in some other more productive sector of the economy. To the extent that the project brought reality into future expectations regarding the industry and discouraged any unsustainable investment, this can be considered as being an economic benefit from the project.

5.4: Realised Environmental Benefits

Impact of stock assessment advice on sea urchin management arrangements

From the start of 2002, NSW Fisheries established a total allowable commercial catch (TACC) limit for the red sea urchin fishery. The significance of the project outputs in influencing these new arrangements can be readily demonstrated.

- In the case of reds, the results from the project on the estimated biomass (1195mt), likely productivity of the resource (between 1-5%), and the sustainability of current fishing levels, were provided to NSW TAC Setting and Review Committee in 2001. The Committee accepted advice from the project that the existing catches coming from regions 3 and 4 were not sustainable and recommended that the fishery be managed on a regional basis, using regionally-based commercial catch limits. The Committee used the regional abundance estimates obtained from the research to recommend regional total allowable commercial catch (TACC) limits (8mt in region 1, 28mt in region 2, 13mt in region 3 and 11mt in region 4), totalling 60mt/year across the state, and recommended that these TACCs remain in place for the next 5 years. These recommendations were implemented by the Government and became effective from 1 January 2002.

- Corresponding advice was provided to the Committee in the case of purples, where biomass estimates (around 20,000mt from the fringe and 30,000mt from the barrens) was combined with estimates of likely productivity (between 1-5%) to indicate a sustainable catch levels from the fringe alone of between 200-1000mt/year, provided catches are spread across the regions in proportion to the purple's relative abundance.

  The Committee used the results from the project that the estimated sustainable yield was far greater than the current catch level to conclude that a TACCs for purple sea urchins was not warranted at the present time.

Had this project not been implemented, NSW Fisheries would have had little if any information on the sustainability of the sea urchin fishery or that the then catch levels of red sea urchin were not sustainable.

Approximately 60mt of red urchin was harvested from region 3 in 2000, and over 20mt in 2001. When regional quotas were established, the quota for region 3 was only 13mt. A

similar situation applies to region 4, where catch was limited to 11mt for 2002 after considerably higher catches had been taken in earlier years.

Quotas were not implemented in time to prevent significant depletion of reds in regions 3 and 4. However, the introduction of quotas did at least restrict further depletion in these regions, as well as preventing widespread depletion in additional regions. In the absence of the project, it is assumed that the introduction of quotas by NSW Fisheries would have been delayed by several years, increasing the risk of more extensive and widespread depletion of the red sea urchin population[4].

The project also enabled NSW Fisheries to gain a better scientific understanding of the stock abundance, distribution and sustainable harvest levels for purple sea urchins. The scientific information vindicated that existing management arrangements – limited entry, but no limits on catch – were appropriate given current harvest levels.

In the absence of the information generated by this project on the widespread abundance of purples, it is likely that when NSW Fisheries eventually become aware that more stringent management measures were needed for reds, more stringent management measures would also have been introduced for purples. Such arrangements are clearly not required at present catch levels, and the costs incurred by NSW Fisheries in implementing such unnecessary measures, together with any costs incurred by industry in complying with such unnecessary measures, can be considered as being benefits to the project.

In Victoria, there has been less interest in the sea urchin fishery compared to NSW, processing/marketing issues have restricted development, and there has not been any specific change in management arrangements in the fishery as a result of this project. The fishery continues to be managed as a developing fishery, and while there has been some discussion about the merits of introducing output controls, these have not been considered necessary given the present low harvest levels.

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[4] The realisation of the environmental benefits from the earlier introduction of quotas depends upon the extent to which there is effective compliance with the quota system by industry, which in turn will be influenced by the effectiveness of the surveillance and enforcement activities of NSW Fisheries. Clearly, if there is inadequate enforcement of the regional quota system, misreporting of either the location of the catch or the species involved, ie misreporting reds as purples, weakens the integrity of the quota system and would erode the environmental benefits arising from the project.

5.5: Realised social benefits

The project has not as yet generated any benefits to regional communities in NSW or Victoria.

5.6: Net Benefits

The main benefits from the project are environmental, in that the fisheries agencies of both NSW and Victoria now have the necessary scientific information on stock abundance, distribution and sustainable harvest levels to properly manage their respective sea urchin fisheries.

These environmental benefits have not as yet translated into economic benefits. The limited abundance of red urchins, an inability to maintain export markets, a subsequent glut of product on the domestic market, and lack of market demand for purple urchins, have adversely affected profitability, and hence development, of the industry.

Should these marketing problems be overcome, as a result of this project the fisheries agencies of both states are well placed to properly manage the sustainable development of their respective sea urchin fisheries.