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Fisheries Economics, Research and Management Pty. Ltd.

EX POST BENEFIT/COST ANALYSIS

PROJECT NO: 1996/139

Changes after twenty years in relative abundance and size composition of commercial fishes caught during fishery independent surveys on south-east fishery trawl grounds

Prepared for the FRDC

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Summary

This project involved the replication in 1996/97 of a research survey undertaken on the NSW upper-slope trawl fishing grounds in 1976/77. The repeat survey used the same vessel and fishing gear and trawled the same grounds at the same time of the year as in the initial survey. Differences between the two surveys in catch rates by species were interpreted as providing an unbiased indication of changes in relative abundance of those species over that 20-year period in the eastern zone of the South East Fishery (SEF).

The project proposal stated that this information would be 'of enormous use in the SEF stock assessment process' and that fishery-independent information such as that produced from the project was 'urgently needed for SEF management purposes'.

The report concluded that based on the results from the project, SEF species can be categorised into three groups:

i) those species that have experienced a substantial decrease in abundance – redfish, jackass morwong, ocean perch and several deepwater shark species;

ii) those species showing little change or increased relative abundance – ling, tiger flathead and spikey dogshark; and

iii) those species known to be migratory and/or schooling or to have unpredictable recruitment onto the NSW slope - gemfish, mirror dory, blue grenadier and spotted warehou – for which the survey results were too uncertain to make any conclusions regarding changes in relative abundance.

Of those species found to have experienced a fall in abundance:

i) a quantitative stock assessment model has been developed for redfish but attempts to fit the model to CPUE data from the two surveys were unsuccessful such that data from the project has no tangible effect on the redfish model;

ii) there is no quantitative stock assessment model for either ocean perch or Jackass morwong at the present time, such that monitoring of these two stocks continues to be based on commercial CPUE data;

iii) AFMA has recently introduced new management arrangements to better control the catch of three deepwater shark species - Harrisson's dogfish, endeavour

dogfish and southern dogfish, and the Commonwealth Environment Minister is currently considering whether these same three species should be listed as threatened species under the Environmental Protection and Biodiversity Conservation Act;

- results from the project provided quantitative data on which changes in abundance were assessed.

Of those species found to have stable/increasing abundance:

i) data from the project was included in a formal stock assessment model for ling, though sensitivity tests showed that inclusion of the project data had negligible impact on the model results. However, the project data corroborated the commercial data and increased the level of confidence in the accuracy of the commercial data and thus the model results;

ii) the quantitative assessment model developed for flathead does not use information from the project.

The total allowable catch (TAC) levels for those species found to have declined in relative abundance – redfish, jackass morwong and ocean perch - remained virtually unchanged in the years immediately following release of the project results. The project results have had little impact on TAC levels.

SEF stakeholders have mixed views regarding the merits of the project. Industry raised concerns with the project from the outset when the initial proposal was considered. While this does not necessarily mean that the project was flawed and should not have been approved, it should have signified the need for greater communication between researchers and industry at an early stage of the project to address these concerns and overcome any misunderstandings:

- no evidence was found to indicate that the dialogue required between researchers and industry to resolve industry's misgivings took place;
- given this, it is not surprising that industry were opposed to the project and that the results have had limited influence on management arrangements.

There is growing awareness among SEF stakeholders of the potential benefits of some form of fishery independent survey in the SEF. This project demonstrates the need for the effective engagement of key stakeholder groups during development of the survey design and consideration of survey results if these potential benefits are to be realised.

1. Introduction

This report describes an ex-post cost/benefit analysis undertaken on FRDC project 1996/139, 'Changes after twenty years in relative abundance and size composition of commercial fishes caught during fishery independent surveys on south-east fishery trawl grounds', implemented by New South Wales Fisheries.

2. Background

The South East Fishery (SEF) is one of the most important Commonwealth fisheries, with catches in recent years around 29,000t valued at around $75m. The SEF is a multi-species fishery, with the management strategy relying on a combination of input and output controls, particularly catch quotas. There are 16 quotas covering 21 different fish species from 13 species groups.

The stock assessments for virtually all SEF species rely to a large extent on monitoring changes in commercial catch rates, and in particular, catch per unit effort (CPUE). These assessments are based on the assumption that CPUE is proportional to stock abundance and that changes in CPUE reflect changes in abundance.

However, as noted in the project proposal:

- it is widely acknowledged that CPUE-derived abundance estimates have numerous sources of error because of poor data quality, changes in fishing power and changes in fishing practices over time; and
- although considerable effort is directed towards standardising CPUE data, doubts persist about the use of standardised CPUE data as stock abundance indices.

The project was therefore developed in the context of increasing concern over the reliability of the SEF stock assessments given that the assessments are heavily influenced by commercial CPUE data.

The use of fishery independent data can potentially overcome the biases associated with commercial CPUE data. A previous research survey had been undertaken on the NSW upper-slope trawl fishing grounds in 1976/77 by NSW Fisheries. The project proposal stated that replicating the survey, using the same vessel and fishing gear and

trawling the same grounds at the same time of the year, and comparing the 1996/97 and 1976/77 catch data, would provide unbiased information on relative changes in abundance of the various SEF species over that 20-year period. The proposal considered that such information 'would be of enormous use in the SEF stock assessment process'.

The collection of other fishery independent biological data - such as length-age data – was also considered desirable to address 'doubts about the representativeness of samples taken from the commercial catch'

3. Project Objectives and Description

Project objectives

i) to quantify changes in the comparative abundance of quota and other important upper slope fish since 1976-77;

ii) to collect fishery-independent comparative data on the size composition of these trawl fish after 20 years of exploitation;

iii) to collect fishery-independent representative samples of otoliths and other biological information as required by the South East Fishery Assessment Group.

Project description

The project involved a repeat of a scientific trawl survey undertaken 20 years earlier and a comparison of the two sets of results.

In order to maintain consistency, the same vessel, fishing gear and sampling protocols were used.

There are three survey locations – Sydney, Ulladulla and Eden.

All locations were surveyed three of four times, with three tows/survey for each of the 8 depths. Most tows were in daylight.

A total of 165 trawls were made, 48 in Sydney, 54 Ulladulla and 63 for the Eden grounds.

The number, weight and length distributions of all commercial and some non-commercial species were recorded from each tow. Where practicable, SEF quota species were identified by sex.

The quantity and length distribution of the 1996/97 catch of both commercial and some non-commercial species were compared to corresponding data from the 1976-77 and 1979-81 surveys.

4. Research Findings

Comparison of 1976/77 and 1996-97 catch data

In aggregate terms, the results indicated a substantial decrease in the overall fish biomass on the grounds surveyed:

- average total catch/hour trawled decreased 68%, from 681kg to 216kg, between the 1976-77 and 1996-97 surveys, while average total commercial catch fell 74%, from 568kg/hour to 148kg hour;
- the most likely cause of the reduced abundance was assumed to be the sustained fishing pressure in the SEF;

On an individual species basis the results:

- implied large reductions in relative abundance for redfish, jackass morwong, ocean perch, endeavour dogfish, Harrisson's and southern dogfish, greeneye dogshark and angel shark;
- implied that the relative abundance for ling, tiger flathead and spiky dogsharks have remained stable or have slightly increased; and
- produced highly variable estimates of relative abundance for gemfish, mirror dory, blue grenadier and spotted warehou such that no conclusions were made regarding changes in relative abundance.

Comparison of length frequency data

- for redfish, jackass morwong, ocean perch and ling, the average size of the fish caught was smaller than in 1976/77 indicating that there had been a substantial fish-down of larger fish;

- no change was detected in the length distribution of tiger flathead;
- for gemfish, mirror dory, blue grenadier and spotted warehou, changes in the size composition of the catch were not assessed given the variability in catch rates.

Collection of otoliths

A total of 4015 pairs of otoliths were collected and sent to the Central Ageing Facility at the Marine and Freshwater Resources Institute, Queenscliff Victoria, for analysis.

- 5 species – ling, ocean perch, redfish, tiger flathead and blue grenadier - accounted for 97% of the otoliths collected.

5. Cost/Benefit Analysis

There are two major components of net economic benefit in cost/benefit analysis - producer's surplus and consumer's surplus. Producer's surplus is a measure of net economic benefit generated in the SEF fishery as a result of the research project. Although somewhat simplified, producer's surplus can be thought of as additional profits generated. In addition, if the research findings induce increases in production and employment, then to the extent that previously unemployed labour is hired, the associated wages would also be included as a benefit in producer's surplus.

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

Cost/benefit 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

The total cost of the project was just under $1.3 million, of which FRDC contributed around 18% (Table 1).

Table 1: Cost of Research Investment

FRDC	Other	Total
$234,892	$1,060,300	$1,295,192

5.2: Potential Benefits

The project proposal suggested that 'the direct benefits of this research will be felt by all those involved in the SEF stock assessment process', noting that 'an understanding of the changes that have occurred in the SEF in the 20 years since its inception will provide much greater security in assessments and therefore contribute to the sustainability of the fishery in the long-term'.

The key benefit arising from the project was therefore envisaged to be improved stock assessment for SEF species which would in turn influence AFMA's future management decisions in the fishery.

5.3: Realised Benefits

The extent to which the three outputs from the project – the catch data, the length frequency data, and the collection of otoliths - have influenced the stock assessments of individual SEF species are considered in the context of:

i) those species which the surveys indicated had experienced a substantial decrease in abundance – redfish, jackass morwong, ocean perch, several species of dogfish – Endeavour, southern, Harrisson's and greeneye - and angel shark; and

ii) those species showing little change or increased relative abundance – ling, tiger flathead and spikey dogshark.

The report recognised that for those species which are known to be migratory and/or schooling or to have unpredictable recruitment onto the NSW slope - gemfish, mirror dory, blue grenadier and spotted warehou - there was too much uncertainty with the survey results to make any conclusions regarding changes in relative abundance and size composition. Accordingly, the survey results for these species are too unreliable to be used in their respective stock assessments and the value of the project for these

species is limited to the benefit derived from any additional information obtained from the analysis of the otoliths collected during the survey.

Species found to have decreased in relative abundance

Redfish

A quantitative stock assessment model has been developed for redfish (see Thomson 2002a). The model provides estimates of CPUE, discard weight, discard levels, catch-length and age-length frequencies which are compared to actual data. The fishery is divided into two sections - north and south of Montague Island.

The base-case models for the northern and southern regions do not use data generated from the project. An attempt was made to fit the models to the decline in redfish CPUE from the 1976/77 and 1996/97 research surveys, to estimate the redfish status assuming the survey CPUE data reflect changes in relative abundance. However, this proved unsuccessful - the decline in CPUE from the surveys was too large to be estimated by the model given the underlying biological parameters and the observed landed catches. With the model unable to fit the project data, the project has no tangible effect on the redfish model.

The model uses standardised CPUE data. However, most likely mindful of the problems associated with using commercial CPUE data, the report noted the importance of having an accurate abundance index and the need for fishery independence surveys in the SEF (Thomson op cit).

This same view had previously been made in 2001 in an independent review of the redfish stock assessment (see Hall 2001). That review, commissioned by AFMA and undertaken by a widely respected stock assessment scientist, considered the results from the project were significant:

> 'The most compelling evidence for this conclusion (that the redfish stock in the SEF has been overfished) is provided from the trawl surveys conducted by the *Kapala* in 1976-7 and repeated in 1996-7'.

The review not only suggested that fishery independent surveys were a good indicator of relative abundance, it raised the possibility that the traditional approach for monitoring stock abundance in the SEF – CPUE analysis – was unreliable:

> 'The Kapala results also add support to the concern that the commercial catch rates may be a poor index of stock abundance, which possibly lead to optimistic assessments of the current stock size when these data are used in fisheries models'.
>
> 'In a multi-species, quota-managed fishery such as the SEF, where catch rates are likely to poorly reflect the abundance of many species, consideration should be given to developing a data set from a statistically well-designed and robust scientific trawl survey..... While such a survey might be expensive, it would considerably reduce the uncertainty of future stock assessments, and thereby reduce the cost to the fishing industry of applying more conservative quotas required to allow for the uncertainty associated with current stock assessments.'

Ocean perch and jackass morwong

Unlike redfish, there is no quantitative stock assessment model for either ocean perch or Jackass morwong at the present time. Other SEF species have been accorded a higher priority in terms of rigorous stock assessment, such that the monitoring of these two stocks is based on CPUE analysis.

Deepwater shark species

Consistent with the emphasis being given to managing fisheries on an ecosystem basis rather than concentrating solely on the target species, greater attention is being given to the sustainable management of deepwater sharks affected by the SEF. Several species of the deepwater sharks have commercial value – particularly their livers which are high in squalene, an oil used as a health and nutritional supplement. Deepwater sharks are usually caught as a bycatch species on the upper-slopes of the SEF, but are at times targeted in the deeper waters.

The results from this project were frequently referred to in FRDC Project 1998/108, 'Catch Analysis and Productivity of the Deepwater Dogfish Resource in Southern Australia'. Using the results from the Kapala surveys, and other supporting information, that project concluded that some upper-slope species have been depleted, suggested that AFMA and Environment Australia give special consideration to the management of these species, considered it unlikely that catch restrictions alone

would be sufficient, and suggested that seasonal closures or closed areas may be required.

Management arrangements for deepwater sharks are currently being reviewed:

- in July 2002, AFMA introduced new management arrangements involving a combined 150kg trip limit on the catch of the three species, of which no more than 30kg can be for Harrisson's dogfish; and
- the Commonwealth Environment Minister is currently considering whether three species of dogfish – Harrisson's, endeavour and southern – should be listed as threatened species under the Environmental Protection and Biodiversity Conservation Act;

One of the authors of a report commissioned by Environment Australia advised that the sections in the report relating to SEF shark species relied heavily on the results of the Kapala surveys and considered that the project provided the only quantitative data available on which to assess changes in abundance of various shark species (see Pogonoski et al 2002).

- in the absence of this project, it is unlikely that comparable quantitative information on the relative abundance of shark species in the SEF would have otherwise been collected.

With respect to deepwater sharks, the project achieved its objective of providing information to improve existing fishery assessments and to influence future fisheries management arrangements.

Species showing little change or increased relative abundance

Ling

Results from the project have been used in a formal stock assessment model for ling (Thomson, Furlani and He 2001). A research fleet was explicitly included along with three other fleets - western trawl, eastern trawl and non-trawl –in this model. Data for the research fleet was sourced from the project and the 1976/77 survey. Model estimates of CPUE, length frequency and age-at-length for the research fleet – and the other 3 fleets - were compared to the actual data obtained from the project. Landed catch and discard data were also used.

The model estimates of CPUE did not match the project data at all well although estimates of catches at age and length were of a similar quality to those of the commercial fleet. Sensitivity tests showed that ignoring the research fleet did not greatly affect the overall model results. It was concluded that the length and age-frequency data from the research fleet were similar to those from the eastern trawl commercial fleet. In other words, adding the project data – and a research fleet –had negligible impact on the model estimates for the other three fleets.

The assessment revealed two apparently irreconcilable signals in the data (Thomson et al, op cit):

i) stable/increasing standardised CPUE, suggesting a stable/increasing ling biomass; and

ii) the average size and age of the ling being caught are falling, suggesting a declining ling biomass.

Not surprisingly, the model was unable to fit these apparently conflicting data and the results from the model were not regarded as being reliable (Thomson et al, op cit).

The data obtained from the project mirrored the data collected from the commercial fleet – that is, catch rates between the 1976/77 and 1996/97 surveys were similar but there was a large decline in the average size of the ling caught.

The project data therefore corroborated the commercial data and 'implies that the trends observed in the commercial fishery do reflect trends in the ling population and are not the result of changes in the behaviour of the fishery' (Thomson et al, op cit).

With respect to ling, while the project had negligible impact on the stock assessment, the consistency of the project results to the commercial data increased the level of confidence in the accuracy of that data.

Tiger Flathead

A quantitative assessment model has been developed for flathead. CSIRO staff responsible for the model advise that the model does not use information from the project.

Analysis of otoliths

The project was not the only source of otoliths for SEF species - the Integrated Scientific Monitoring Program (ISMP), and its predecessor, the Onboard Scientific Monitoring Program, also collected otoliths from SEF species on a regular basis for analysis by the Central Ageing Facility. While the actual number of otoliths collected varies from year to year according to the research needs of the time, around 10,000-12,000 pairs of otoliths from SEF species would be collected in a typical year.

The otoliths collected during the project enabled a greater number of otoliths to be aged than otherwise would have been the case for 5 SEF species – ling, ocean perch, redfish, tiger flathead and blue grenadier. This is turn would have produced a more precise age-length relationship for those 5 species in that particular year.

However, the impact on individual species stock assessments from a one-off increase in the otolith sample size of these 5 species is at best considered marginal:

i) one of the key reasons for the collecting and analysing of otoliths under the ISMP program is to monitor trends in the age-length relationship over time. However, the otoliths collected from the project were taken within a 11-month period May 1996-March 1997, such that they were of little use in terms of detecting trends over time;

ii) the number of otoliths collected under the ISMP programme is based on model estimates of the sample size needed to produce sufficiently robust estimates of the age-length relationship for that given year. So, although the Kapala otoliths would have improved the estimate of size structure for those species in that year, enough otoliths would have been collected under the ISMP program to meet the assessment needs for that year.

The project proposal suggested that because of targeted fishing practices, there was some doubt about the representativeness of the sample of otoliths collected from commercial fishing activities (such as the ISMP program). The proposal cited the example of ling, where the length/age relationships were thought to be biased by a disproportionately low proportion of older, larger fish in the commercial catch.

- however, very few larger, older ling were caught in the survey trawls, such that there would have been little difference in the size distributions of the fish from which the project and the ISMP obtained their respective otoliths.

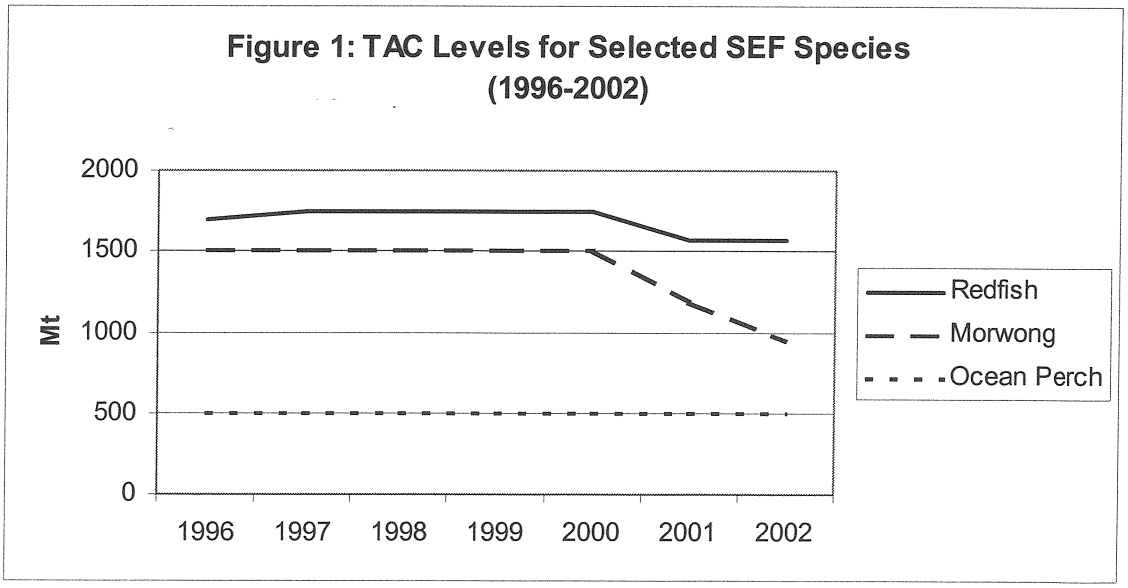
Impact of the results on fishery management arrangements

The project proposal stated that comparative fishery-independent estimates of changes in stock abundance with time are urgently needed for SEF management purposes. In this context, it is appropriate to examine the extent to which the results from the project led to changes in SEF management arrangements.

The impact of the project results in terms of influencing new management arrangements for three shark species has already been discussed. With respect to other species, presumably the project results would have greatest impact on the total allowable catch (TAC) set for each SEF quota species. It also follows that this impact would be greatest for those species considered to have declined in relative abundance – redfish, jackass morwong and ocean perch.

However, TACs for these species remained virtually unchanged in the years immediately following release of the project results (Figure 1).

Figure 1: TAC Levels for Selected SEF Species (1996-2002)



TACs for morwong, and to a lesser extent redfish, have fallen in the last two years. However, this is being driven more by observed falls in CPUE rather than any belated recognition of the project results.

The AFMA Board had access to the results from this project, together with a range of other relevant information, when it made its decisions regarding appropriate TAC levels for the SEF. It is beyond the scope of this report to consider whether, based on the project results, the TACs should have been reduced: all that can be said is that the project results appear to have had little impact on TAC levels.

5.4: Level of support for the project

Discussions with industry members, fisheries scientists, fisheries managers and other SEF stakeholders have revealed two schools of thought regarding the merits of the project:

- there are those that strongly support the project, arguing that the consistency between the 1976/77 and 1996/97 surveys – using the same vessel, the same gear, fishing the same locations at the same time of the year – means that changes in catch rates in the two surveys are a meaningful indicator of changes in relative abundance; and
- there are others that are strongly opposed to the project, questioning whether sufficient sampling was done to give reliable abundance indicators, whether the extent to which any declines in abundance could be attributed to the fishing-down of what in 1976/77 was essentially a virgin fishery, and the extent to which any observed differences in abundance between the two surveys could be attributed to environmental fluctuations compared to overfishing.

It is beyond the scope of this review to evaluate these opposing views. However, it is suggested that the level of division on the merits of the project has limited the extent to which the project results have been used and the extent to which the results have influenced management arrangements in the fishery.

Interestingly, although there remain opposing views on the merits of this project, there is growing awareness among SEF stakeholders of the need for some form of fishery independent surveys. Two separate processes are running concurrently to assess the merits of a further research survey in the SEF:

- the AFMA Board is actively considering the costs associated with undertaking a repeat survey;
- a separate FRDC project has recently commenced to assess the sampling intensity required to develop robust indices of relative abundance and to increase the level of understanding and support for future fishery independent surveys from SEF stakeholders.

If there is general agreement on the need for future fishery independent surveys, why does there continue to be conflicting views on the value of this project? And what lessons can be learnt from this project to improve the acceptance of the results from any future fishery survey?

Some supporters of the project have suggested that the industry opposition to the results is because the results reveal significant depletion of several commercially important stocks. Were industry to have accepted these results, AFMA would in all likelihood have reduced the TACs for those species:

- this argument is plausible: those operators facing short-term financial pressures – such as loan repayments – may actively oppose reductions in the TAC, even if they believe that such reductions are warranted.

However, a review of the available information demonstrates that industry had concerns with the project from the outset and that the industry opposition to the project has more substance than a 'shoot the messenger' type response.

The initial proposal was considered by the South East Trawl Management Advisory Committee (SETMAC) research sub-committee in 1995 and accorded a low priority. The proposal was then considered by SETMAC at its meeting in October 1995. SETMAC did not accept the research sub-committee's low priority ranking: instead, SETMAC considered that the proposal may have some merit, but raised a number of questions about the feasibility of the project and requested the project be modified.

A revised proposal – the proposal subsequently approved by FRDC – was reconsidered at the next SETMAC meeting in December 1995. Records from that meeting indicate that:

> 'the proposal was discussed at length with members divided as to the relative merits of the proposal';

'industry members considered that the project had a major flaw in it as it would be merely taking a second snap-shot, twenty years after the first, and would not be taking into account issues such as fish behaviour and the cyclic nature of the fishery';

'industry members were particularly opposed to the objective to quantify changes in the comparative abundance of quota and other important upper slope fish since 1976-77'; and

'SETMAC agreed to rate the project as high, but lower in priority than the seven projects rated high at the previous SETMAC meeting. Further, the high ranking was provisional on objective one – quantifying changes in the comparative abundance – being removed'.

Industry had concerns with the project from the outset. While this does not necessarily mean that the project was flawed and should not have been approved, it signifies that there was a need for greater communication between researchers and industry at an early stage of the project to overcome these concerns/misunderstandings.

- No evidence has been found to indicate that the dialogue required between researchers and industry to resolve industry's misunderstandings/misgivings with the proposal took place.

Given that:

i) industry raised initial concerns about the proposal;

ii) the proposal was rated by SETMAC as being only the eighth highest priority in the fishery in that year;

iii) this high priority rating was provisional on one of the objectives being removed;

iv) the proposal as approved by FRDC included this 'contentious' objective; and

v) there does not appear to have been effective dialogue between researchers and industry to address industry's concerns/misunderstandings;

it is not surprising that industry did not readily accept the results of the project and that these results have had limited impact in terms of influencing management outcomes for the principal SEF species.

As previously noted, the results have had a direct influence in shaping future management arrangements for deepwater shark species and the methodology used in the study will contribute to a subsequent FRDC project.

5.5: Prospects for future use of the project results

The results and experiences from the project are influencing the development of possible future fishery independent surveys. For example, the sample design used in the project will be considered in the new FRDC project examining the relationship between sampling intensities and robustness of survey results.

Work is also on-going to develop a range of indicators - such as using catch-curve analysis – of the status of SEF stocks (Thomson 2002b). The catch curve analysis uses length frequency data and age-length data to estimate the level of fishing mortality. Length-frequency data and one year of age-length data from the project is being used in this analysis.

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