Report on options for reducing the dependency of the Australian aquaculture industry, ornamental fish industry, commercial and recreational fishing industry on imported aquatic products

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Notice:

Please note that the information presented in this report was considered to be true and accurate as at the end of December 1995. A number of changes are likely to have occurred since this time. The Task Force on Imported Fish and Fish Products requested that this report not be released until after the release of their report (December 1996) so as not to preempt any of the recommendations made by the Task Force in its report.

Acknowledgments:

The information presented in this study has been collated from information provided by key industry members, researchers and government officials associated with that particular issue, as well as all the members of the Working Group and the Task Force on Imported Fish and Fish Products. I am grateful for the co-operation and interest shown by all of the above contributors to this study.

Disclaimer:

This report has been prepared by Aquaculture Development and Veterinary Services P/L (ADVS) for the FRDC to act as part of the information gathering process undertaken by the National Task Force on Imported Fish and Fish Products. This report has been based on broad consultation with industry, government, researchers, and members of the Working Group and Task Force on Imported Fish and Fish Products. Whilst all care has been taken in collecting, collating, interpreting and presenting this information, neither ADVS nor its directors undertake responsibility in any way whatsoever to any person (other than the FRDC) in respect of the report, including any errors or omissions therein.

1. NON-TECHNICAL SUMMARY

95/176 Report on options for reducing the dependency of the Australian aquaculture industry, ornamental fish industry, commercial and recreational fishing industry and stockfeed industry on imported aquatic products

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OBJECTIVES:

1. Identify the specific sectors of the aquaculture industry, ornamental fish industry, commercial and recreational fisheries and stockfeed industries which utilise imported aquatic products and identify the particular products involved.

2. Determine the extent of reliance by the above industry sectors on imported aquatic products.

3. Identify options for reducing the dependence of the above industry sectors on imported aquatic products.

* The study did not extend to product for human consumption.

NON TECHNICAL SUMMARY:

In 1995 a National Task Force on Imported Fish and Fish Products was set up by the then Minister for Primary Industries and Energy, Senator Bob Collins and the Minister for Resources, David Bedall. This was in response to a number of events which had raised concern within Australia regarding the potential for imported aquatic products to introduce exotic pathogens and pest species into Australian waters. The Task Force was comprised of a broad range of representatives from key Commowealth agencies, State agencies, research organisations, industry, recreational and environmental groups. The role of the Task Force was to address all relevant matters relating to the use of imported aquatic animals and their products, including fish health and quality, socioeconomic, industry and environmental aspects in order to develop a policy framework and nationally agreed mechanisms for the importation and handling of aquatic imports. The Task Force was also to address all relevant aspects of the "Report of the Scientific Working Party on Aquatic Animal Quarantine" (BRS Report).

The Task Force established a Working Group to provide analysis and prepare reports on specific subjects for the main Task Force and reported jointly to the Ministerial Council for Forestry, Fisheries and Aquaculture (MCFFA) and the Agricultural and Resources Ministerial Council of Australia and New Zealand (ARMCANZ) in December 1996.

The demand for imported aquatic products is considerable, and includes a broad range of products (e.g. feed and feed ingredients for aquaculture, bait for commercial and recreational fishing, pet food, product for human consumption and aquarium fish). A significant percentage of the aquaculture industry, ornamental fish industry, commercial and recreational fisheries, and the stockfeed industry are very reliant on these products for the viability of their businesses and the outcomes of the recent review of quarantine policy could have significant impacts on the availability of imported aquatic animals and their products to these industries. The Task Force therefore, recognised the need to take full account of industry's reliance on these products. The Task Force also recognised that it is important to identify mechanisms for reducing industry's reliance on aquatic imports. This is especially important where following a detailed Import Risk Analysis, imported aquatic animals or their products are considered to pose an unacceptable risk to the Australian aquatic environment. The information consolidated in this study assisted the Task Force and Working Group to take account of these issues in its deliberations and a copy of this report is included in the final "Report of the National Task Force on Imported Fish and Fish Products".

This study noted three general options for reducing the dependency of Australian industries on imported aquatic products, including:

a. Identification and/or development of a local supply of the same product
b. Identification and/or development of a local supply of an alternative product
c. Identification and/or development of an overseas supply of an alternative product

and identified a number of factors to be taken into consideration in determining the priority of any particular options, including:

a. Existing level of research or development of the import replacement option
b. Measures (including resources) necessary to achieve import replacement
c. Likelihood of successfully achieving the import replacement measure
d. Time necessary to achieve import replacement
e. Likelihood that the import replacement measure will be sustainable
f. Likelihood of industry adoption of the import replacement measure
g. Level of import replacement likely
h. Compatibility with other industry and government strategic priorities

Due to the many aquatic animals and their products currently imported into Australia, it was not possible to investigate options for reducing dependency on all of them. This study therefore, identified seven (7) key aquatic imports and conducted case studies to investigate in detail, the options available for reducing industry dependence on them. These case studies included:

* Pilchards for feeding to farmed Southern Bluefin Tuna (SBT)
* Marine aquarium fish
* Freshwater aquarium fish
* Complete artificial prawn feeds
* Salmonid starter diets
* Feed ingredients sourced from aquatic products for incorporation into aquaculture feeds
* Fish products for rock lobster bait

In many cases, measures which can be undertaken to reduce the dependency of industries on aquatic imports are likely, or have potential to achieve a number of other strategic priorities for the

industry concerned, irrespective of any judgements made (following an Import Risk Analysis) relating to the possible disease or pest risks associated with importation. For example, the environmental and logistical advantages of an artificial feed for the SBT farming industry.

As recommended in the Report of the National Task Force Report, support should be encouraged and forthcoming for research and/or development of products to reduce the dependency of Australian industries on aquatic imports. Key areas for R&D support, identified in this study include: artificial feeds for farmed SBT, artificial craypot baits, aquatic animal meal replacements and aquarium fish farming.

2. BACKGROUND

A number of recent events have raised concern within Australia regarding the potential for imported aquatic products to introduce exotic pathogens and pest species into Australian waters. These included the Japanese sea star infestation in southern waters, the appearance of European fan worm colonies in Port Phillip Bay and the possibility of a pathogen in imported pilchards contributing to the mortalities in pilchards around the coast of the southern half of Australia, although this has not been proven to be the case.

In response to the above issues, a National Task Force was set up by the Minister for Primary Industries and Energy, Senator Bob Collins and the Minister for Resources, David Bedall. The Task Force was comprised of a broad range of representatives from key Commonwealth agencies, State agencies, research organisations, industry, recreational and environmental groups.

The role of the Task Force was to address all relevant matters relating to the use of imported aquatic animals and their products into Australia, including fish health and quality, socioeconomic, industry and environmental aspects in order to develop a policy framework and nationally agreed mechanisms for the importation and handling of aquatic imports. The Task Force was also to address all relevant aspects of the "Report of the Scientific Working Party on Aquatic Animal Quarantine" (BRS Report).

The Task Force established a Working Group to provide analysis and prepare reports on specific subjects for the main Task Force.

The Task Force reported jointly to the Ministerial Council for Forestry, Fisheries and Aquaculture (MCFFA) and the Agricultural and Resources Ministerial Council of Australia and New Zealand (ARMCANZ) in December 1996.

The demand for imported aquatic products is significant and includes a broad range of products including feed and feed ingredients for aquaculture, bait for commercial and recreational fishing, pet food, product for human consumption and aquarium fish. A significant percentage of the aquaculture industry, as well as commercial and recreational fisheries are very reliant on these products for the viability of their businesses. The Task Force and Working Group acknowledged that this issue must be an important consideration in its recommendations.

The information consolidated in this study assisted the Task Force and Working Group to take account of the reliance by the aquaculture industry, ornamental fish industry, commercial and recreational fisheries on the importation of aquatic animals and their products. The study also investigated mechanisms for reducing the reliance of these industries on such products, in particular identifying areas of research that would assist in achieving this goal.

3. NEED

The outcomes of the recent review of quarantine policy could have significant impacts on the availability of imported aquatic animals and their products to the aquaculture industry, ornamental fish industry, commercial and recreational fisheries and the stockfeed industry. Any reduced availability of such products could subsequently have serious implications for the viability of the affected industry.

The Task Force recognised the need to take full account of industry's reliance on these products in its considerations of the issue. The Task Force also recognised that it is important to identify mechanisms for reducing industry's reliance on aquatic imports. This is especially important where imported aquatic animals or their products are considered to pose an unacceptable risk to the Australian aquatic environment.

4. OBJECTIVES

(i) Identify the specific sectors of the aquaculture industry, ornamental fish industry, commercial and recreational fisheries and stockfeed industries which utilise imported aquatic products and identify the particular products involved.

(ii) Determine the extent of reliance by the above industry sectors on imported aquatic products.

(iii) Identify options for reducing the dependence of the above industry sectors on imported aquatic products.

* The study did not extend to product for human consumption.

It is important to note, that this study was undertaken to form part of the "Report of the National Task Force on Imported Fish and Fish Products" which was presented by the Task Force to the MCFFA and ARMCANZ. This study deals in detail with Objective (iii), while Objectives (i) and (ii) have been covered in more detail in other sections of the Task Force Report.

Due to the many aquatic animals and their products currently imported into Australia, it was not possible to investigate options for reducing dependency on all of them. The study therefore considered general options for reducing the dependency of Australian industries on imported aquatic products and the factors which affect the priority of these options. It then applied these principles to the investigation of seven (7) case studies relating to key aquatic imports.

5. METHODS

The study was conducted through broad consultation with key personnel involved with the industries investigated in the seven case studies. This included industry members, industry organisations, government officials and researchers. All those spoken to were given an opportunity to comment on draft papers. The study was further reviewed by all members of the Working Group and National Task Force on Imported Fish and Fish Products. This final FRDC report is as presented in the "Report of the National Task Force on Imported Fish and Fish Products".

6. DETAILED RESULTS

6.1 Introduction

Government, industry and the public in Australia are concerned at the potential for imported aquatic products to carry exotic disease agents or for live aquatic imports to become pest species. This risk is sometimes unacceptable, so it may be necessary to apply restrictions on the importation of such products. However, the very fact that an aquatic product is imported into Australia implies some degree of reliance on that import. Therefore, any import restriction will necessarily affect the ability of the user to conduct their business.

In some cases however, existing or potential alternatives could fulfil the same role as the imported product, and therefore reduce the associated risks of disease and/or pest introduction. Unfortunately, not all of these alternatives are practical or feasible, particularly in the short term.

This report will:

(i) Outline the general options available for reducing the dependency of Australian industries on imported aquatic products.

(ii) Examine the factors that affect the priority of options.

(iii) Present case studies which investigate the import replacement options for seven currently imported aquatic animal products.

6.2 General options for reducing the dependency of Australian industries on imported aquatic products.

a. Identification of a local supply of the same product

Existing Australian sourced supplies of the same product may not have been identified by industry, however this is unlikely.

b Development of a local supply of the same product

A local supply of the same product may be available but industry is reluctant to use it. The local product may be poorer quality, more expensive or inconsistent in supply. Assisting the local supplier to overcome these issues may encourage industry to use more local product (e.g. supporting the development of the aquarium fish farming industry). This may involve the provision of financial and/or technical assistance to install more modern equipment, or it may require the provision of low interest loans to assist industry expansion. It may also be necessary to assist with research to overcome some of the above problems.

An existing local product may not have been commercialised (e.g. an underexploited source of pilchards in Australia for feeding to farmed southern bluefin tuna (SBT) or a local source of the product may be possible, but not yet attempted (e.g. expanding the species range of farmed aquarium fish). Commercialisation may require technical and/or financial assistance with or without a period of research support.

c. Identification and development of a local supply of a suitable alternative product

An existing local supply of a suitable alternative product may not have been identified by industry (e.g. Atlantic salmon heads for rock lobster bait), or suitable alternative local product may be available, but industry is reluctant to use it. The local product may be poorer quality, more expensive or inconsistent in supply (e.g. artificial prawn feeds or salmonid starter diets). Industry's reluctance to use this product may be overcome through direct technical or financial assistance or research.

An existing local supply of a suitable alternative product may not have been commercialised (e.g. discards from another fishery for feeding farmed SBT).

Where there is no suitable alternative local product, there may be potential to develop such a supply. This may require technical and/or financial assistance with or without a period of research support (e.g. research into artificial feeds for farmed tuna or artificial rock lobster baits).

d. Identification and development of an overseas supply of a suitable alternative product

An existing overseas supply of a suitable alternative product which does not present the same risks of disease and/or pest introduction as the current import may not have been identified by industry (e.g. an overseas artificial rock lobster bait, wild caught vs. aquaculture derived fish etc.). A suitable alternative product may be being developed overseas. Australian companies or industries could encourage or assist in the development of such products with the goal of importing that product once it is available.

(Note - Examples are given only to illustrate the point and do not necessarily represent suitable options)

A combination of two or more of the above options may achieve greater import replacement than one option alone (e.g. an artificial SBT feed or rock lobster bait containing some pilchards as an attractant may be supported by a local pilchard fishery, whereas this same feed may be unsuccessful without pilchards as an ingredient).

It must be remembered that a significant reduction in the risk of disease introduction may be possible through partial replacement of imports.

6.3 Factors affecting the priority of options

There are a number of factors to be taken into consideration in determining the merit or otherwise of an import replacement option. They include the current level of imports and size and dependence of local industry on the import. This must be equated with the extent of the exotic disease risk presented by the import (if any) and the potential of other risk reduction options (e.g. heat treatment, quarantine).

Issues which are important in determining the priority which might be given to seeking replacement options include:

a. Existing level of research or development of the import replacement option

Research or industry development is underway on a number of import replacement options. These measures may or may not be driven by the import replacement issue, but where there are resources and effort being expended, it suggests that a substantial driving force already exists to achieve results in that area.

b. Measures (including resources) necessary to achieve import replacement

c. Likelihood of successfully achieving the import replacement measure

d. Time necessary to achieve import replacement

Some options may only involve relatively short term development and/or implementation phases, others may be long term strategic or open-ended measures.

e. Likelihood that the import replacement measure will be sustainable

f. Likelihood of industry adoption of import replacement measure

The success of an import replacement measure relies entirely on industry adoption, which is more likely through industry involvement. In some cases industry may have no choice but to adopt an import replacement measure, if for example a particular aquatic import was banned. It would be critical however, that such measures were economically viable, otherwise the industry may collapse.

g. Level of import replacement

While 100% import replacement is ideal, partial replacement of certain currently imported aquatic products may still achieve significant reductions in the disease or pest risks.

h. Compatibility with other industry and government strategic priorities

Measures which achieve other objectives in addition to import replacement may attain a higher priority.

6.4 Case Studies

Following are seven case studies that investigate possible import replacement options and their priority:

(i) Pilchards for feeding to farmed Southern Bluefin Tuna (SBT)
(ii) Marine aquarium fish
(iii) Freshwater aquarium fish
(iv) Complete artificial prawn feeds
(v) Salmonid starter diets
(vi) Feed ingredients sourced from aquatic products for incorporation into aquaculture feeds
(vii) Fish products for rock lobster bait

Case Study 1 - Pilchards for feeding to farmed Southern Bluefin Tuna (SBT)

Options for reducing import dependency

The best option for reducing the dependency of the SBT farming industry on imported pilchards is development of a successful locally produced artificial feed. However, some potential to supplement this option or achieve partial import replacement through expansion of the local pilchard fishery may be possible.

Option 1- Development of an artificial SBT feed

(i) Existing level of research on artificial SBT feeds

Three commercial feed companies (Ridley Agriproducts Pty/Ltd, Gibson's Ltd. and Kensway Pty Ltd) have shown interest in the development and future production of an artificial SBT feed. Two of these companies are Australia's largest aquaculture feed producers. The third company's interest in feed production is specifically allied to the development of an artificial SBT feed, particularly the production technology associated with the manufacture of diets. This company does not currently operate a commercial feed mill, but might do so if the opportunity arose to produce commercial volumes of artificial SBT feed.

Significant research effort exists in Australia to develop a commercial artificial feed for farmed SBT.

* A substantial co-operative research effort under the CRC for Aquaculture Program "Development of pelleted feeds and optimisation of feeding strategies for SBT tuna".

The aim of this research is to develop a commercial artificial feed for farmed SBT and the project is co-ordinated by the South Australian Research and Development Institute (SARDI). Participants in the research include: SARDI, the Tuna Boat Owners Association of Australia (TBOAA), the University of Tasmania in Launceston (UTAS), two commercial aquaculture feed producers (Ridley Agriproducts Pty Ltd, and Kensway Pty Ltd) and the International Food Institute of Queensland (IFIQ).

* Gibson's Ltd. is also participating with SARDI and the TBOAA in research on artificial SBT feeds, but is not actually a participant in the CRC project.

Research is conducted in sea cages located at the TBOAA marine lease in Boston Bay, Port Lincoln. There are now 9 individual research cages plus a holding cage. Each cage is stocked with approximately 60 SBT caught during the routine purse seining operations of a commercial SBT farmer. The performance of SBT fed on trial diets is compared against that of SBT fed on pilchards. IFIQ is assessing flesh quality parameters in SBT fed these diets.

(ii) Measures necessary to achieve a successful commercial artificial feed for farmed SBT

Working with SBT is logistically and technically difficult due to the large size, method of capture and high value of the fish. Thus considerable levels of funding and staffing are required to conduct research trials with this species. While existing funding for this project is substantial, most participants believe that additional funding and resources would reduce the time required to achieve a successful outcome. Progress is also limited to some degree by the seasonal nature of fish performance in trials. Even if two intakes of SBT were available to stock research cages, the results of winter trials may not be transferable to SBT farmed during warmer months.

Due to the lack of local and international experience in the development of novel commercial finfish feeds and knowledge with SBT in aquaculture, additional international expertise, (especially commercial expertise) is seen as important. This could be achieved either by establishing an International Expert Advisory Committee consisting of 4-6 recognised international experts in fish nutrition paid for their time on a consultancy basis or by seeking input from such experts individually as required.

Another issue that increases the difficulty of nutrition research in SBT is the number of interested parties. While this is positive in driving the research effort, co-ordination is sometimes difficult, particularly with involvement of three commercial feed companies (not all associated with the CRC project) all trying to secure their position in the eventual commercialisation of any successful product and because they have different strategies/ products in mind. The high level of co-ordination required, necessitates the allocation of considerable resources to this area.

The establishment of some form of joint venture agreement between the commercial interests (i.e. TBOAA and feed manufacturers) may reduce the commercial uncertainty for commercial interests and maximise the level of co-operation and resources dedicated to the development of an artificial SBT feed. While this approach may stifle competition in the feed supply sector for the SBT farming industry, this industry may not support more than one feed supplier anyway.

It is probably undesirable however, for the TBOAA or Aquaculture CRC to establish a joint venture with any one feed company. This would potentially hinder development at this early stage because each feed company has only one type of processing equipment and the final solution is unknown.

(iii) Likelihood of successfully achieving a commercial artificial feed for farmed SBT

There is general agreement that a successful commercial artificial SBT feed will be developed. Progress has already been made in understanding the experimental approach required for SBT, however trial diets have not achieved the same performance as fresh or frozen pilchards to date.

(iv) Time necessary to achieve import replacement

There are varying degrees of optimism for the development of a successful initial commercial feed ranging from 6 months to 3 years. Full adoption of this feed however, by the SBT farming industry is likely to be phased in as this initial feed is improved.

The actual time required will depend on a number of factors including:

* The level of available funding and resources
* The degree of co-operation between, and co-ordination of all interested parties
* The ability of artificial feeds to maintain acceptable flesh quality in SBT product
* The type of feed targeted (e.g. mash, semi-moist or drier feed)

(v) Likelihood that the import replacement measure will be sustainable

There is strong interest in this research by a number of aquaculture feed manufacturers and a desire by the SBT farming industry to embrace any successful artificial feed. In view of this and the significant market potential for such a product, there should be no problem in sustaining the supply of any successful SBT feed once adopted by industry.

(vi) Likelihood of industry adoption of import replacement measure

Both the TBOAA and individual SBT farmers have demonstrated support for the development of a commercial artificial SBT feed including significant contributions of funding and resources. In fact, the level of interest from industry is so strong that there is concern that the industry may adopt an artificial SBT feed prematurely based on early research results with potential repercussions (e.g. fish health problems or flesh quality problems). Marketing problems could be avoided by testing the acceptability of SBT in the marketplace following trials.

(vii) Level of import replacement

There is general agreement that a successful semi-moist artificial SBT feed would achieve significant replacement of imported pilchards (<100%). Some pilchards may however, be required in the feed to achieve acceptable palatability. If this is the case, these pilchards should be available from local sources.

(viii) Compatibility with other industry and government strategic priorities

A number of other strategic issues reinforce the need to develop an artificial SBT feed. These are:

* The need to minimise and control the environmental impacts of SBT feed on surrounding waters and the benthos.

* The logistics and costs associated with storing, thawing, transporting and feeding many tonnes of fresh raw pilchards per day. Especially when feeding SBT while towing cages of fish from the point of capture to the farm sites.

* Only through a pellet can fish health additives (e.g. vitamins) and flesh quality improvers (e.g. krill meal) be added. Higher prices are attainable if flesh colour is improved and vitamins may be important in improving the fishes ability to maintain good health.

* Further industry expansion is potentially limited by the lack of a successful commercially available SBT feed.

The complete replacement of imported pilchards by a locally produced artificial SBT feed may not eliminate the use of imported aquatic products. This feed may contain imported fish meal and fish oil. It is therefore necessary to make a judgement on whether the importation of such feed ingredients is a greater or lesser risk than the importation of pilchards.

An FRDC project is investigating the "Development of an in vitro assay for the assessment of alternative protein sources for use in artificial diets for SBT". This project is co-ordinated by SARDI with participation from the UTAS, the TBOAA and the University of Adelaide. While the aim in the short term should be the development of a local successful commercially available artificial SBT feed as quickly as possible, this project may assist in the long term by reducing the need for importation of feed ingredients sourced from aquatic products. Because SBT are a carnivorous species, alternative protein sources are only likely to provide partial replacement of feed ingredients sourced from aquatic animals.

Option 2 - Expansion of the Australian pilchard fishery

(i) Existing level of development and research in the pilchard fishery

The pilchard fishery in Australia is mainly comprised of the species *Sardinops neopilchardus*, however other small pelagic species from the Families, Engraulididae and Clupeidae are also included. Pilchard fisheries exist in Western Australia, South Australia and Victoria. In Western Australia the fishery is divided into a number of regions (Esperance, Bremer Bay and Albany) each with its own Total Allowable Catch (TAC). Fishing also occurs on the west coast and a TAC is likely for this region soon. The combined Western Australian catch in 1996 is approximately 12,000 tonnes which is up 2,000 tonnes on 1995. Most pilchards caught in Western Australia are used for angling bait, with the remainder used for SBT feed, pet food, rock lobster bait and human consumption. The TAC's are assessed annually and are likely to fluctuate on a yearly basis with a long term annual average anticipated at 12,000-15,000 tonnes.

Until 2 years ago no pilchard fishery existed in South Australia, although SBT fishermen did catch pilchards to use as bait for pole fishing and longlines. The TAC for 1996 is 3,500 tonnes. The South Australian government has however, made a commitment to increase this TAC to 6,000 tonnes later this year if the "Offshore Constitutional Settlement" is finalised in March of 1996. This agreement with the Commonwealth would give the South Australian government responsibility of fishery management to the 200 mile limit. Currently, South Australia is responsible to the 3 mile limit, and the Commonwealth from 3 miles to 200 miles. The additional 2,500 tonnes of pilchards will be allocated to the TBOAA and then issued pro rata to quota holdings by residents of South Australia. Most pilchards caught in South Australia are used as SBT feed, although a small market also exists for human consumption.

No TAC's are set for the pilchard fishery in Victoria, however each year up to 2,000 tonnes are caught in Port Phillip Bay and up to 4,000 tonnes in Lakes Entrance. Most are used for angling bait and pet food, but there is also a small market for human consumption.

A pilchard fishery existed in NSW in the late 1980's, but catches were less than 500 tonnes annually. Some pressure has been placed on the Queensland government to allow pilchard fishing, however the potential for this fishery is small.

Pilchard fisheries around the world are notorious for collapsing, and so there is considerable caution by fishery managers in Australia when setting TAC limits for these fish. Reasons for this fishery's sensitivity to fishing pressure, include:

* pilchards have a relatively short life span with the oldest fish in a population being 8 - 9 years old and most populations mature at 3 years old. Overfishing can severely reduce fish numbers once fully recruited to the fishery. This can have serious consequences for the future recruitment of the fishery.

* large natural variations in pilchard numbers occur from year to year. This may be associated with tenuous life cycle events such as the spread of larvae by ocean currents or fluctuations in recruitment associated with annual variations in water temperature and weather conditions during critical periods of their life cycle.

* pilchards are often caught during annual spawning aggregations which means that many fish may miss the opportunity to spawn in that year. If the population numbers are low, this could be devastating for the future recruitment of the fishery.

* pilchards tend to school even when population numbers are low which leaves them vulnerable to fishing even at this depleted stage of their population dynamics.

An FRDC research project titled "A collaborative investigation on the usage and stock assessment of bait fishes in southern and eastern Australian waters, with special reference to pilchards (*Sardinops sagax neopilchardus*): extension into Queensland and New South Wales" is currently investigating the potential of the pilchard fishery in south-east Australia. This study will assist fishery managers to determine future catch limits. The project is managed by the SARDI with participation also from the Fisheries Departments in Victoria and Queensland and the University of New South Wales.

Pilchard research has also been underway in Western Australia for the past seven years.

(ii) Measures necessary to achieve import replacement.

Approximately one third of the pilchards currently caught in Australia are used for feeding to farmed SBT. Increasing the local pilchard catch should reduce the need for imports. However, due to the potentially fragile nature of this fishery, a cautious approach is needed for its management and research such as the FRDC project outlined above will assist fishery managers in their task.

(iii) Likelihood of successfully achieving import replacement measure

Locally caught pilchards are used for SBT feed, with some anecdotal evidence that when they are fed fresh to farmed SBT they give better market results than achieved by frozen pilchards. It is important however that any pilchards fed to farmed SBT are:

* Fresh rather than rancid. The quality of frozen pilchards deteriorates after only one month at -20°C if not handled/ frozen properly.

* High in fat content. Fat levels can vary between 1 and 22%. Usually pilchards caught in warmer waters and after spawning have lower fat levels.

Potential problems exist with the continuity of supply of locally caught pilchards due to adverse weather conditions affecting fishing patterns.

(iv) Period of time necessary to achieve replacement (N/A)

(v) Likelihood that the import replacement measure will be sustainable

The sustainable limits of pilchard fisheries in Australia is open to debate. Appropriate management strategies should ensure sustainability, however the fishery remains vulnerable due to marked natural yearly fluctuations in fish numbers. The availability of pilchards for SBT feed will depend largely on commercial pressures in pilchard markets and the extent to which increased local pilchard catches can be sustained.

(vi) Likelihood of industry adoption of import replacement measure

SBT farmers are likely to use any locally caught pilchards supplied at a reasonable price, however the development of a successful artificial SBT feed may eliminate their need for pilchards, unless pilchards were one of the ingredients in such a feed. This is an important consideration for fisherman gearing up for any expansion of the pilchard fishery, although potential for the development of alternative pilchard markets exists. Pilchards may be a substantial ingredient in a mash feed.

(vii) Level of import replacement

Pilchard fisheries in South Australia and Western Australia may sustain increased fishing, while future catch levels in Victoria are uncertain. Future catch levels in all states will depend largely on an increased understanding of the fisheries population dynamics and the success of the fishery's management. At current farmed SBT production levels, local pilchards can only be expected to partially replace imported product unless pilchards simply become an ingredient in commercial artificial SBT feed or other markets for pilchards decline.

(viii) Compatibility with other industry and government strategic priorities

A considerable research effort exists to develop an artificial SBT feed. Such a feed will reduce, if not totally eliminate the need for pilchards by SBT farmers. The use of an artificial SBT feed will still have environmental and logistical advantages for the SBT farming industry compared to pilchards and these will drive the industry towards this goal.

The availability of pilchards as SBT feed also depends on competitive pressures within the pilchard fishery. If more lucrative markets were available for these fish they may become more expensive or less available as SBT feed. For example, a ban placed on bait importation for recreational fisherman would cause the price of locally caught pilchards to rise significantly. High natural variability in local pilchard catches also makes it prudent for SBT farmers not to rely entirely on this source of food for farmed SBT.

Case Study 2 - Imported marine aquarium fish

Options for reducing import dependency

Little successful commercial aquaculture of marine aquarium fish occurs world-wide. Therefore, local culture of these fish does not present a realistic option for import replacement in the short term. However, with rapidly expanding expertise, experience and knowledge in the aquaculture industry there may be potential for the commercial aquaculture of marine aquarium fish in the future and this could be a suitable long term strategy for the marine aquarium fish industry. In the short term however, there would seem to be limited potential for the existing local wild caught marine aquarium fish industry to replace imports.

Option 1 - Development of the existing local marine aquarium fish collecting industry

(i) Existing measures for developing the marine aquarium fish collecting industry

The marine aquarium fish industry in Australia is based on collection of fish from the wild. This mostly occurs on the Great Barrier Reef in Queensland, however there is also significant collection of fish in other areas of Queensland and some collection of fish in Western Australian coastal waters. To legally collect marine aquarium fish, the collector must possess a government permit. The number of these permits in Queensland has decreased from approximately 170 to 70 in the last few years. Of these, only about 40 permit holders are actively collecting fish. Despite this reduction, the numbers of fish collected has increased slightly, and currently totals < 250,000 annually. Of these, in the order of 50 - 60% are sold on the domestic market.

In Western Australia the marine aquarium fish collecting industry is a limited entry fishery. There are only about 8 - 10 part time collectors at present although there are expressions of interest from a number of other potential collectors.

There is some concern by collectors that this reduction in permit holders is part of a gradual scaling down or phasing out of the industry. A number of permits have been sold over the years, however, this practice has never been legally allowed. Therefore, approximately 6 months ago the illegal nature of permit sale was clarified with the collecting industry. This is seen as a positive step in the short term by some industry members for two reasons. Firstly, it removes the possibility that the large number of non-utilised permits will transfer to operators actively collecting fish. While increased collectors per se is not a problem, this would be detrimental to the collecting industry if a significant number of these collectors became active in the same region. Secondly it removes the financial imperative to collect fish placed on operators who purchase permits, in one case up to $300,000 (mostly $10,000 - $20,000). Unfortunately however, this ban is likely to place financial pressure on operators who bought into the industry recently and it is not necessarily seen as a good long term condition of the permit once the industry has been rationalised in Queensland.

In Queensland the management of marine aquarium fish collection occurs under the new Fisheries Act 1994, which focuses primarily on the sustainable use of stocks. The

responsibility for management of the industry has recently transferred from the Queensland Department of Primary Industries (QDPI) to the Queensland Fisheries Management Authority (QFMA) who are the lead agency for this fishery. Permits are also required under the Great Barrier Reef Marine Park Act and Queensland Marine Parks Act. These permits are usually assessed and granted by the Queensland Department of Environment and Heritage (QDEH) under authority delegated by the Great Barrier Reef Marine Park Authority (GRMPA).

A large number of species and their associated varieties are traded in the marine aquarium fish industry. Only 20 - 25% of these are currently available from local sources. There is therefore no potential to replace the other 70% of imported fish without expansion of the local industry into new areas. Even with this sort of expansion, the potential for increasing the number of available species and varieties is limited, perhaps up to 30% if areas became accessible in Torres Strait and Western Australia.

A number of issues faced by the marine aquarium fish collecting industry at present, include:

* Increasing pressure being placed on the industry to develop a strategic management plan before any further development occurs.

* Logistical problems in getting fish from the collection sites to the retailers. This includes: distance from collection site to shore, availability of flights and overcoming inconsistency of supply to retailers.

* Lack of co-operation between collectors

* Lack of governmental support for the industry (e.g. other priority uses of available resources such as Beche-de-mer and Trochus shell fisheries).

* Opposition to the collecting industry's activities by other (passive) users of the resource e.g. underwater viewers/ photographers, divers etc.

There is concern in the industry that there will be increasing pressure to reduce the number of permit holders and consequently the number of fish collected in the future. The industry is attempting to overcome this in a number of ways, including:

* The Queensland Aquarium Supply Divers Association (QASDA) is attempting to organise a TAFE course for collectors of marine aquarium fish. This course would improve the catching, holding and transport techniques used within the industry.

* QASDA is co-operating with QFMA to establish an industry management strategy. QDPI had a plan in place in 1991 which forms the basis of current policy but provides the collecting industry with limited flexibility.

* QASDA has formed a committee to liaise with the tourism industry. There is some concern by the tourism industry that collectors are denuding sites of fish. However, collectors believe this is not the case and the committee should improve communication between the two industries.

QFMA is aware of the need to develop a strategic management plan and is endeavouring to support this process so that the industry can ensure its sustainability and therefore secure its future. The QFMA is a self-funding agency however, and needs to recoup the cost of this process from industry. This is estimated at up to $300,000 over the duration of the plan. Further funding will be necessary for ongoing administrative costs such as data collection, licensing and research. The QFMA is also responsible for the management of all other fisheries in Queensland and consequently capacity to address aquarium fishery issues is limited by the availability of resources. The QFMA estimates it will take 2 years to develop a strategic management plan which could be expected to remain in force for up to 5 years before review. With proper management there may be potential to expand the collecting industry as many regions are not yet fished, but overcapacity in other areas of the fishery inhibits the adjustment process.

GRMPA and QDEH are concerned that any management strategy ensures industry is not only sustainable, but also ecologically sustainable. The whole of the Great Barrier Reef is a World Heritage Area. Therefore, Australia has an obligation to ensure that any activity which impacts on the environment of the Great Barrier Reef should not occur if there is a prudent and feasible alternative or where there are methods or techniques to mitigate against such an impact.

(ii) Measures required to achieve import replacement

Capacity of the local industry to replace imports is limited, however this could be maximised by:

* Developing a long term management strategy in co-operation with QFMA. This strategy should:

- maximise the number of species and associated varieties which can be collected
- rationalise participation in the industry
- increase the capacity of responsible permit holders to collect fish
- rationalise the fishing pressure on any particular source of fish (e.g. by regional management)

Significant resources are required to develop a long term industry management strategy. At present the industry is reluctant to contribute financially to the development of this strategy because there is no long term security for the viability of their business.

* Developing suitable storage facilities for collectors to hold fish before sale to wholesalers or retailers. Good quality storage facilities would enable collectors to overcome some of their existing problems. For instance, consistency of supply could be maintained because they would not be at the mercy of the weather and availability of flights.

* Developing and implementing industry training programs e.g. TAFE courses, workshops, and/ or seminars. Permit holders are only restricted in the number of fish they are allowed to collect, by the number of assistants they are allowed to engage, vagaries of the weather and availability of markets. Collectors able to get fish to markets in good quality apparently have no problems in selling all they can catch. Industry training which improves the ability of all collectors, particularly those who are currently sustaining some losses or unable to maintain good quality, will assist the whole industry to maximise its potential in the Australian market.

(iii) Likelihood of successfully achieving import replacement measure

As outlined in the section on background to this industry, there is some concern within industry that collection of marine aquarium fish may be phased down if a suitable long term management strategy for the industry is not developed. Therefore, any limited import replacement potential is very dependent on this strategy.

The ability of the industry to achieve substantial import replacement is undermined by the capacity of the export market to absorb increased numbers of collected fish.

(iv) Time necessary to achieve import replacement

Due to the current pressures on the industry and the limited capacity for import replacement, any import replacement which can be achieved will need to be a long term, rather than a short term goal.

(v) Likelihood that import replacement measure will be sustainable

If an appropriate long term management strategy is developed for the industry, then any import replacement that is achieved should be sustainable, depending on competing pressures with the export market.

(vi) Likelihood of industry adoption of import replacement measure

Any measure which increases the capacity of the local industry to replace imports is likely to be embraced by industry.

(vii) Level of import replacement

Some collectors believe they are only meeting 25% of the local demand for marine aquarium fish from their business. This demand from certain collectors however, is probably more a reflection of the good quality of their product and the consistency of their supply rather than any unfilled demand in the total marketplace. Currently, excess demand from certain collectors is being satisfied by other collectors. Therefore the overall capacity of the local industry to replace imports appears to be limited.

(viii) Compatibility with other industry and government strategic priorities

Overseas demand for marine aquarium fish from Australia is high with current exports only being a fraction of their potential. However, without the development of a long term management strategy, government regulations will limit industry's desire to fill this export demand. Developing the export market is not likely to assist import replacement. In fact, it may have the opposite effect depending on the price differential achievable by collectors from local and export markets. The price currently received for exported fish is much higher than for those sold locally largely because high priced endemic species tend to be exported and this conflicts directly with achieving import replacement.

Some industry members also believe it is important to educate staff in retail outlets and their customers. A number of marine aquarium fish fail to survive for long after they leave the retailer mainly due to the low level of expertise of the collector, retailer and/or the customer. Increased training and information transfer at all levels could increase the market for marine aquarium fish through expansion of the number of successful aquarists. Again, this education process is unlikely to reduce the demand for imports.

Case Study 3 - Imported freshwater aquarium fish

Options for reducing import dependency

The freshwater aquarium fish industry in Australia is based mostly on farmed fish either from overseas or locally produced in Australia. The only viable option for reducing the Australian aquarium fish industry's dependence on imported freshwater aquarium fish therefore, is to develop the already significant local freshwater aquarium fish aquaculture industry.

Option 1 - Developing the freshwater aquarium fish farming industry in Australia

(i) Existing measures for developing the freshwater aquarium fish farming industry

Currently freshwater aquarium fish farmers in Australia supply approximately 5 - 7 million fish to the Australian aquarium fish industry. This represents 40 - 50% of the industry's total turnover in freshwater aquarium fish. The aquaculture of freshwater aquarium fish in Australia comprises hundreds of operators varying from small scale back yard operations to large scale pond or shed facilities. A small percentage of freshwater fish are also collected from the wild.

The local industry has some advantages over overseas producers, including absence of quarantine restrictions and the 22% sales tax placed on imported aquarium fish. This effectively gives the local industry a financial margin by which it can compete with low cost overseas producers. Locally farmed aquarium fish are relatively free of disease which decreases their cost of production and improves product quality. Close proximity to the marketplace assists local farmers to supply a high quality product, but makes little difference to freight costs.

Local aquarium fish farmers will however, need to overcome some disadvantages before they can successfully replace imports, including the relatively small market available in Australia. Larger commercial producers in Australia need to produce consistent supplies of a significant number of different species and/or varieties to remain commercially viable, which is in stark contrast to most other forms of aquaculture where only one or two species are farmed (e.g. salmonid aquaculture and overseas producers of aquarium fish). This results in higher costs of production compared to overseas producers, particularly due to the labour intensive nature of the industry and relatively high labour costs in Australia. In America, each freshwater aquarium fish farm tends to be very large and only farms a few species, (e.g. one goldfish farm in Missouri produces 66 million goldfish annually). In Asia, farms tend to be family operated and deal with only a couple of species. These small scale farmers supply very large wholesalers, with huge economies of scale and the ability to guarantee a consistent readily available supply of fish to their markets.

A significant number of small scale producers in Australia do supply to large wholesalers in a similar system to that in Asia, however, because most of these are part-time or backyard operations, a problem remains with consistency of supply and quality of stock. Sometimes a small scale operator will produce significant quantities of certain species or varieties which are sold cheaply as a batch to wholesalers or retailers. This can seriously affect the cash flow of

larger producers. Also, due to lack of communication between farmers, a number of producers may decide to farm the same easily grown species with a glut resulting in the marketplace.

Export potential is limited due to the very large scale of the freshwater aquarium fish aquaculture industry overseas. Exports are most likely for certain high priced species. Therefore, local freshwater aquarium fish farmers are significantly constrained by the size of their market.

The large number of small scale operations, the reluctance of producers to co-operate and share information and inadequacy of government support leaves the industry vulnerable to disease and environmental problems during its developmental phase.

Issues involving the freshwater aquarium fish industry are currently dealt with by the Pet Industry Joint Advisory Council (PIJAC). Only a limited number of freshwater aquarium fish farmers are members of PIJAC, however these members represent a large percentage of the dollar value of the industry.

PIJAC is currently supporting development of the freshwater aquarium fish farming industry by encouraging all producers to become members of PIJAC and to actively participate in the organisation. This would improve co-operation and co-ordination within the industry which is so crucial to its successful development. It would also enable more effective involvement by the industry through PIJAC in a national aquaculture body, should this eventuate.

(ii) Measures necessary to achieve import replacement

Research is not a high priority for development of the industry in the short term. The technology already exists for the culture of some 75% of currently imported freshwater aquarium fish. While this technology is not always directly transferable to local conditions, it provides a good basis to develop successful commercial production techniques locally.

This developmental phase includes a certain amount of trial and error, but only through practical hands on application and adaptation of this existing technology will the industry will develop. Research will play a more critical role in developing successful farming methods for those species currently difficult or impossible to grow.

In the short term the industry requires assistance and support in applying existing technology to the successful commercial culture of freshwater aquarium species in local conditions at a cost competitive price. This assistance and support could include:

* Controlled financial assistance to genuine commercial producers of freshwater aquarium fish to encourage and hasten the development of the industry.

* Support to increase information transfer and co-operation within the industry through workshops and seminars, although these should be industry based. A facilitated overseas study tour may be of benefit, although some industry members believe this may not be value for money. Improved co-operation between industry players will also minimise potential for oversupply of certain fish species or varieties and maximise consistency of supply from the industry.

* Support from government on health and environmental issues (e.g. disease diagnosis and control, disease surveillance, registration and availability of suitable medications, development of industry codes of practice and training in the area of fish health).

* Support from government for setting up and operation of aquaculture facilities, or at least ensuring there are no unnecessary restrictions to development.

Significant potential exists for the freshwater aquarium fish aquaculture industry to develop techniques for culture of endangered Australian native species. This already occurs for some species (e.g. Macquarie perch and Trout cod) and would have a number of potential benefits:

* Stock enhancement programs assist in the rehabilitation of populations of endangered native fish species.

* Government or community funded stock enhancement programs assist the aquaculturist in decreasing costs of production. This assists the development and profitability of the industry generally.

* Stock enhancement programs for endangered species provide common ground between various industry, government and environmental groups and therefore encourage improved communication between these groups.

* If the culture of endangered freshwater species was managed successfully potential may exist for the freshwater aquarium fish aquaculture industry to commercially market these species (e.g. industry members culturing endangered species for restocking in the wild may be allowed to sell a certain percentage of their stock commercially).

Industry would also be assisted by an agreed national approach to listing of noxious fish. PIJAC believes that there should be a national noxious fish list to ban keeping and breeding of fish of concern. Currently species are being cultured, based on the species listed in Schedule 6 of the Wildlife Protection (regulation of Exports and Imports) Act 1982, plus an assessment of those exotic species not on the schedule, but already cultured and sold in Australia. This creates anomalies and is restrictive. In Victoria for example, fish farmers are unable to breed fish not on this list which means that they are unable to breed certain fish species being bred in other states and shipped to Victoria or being produced locally and elsewhere by unlicensed producers.

(iii) Likelihood of successfully achieving the import replacement measure

The local aquaculture industry is likely to develop to replace 75% of the currently imported freshwater aquarium fish. Further import replacement is less certain due to a number of constraining factors outlined elsewhere in this case study.

(iv) Time necessary to achieve import replacement

It is likely to take 4 - 6 years to achieve the successful commercial aquaculture of the 75% of imported freshwater aquarium fish where the technology already exists. Over this period the local industry needs to develop and finance new facilities and adapt existing technology to local conditions.

After this, industry expansion into the culture of other less easily farmed species is likely to be slower.

(v) Likelihood that the import replacement measure will be sustainable

Sustainability of a local freshwater aquarium fish aquaculture industry depends largely on the industry's ability to be cost competitive and provide a consistent supply of high quality stock. This hinges on a number of factors such as maximised cost effectiveness of farming operations, availability of new genetic material and level of government support.

(vi) Likelihood of industry adoption of import replacement measure

The aquarium fish industry in general, supports the development of a local freshwater aquarium fish aquaculture industry and appears to purchase stock from this source wherever possible. However, the local aquaculture industry needs to be competitive on price, quality and consistency of supply to maximise its share of the market.

(vii) Level of import replacement

Industry members believe that 75 - 80% of currently imported freshwater aquarium fish could be farmed in Australia with the adaptation of existing technology. It may also be possible to develop aquaculture techniques for a proportion of the remaining 20 - 25 % of fish based on research and industry experience.

(viii) Compatibility with other industry and government strategic priorities

The aquarium fish industry is supportive of the local freshwater aquarium fish farming industry regardless of the import replacement issue, as a successful local industry will potentially supply high quality fish without the logistical hassles of importation and quarantine.

Case Study 4 - Complete artificial prawn feeds

Options for reducing import dependency

The most appropriate option for reducing dependency of the Australian prawn farming industry on imported prawn feed is the development of a successful locally produced commercial prawn feed.

Option 1 - Development of a local supply of a successful commercially available prawn feed

(i) Existing level of development for prawn feeds in Australia

In 1995, the majority of prawns farmed in Australia were Black tiger prawns - *Penaeus monodon* (approximately 1,500 tonnes) however there is also a significant number of Kuruma prawns - *Penaeus japonicus* (approximately 250 tonnes). Considerable potential exists to increase the production for both species. Nutritional requirements of the two species are quite different, with higher protein levels in particular being necessary for good performance in kuruma prawns.

One commercial aquaculture feed company is currently producing prawn feed for *P. monodon* on a commercial basis. Historically results have varied between batches and in some cases were associated with serious problems for the prawn farmers involved, hence some prawn farmers are cautious in their approach to feed trials.

An existing research program under the auspices of the CRC for Aquaculture is investigating the nutritional requirements of prawns. This project is being undertaken collaboratively between CSIRO (Cleveland) and QDPI (Bribie Island Research Station).

(ii) Measures necessary to achieve a successful locally produced prawn feed

Extensive experience and knowledge exists overseas on the formulation and production of prawn feeds. One local feed mill has already developed a prawn feed which performs well with certain batches in commercial trials and is cost competitive with imports. Previous problems with feeds have made some farmers cautious about the use of local product. It is understood that local feed mills have addressed past feed production problems, and this is reflected in their increasing market share.

There are commercial advantages for feed mills in maintaining confidentiality of their knowledge and expertise in the area of feed production. Researchers believe however, that research may play a role in maximising the efficiency of locally produced prawn feeds into the future, and there is some in house collaboration between researchers and feed mills currently in progress. One feed company, for example, has entered into a major research program with CSIRO to develop improved prawn feeds. While public funding is less accessible for confidential research, most research agencies will participate in confidential projects for private companies.

Prawn farmers do not believe on-farm research is a high priority in the short term because some locally produced feeds have performed well in commercial trials. Past bad experiences with locally produced feed have made some growers cautious in their adoption of these feeds; however client trust will be developed through continued attention to production of consistently high quality feeds.

Therefore two main issues confront the successful replacement of imported prawn feed:

* The need for local feed mills continuing development and production of prawn feeds of consistent quality, and

* Reluctance on the part of prawn farmers to use locally produced feed due to previous bad experiences with trial batches (noting that feed mills advise the problems associated with these batches have been addressed).

(iii) Likelihood of achieving a successful locally produced commercial prawn feed

P. monodon - Acceptable performance in farmed *P. monodon* has already been achieved with some locally produced feed. Feed mills advise that commercial production of consistent batches of this feed has been achieved.

P. japonicus - Feed for this species is more expensive to produce, but is readily available from overseas suppliers. Therefore, development of a successful feed for this species should be possible.

(iv) Time necessary to achieve a commercial supply of locally produced prawn feed

P. monodon - Successful batches of feed for this species are being commercially produced already, however, further market penetration both locally and on export markets will depend largely on the capacity of feed mills to continue to produce a product of consistent quality and then convincing prawn farmers that this is the case. Realistically, this should occur in 1 - 2 years. Feed mills advise that local market sales are already significantly increasing.

P. japonicus - The major thrust to date by one feed mill has been to develop feed for *P. monodon* mainly because this species provides the larger market. Development of a successful feed for farmed *P. japonicus* should follow the successful development and industry adoption of locally produced *P.monodon* feed.

(v) Likelihood that a commercial supply of locally produced prawn feed will be sustainable

The local prawn farming industry is only a relatively small market for prawn feed (approximately 4,000 tonnes in 1995). Sustainability of a commercial supply of locally produced prawn feed will therefore depend largely on how the industry develops and the level of adoption of locally produced feeds by industry. One local feed mill has already demonstrated its commitment to the development of a successful prawn feed.

(vi) Likelihood of industry adoption of a locally produced prawn feed

The import of prawn feeds presents a number of logistical problems for prawn farmers. Feed requirements can be very difficult to predict in large scale prawn farming operations, particularly towards the end of a harvest season. Imported feed is ordered many weeks in advance and often shipments can arrive either early or late. Early arrival can create feed storage problems, while late arrival may leave extensive prawn stocks without any feed. In addition, up to 3 weeks of the shelf-life of imported feeds is used up during shipment to the farm. Because prawn feeds are expensive these problems can be very costly. The high cost of prawn feed and the early ordering which is necessary also places an increased burden on the cash flow of prawn farmers.

Locally produced feed would overcome most of these problems. Therefore, the industry is supportive of attempts to develop prawn feed and would embrace any such product if they were convinced it performed well, quality was consistent and price was competitive.

Prawn farmers may be less inclined to use locally produced *P. japonicus* feed if Japanese buyers continue to pay more for these prawns if they are fed on Japanese feeds.

(vii) Level of import replacement

There is some question as to the extent of market share currently held by local manufacturers. Estimates range from 10-30%. Provided such feeds maintain a consistent high standard of quality and remain price competitive with imported feeds, it is possible that they could achieve close to 100% import replacement. Prawn farmers with close links to overseas interests may continue to import prawn feed. Other farmers may import some of their feed to maintain competition in their feed supply and/or as a buffer against any problems encountered with the local product. Competition would be created if two local feed manufacturers produced prawn feeds, however the industry may not be large enough to support two feed mills.

(viii) Compatibility with other industry and government strategic priorities

Prawn feed quality is closely linked to a number of environmental issues important to the prawn farming industry (e.g. disease and water quality). Poor quality feed can cause or exacerbate disease and/or environmental problems on prawn farms.

The total replacement of imported prawn feeds by local product is unlikely to eliminate the need for industry to use imported aquatic products. Locally produced prawn feed is likely to contain imported fish meal or prawn meal and in considering the options for import replacement it is necessary to make a judgement on whether the importation of complete prawn feeds is a greater or lesser risk than the importation of feed ingredients such as fish meal and prawn meal.

Researchers at CSIRO Laboratories (Cleveland), QDPI (Bribie Island Research Station) and the Queensland University of Technology have been conducting a number of prawn nutrition research projects under the FRDC Sub-Program "Replacement of Fishmeal in Aquaculture Diets". The objectives are to:

* determine digestibility of alternative protein sources and assimilation of nutrients in them.
* investigate methods of enhancing digestibility of feeds and feed ingredients
* develop methods to enhance the nutrient balance, attractiveness and palatability of diets formulated using alternative protein sources.
* determine the protein requirements in relation to different amounts of digestible energy available in the feed.
* use this information in the continued testing of potentially commercial diets using selected alternative protein sources to partially replace fishmeal.

This project may develop alternative protein sources for incorporation into commercial prawn feeds which would reduce the need for imported ingredients such as fish meal and prawn meal. This has not been very successful overseas and only partial replacement of aquatic animal meals is likely.

Case Study 5 - Starter diets for salmonids

Options for reducing import dependency

The most appropriate option for reducing dependency of Australian salmonid hatcheries on imported starter diets is to develop successful commercial starter diets locally.

Option 1 - Development of a local supply of commercial salmonid starter diets

(i) Existing level of development for salmonid starter feeds in Australia

Two commercial aquaculture feed companies in Australia manufacture and supply salmonid starter diets and many salmonid hatcheries already use these diets. However, the quality of feed is critical at all stages of salmonid production, particularly during the early feeding stages of fry. Poor nutrition during this period can have devastating and irreversible implications for the future performance of these fish. With this in mind, some salmonid hatcheries continue to import starter diets because the local diets have not yet reached the quality standards achieved in imported feeds. These hatcheries are however, working with the feed mills to develop an acceptable product.

(ii) Measures necessary to achieve import replacement

Extensive experience and knowledge exist overseas on the formulation and production of good quality salmonid starter diets. The application of this information to the production of local starter diets should result in the development of a product that is acceptable to all salmonid hatcheries. This is likely through co-operation between feed manufacturers and the industry without the need for outside funding or resources.

(iii) Likelihood of achieving a successful locally produced salmonid starter diet

Local starter diets are already achieving acceptable results in many salmonid hatcheries. Further development of the product to reach the standards of imported feeds should be readily achievable.

(iv) Time necessary to achieve a commercial supply of locally produced salmonid starter diets

A salmonid starter diet acceptable to all salmonid hatcheries in Australia should be available in 2 - 3 years.

(v) Likelihood that a commercial supply of locally produced salmonid starter diets will be sustainable

Salmonid starter diets are a low volume product compared with the large quantities of feed used in other stages of the salmonid production cycle and there is little direct financial incentive for commercial feed mills to develop these diets. However, there is some commercial pressure on feed mills to provide a full range of diets for the salmonid industry and feed quality during the fry stage of production is a crucial precursor to the future performance of these fish.

(vi) Likelihood of industry adoption of a locally produced salmonid starter diet

Many salmonid hatcheries in Australia already use locally produced salmonid starter diets. Once the quality of this product is of acceptable standard, all salmonid hatcheries would use it. Some salmonid hatcheries however, may still wish to import a percentage of their starter diet requirements as a buffer against any problems encountered with the local product. Some of these hatcheries currently purchase salmonid starter diets from a number of overseas sources for this reason and the quantity they continue to import is likely to depend on their confidence in the locally produced product.

(vii) Level of import replacement

The development of an acceptable locally produced salmonid starter diet should see close to 100% replacement of imports. There may however, continue to be a small quantity imported as an insurance policy against any unforeseen problems with the local product, e.g. inconsistent quality.

(viii) Compatibility with other industry and government strategic priorities

The complete replacement of imported salmonid starter diets will not eliminate the need for salmonid hatcheries to utilise imported aquatic products. A locally produced salmonid starter diet is likely to contain imported fish meal and fish oil. It is therefore necessary to make a judgement on whether the importation of complete salmonid starter diets is a greater or lesser risk than the importation of these ingredients.

Some potential may exist to use alternative protein sources in salmonid starter diets, however this is only likely to be limited due to the carnivorous nature of the fish.

Case Study 6 - Feed ingredients sourced from aquatic products for incorporation into aquaculture feeds

Options for reducing import dependency

Reduction of the dependency of the Australian aquaculture industry on imported feed ingredients sourced from aquatic products necessitates the development of suitable alternative locally available ingredients.

Option 1 - Development of suitable alternative feed ingredients for aquaculture feeds

(i) Existing research and development into suitable alternative feed ingredients for aquaculture feeds

Development of alternative aquaculture feed ingredients is a global issue with a considerable amount of research already being conducted in this area.

In Australia a substantial co-ordinated program of research has been implemented under the FRDC Sub-Program "Replacement of Fishmeal in Aquaculture Diets". This research has been occurring for approximately 2 years and significant progress has been made in a number of areas. While the title of this Sub-Program implies that research is focused on the replacement of fish meal, there is also significant potential to replace other aquatic animal based feed ingredients (e.g. fish oil and prawn meal). Funding for this Sub-Program is due to finish in October 1996 and an application has been made to the FRDC to continue this work under a new Sub-Program Title, "Aquaculture Diet Development" which reflects the broader focus of proposed future research.

The FRDC Sub-Program is managed by a scientist with NSW Fisheries (Port Stephens Research Centre), and involves scientists from a number of other institutions, including: CSIRO Division of Fisheries (Cleveland), Queensland Department of Primary Industries (Bribie Island Aquaculture Research Station), Queensland University of Technology, NSW Agriculture (Wollongbar Agricultural Institute), University of Queensland, CSIRO Division of Food Science and Technology (North Ryde), Queensland Department of Primary Industries (International Food Institute of Queensland), Queensland Department of Primary Industries (Walkamin Research and Fisheries Station), University of Tasmania (Launceston).

Research projects are based around four commercial aquaculture species i.e. Atlantic salmon, Silver perch, Barramundi and prawns, with many research areas under investigation including:

* The identification of feed ingredients with the potential to replace existing ingredients

* The development and validation of techniques for determining digestibility in target species

* The investigation and standardisation of analytical methods for nutritional research.

* The determination of apparent digestibility coefficients in target species for a range of potential feed ingredients

* Investigation of methods to enhance the digestibility, nutrient balance, attractiveness and palatability of feeds and feed ingredients.

* Investigation of the nutrient requirements for each target species including the determination of digestible protein requirements in relation to different amounts of digestible energy in the feed.

(ii) Measures necessary to achieve suitable alternative feed ingredients for aquaculture feeds

The FRDC Sub-Program provides a good mechanism for addressing this issue. There has been significant progress in certain areas and although there was some scepticism by feed manufacturers in the initial stages of the Sub-Program they now appear to be supportive of the work.

Probably the most crucial issue in the successful development of alternative feed ingredients is the maximisation of effective communication between all the interested parties. Not only will this increase the speed with which results are achieved, it may make the difference between achieving a successful outcome or not. This is because:

* The development of alternative feed ingredients for aquaculture feed is a global issue with researchers all over the world working towards the same goal.

* There are a number of terrestrial industries in Australia and overseas also investigating the potential of alternative feed ingredients in their associated feeds (e.g. pig and poultry industries).

* A number of other industries may benefit from the production of alternative feed ingredients such as agricultural industries (e.g. grains, legumes and meat by-products) and fisheries (e.g. fishery by-products or fish processing wastes). These industries may already be developing products with potential as alternative feed ingredients or be interested in participating further in the strategy.

* The commercial potential of any possible alternative feed ingredients must be realistically achievable.

* Potential feed ingredients must not only be commercially viable, but also cost-competitive with other ingredients for feed manufacturers and the aquaculture industry to adopt them.

* Development of suitable alternative feed ingredients is largely a long term strategy that requires the allocation of considerable funding and resources. It would be extremely difficult for any one research or industry group to achieve substantive results on their own. This is exemplified by the fact that only limited progress has been made in this area, despite a world-wide effort on this issue over a number of years.

* There are a considerable number of funding sources for this work. Because the resources required are significant it is important to identify and access all available funding avenues.

In view of the above, it is essential that effective communication is maintained between all interested parties and that access is made to all relevant information both locally and globally.

This assists in maximising the efficiency of the developmental and research effort as well as maintaining a realistic and practical focus for those involved.

(iii) Likelihood of successfully developing suitable alternative feed ingredients for aquaculture feeds

Many overseas aquaculture feed manufacturers are already incorporating increasing levels of alternative feed ingredients into their feeds. The levels used are often higher than currently used in locally produced feeds for the same species. Therefore there is already some capacity to increase the level of alternative ingredients in certain aquaculture feeds (e.g. the use of soya bean or canola meal in Atlantic salmon feeds). This capacity is not being utilised because:

* Aquatic animal meals and oils are readily available and reasonably competitively priced, although this may be changing, with good quality fishmeal and fish oil being difficult to source in the last six months and expensive. This has occurred due to mainly due to massive increases in demand for these products from countries such as China and relatively poor catches of baitfish.

* It is easier and more commercially secure for feed manufacturers and aquaculture industries to use feed ingredients known to give good performance than to experiment with new ingredients when there is no commercial imperative to do so.

* Profitability in certain aquaculture industries where alternative feed ingredients could be utilised is still high enough that the vigorous pursuit of least cost rations is not an imperative

* The nutrient requirements of target species are often poorly understood. This makes it difficult for feed manufacturers to fine tune rations and consequently many diets continue to provide certain nutrients in excess.

Development of alternative feed ingredients for aquaculture feeds depends significantly on the feeding habits of the species concerned. In omnivorous species (e.g. silver perch) success is much more likely than in carnivorous species. At best alternative feed ingredients are only likely to achieve partial replacement in carnivorous species, at least in the foreseeable future.

(iv) Time necessary to achieve import replacement

This is difficult to determine because a number of issues need resolving before any potential alternative ingredients will be adopted by industry, including:

* Suitable alternative feed ingredients need to be identified or developed

* Commercial quantities of these products are required for incorporation into aquaculture feeds

* It needs to be demonstrated that feeds incorporating alternative ingredients give competitive performance in aquaculture species

* Alternative feed ingredients must be competitively priced

* Alternative feed ingredients must maintain acceptable quality in end products.

Capacity to achieve all of the above will depend largely on the target aquaculture species and the alternative ingredient under consideration.

Further expansion of existing aquaculture industries and successful development of locally manufactured commercial feeds for industries such as the SBT and prawn farming industries will increase the importation of aquatic animal based feed ingredients in the short term because they are likely to be ingredients in such feeds.

(v) Likelihood that import replacement will be sustainable

There is a genuine interest by aquaculture industries and feed manufacturers in the development of alternative feed ingredients, however the sustainability of any achievements in this area are dependent on the commercial factors outlined previously.

Development of aquaculture globally necessarily involves the production of more aquaculture feeds. There is limited capacity however for increasing fishing pressure in wild fisheries to support this increasing requirement for aquatic animal based ingredients. It is likely therefore that Australian aquaculture industries will be under increasing pressure to use alternatives. Alternative sources of feed ingredients based on agricultural products are likely to be much more sustainable than ingredients based on aquatic animals.

(vi) Likelihood of industry adoption of alternative feed ingredients

While aquaculture industries and feed manufacturers have a strong interest in the development of alternative feed ingredients, commercial realities will prevail. Feeds incorporating these ingredients must achieve similar or improved performance, be competitively priced in target species and maintain acceptable quality in end product. In the current highly competitive marketplace the aquaculturist is not able to subsidise the use of alternatives, if currently proven feed ingredients are readily available and competitively priced.

(vii) Level of import replacement

There is more likely to be an increase in the import of aquatic animal feed ingredients in the short term than a decrease due to the potential local production of SBT and prawn feeds. In addition, these ingredients may be components of an artificial lobster bait. Therefore this option should be a long term strategy. A proportion of this increase in the short term may however be replacing the need to import other higher risk aquatic imports.

(viii) Compatibility with other industry and government strategic priorities

While the development of alternative feed ingredients is important for all aquaculture industries, this work requires considerable resources and funding. This research must therefore be kept in context with other strategic priorities of government and industry. For example, it may be more important in the short term to support the development of a successful commercial feed (which is an essential precursor to fishmeal replacement) for the SBT farming industry, no matter how imperfect this initial feed might be, than to allocate funding and resources at an early stage to developing alternative feed ingredients for this species. This is especially so when successful research outcomes in other species are likely to be at least partially transferable to SBT feed.

Responsible management of aquaculture operations with regard to the environment is not only an important issue for the government and the public, but a critical factor in the sustainability of aquaculture itself. The commercial potential of any alternative feed ingredients is closely linked to its effects (good or bad) on the environment.

A number of alternative feed ingredients are likely to come from agricultural industries and there is already significant interest and participation in the FRDC Sub-Program by organisations and funding bodies (e.g. Meat Research Corporation, Grains Research and Development Corporation) representing them. Development of alternative products could present substantial new markets for these industries, particularly overseas and they are well placed to become a cost-competitive supplier of high quality protein sources for global markets in the future.

The pig and poultry industries in Australia are currently much larger users of imported fish meal than the aquaculture industry. Consequently, there is a considerable amount of research that has been and is currently being conducted to develop alternative feed ingredients for these species. Much of this work may be directly or indirectly relevant to aquaculture feeds and vice versa, therefore close communication with these industries is essential.

Case Study 7 - Fish products for rock lobster bait

Options for reducing import dependency

The most attractive option for reducing dependency of the Rock Lobster industry on imported fish products is development of an artificial lobster bait. Another option may be to increase the quantity of locally caught baitfish available to the industry, however this would depend on the capacity of the existing fisheries to increase in production. Utilisation of by-catch or waste products from existing fisheries would only be feasible if such material was found to be a suitable product for lobster bait.

Option 1 - Development of an artificial rock lobster bait

(i) Existing level of research and development on artificial lobster baits

Lobster baits comprise one or more of a range of frozen fish products (e.g. various species of bait fish, fish frames and fish heads) as well as 'hocks and hides' (derived from cattle). The actual products used by fishermen vary from state to state and within each state.

Attempts have previously been made to develop an artificial lobster bait however to this time no artificial bait has been adopted by the lobster industry.

Existing research includes:

* FRDC research co-ordinated by staff at the Western Australian Fishing Industry Council (WAFIC) into the "Development of a dried, pelletised barramundi food from catfish by-product". This research has resulted in the development of an alternative method for dry pelletising that produces a very water stable pellet. Commercial sea trials, and a full cost benefit analysis of those baits (if any) that have prospects for commercialisation is scheduled for 1999. Further work utilising this technology under another FRDC project "New product development from low value species" resulted in the development of a trial artificial lobster bait that has shown potential in small scale experiments. The applicability of these results to the commercial industry is as yet unknown. The manufacturing process involved may also kill any pathogens in the ingredients.

* An honours project undertaken at SARDI titled "Bait Preferences and Chemoattraction in the Southern Rock Lobster; *Jasus edwardsii*".

(ii) Measures necessary to achieve a successful artificial lobster bait

If an artificial bait is not perceived by lobster fishermen to be as good or better than existing baits and is not available at a cost effective price, it will not be adopted by the industry. To develop an artificial lobster bait to the point where it can be commercially assessed will require extensive research in conjunction with the industry.

(iii) Likelihood of successfully achieving an artificial lobster bait

Researchers suggest that early trials with artificial baits have shown some potential, but the applicability of these results to the development of a lobster bait for the commercial industry is yet to be proven.

(iv) Time necessary to achieve import replacement

The feasibility of a commercial lobster bait is as yet unknown, therefore the time necessary to develop such a bait cannot be determined. It would take at least one season of successful testing by lobster fishermen before they are likely to adopt it as a commercial bait.

(v) Likelihood that import replacement will be sustainable

Over 20,000 tonnes of fish products are used annually as bait by the Rock Lobster industry in Australia. Adoption of an artificial bait by this industry would therefore present a significant market for such a product.

If an artificial bait is developed with the required characteristics, the likelihood of it being sustainable will depend on the sustainability of the components of the bait.

(vi) Likelihood of industry adoption of an artificial lobster bait

An artificial bait with the right attributes is likely to be adopted by the Rock Lobster industry. The level of adoption however will depend on the level of superiority of the artificial bait over existing baits. Key attributes include:

* Effectiveness of the bait in attracting lobster into lobster pots over extended periods of time
* Competitive cost per unit of bait
* Capacity of the bait to last in the pots e.g. resistance to physical damage by lobster, water movement and sea lice
* Capacity of the bait to be stored and transported without the need for refrigeration
* Minimal size and weight of individual units (ability to fit into conventional bait holders)
* Reduced risk of injury to fishermen (knife wounds and fish spines)
* Reduction in time to bait pots

Potential exists for an artificial bait to produce superior performance over currently used baits on a number of these attributes.

(vii) Level of import replacement

If an artificial lobster bait was superior to fish baits then it is likely that it would be widely accepted, if however it was marginally better than alternatives then it would share the favours of fishermen with alternative baits.

(viii) Compatibility with other industry and government strategic priorities

If an artificial lobster bait was developed it may have benefits for lobster fishermen, other than import replacement. These could include lower cost of baits, and reduced requirements for refrigeration and bait storage on board fishing vessels.

Development of an artificial lobster bait with the requisite attributes could also have other benefits:

* A number of the attributes of an artificial bait may be applicable to the feeding of held lobster. The holding of lobster is gaining increasing interest, particularly in South Australia.

* The artificial lobster bait may be used by the recreational fishing industry for catching of lobster and possibly other commercial and recreational fishermen for species such as mud and blue swimmer crabs.

Option 2 - Development of alternative fresh products for lobster bait

(i) Existing level of development of alternative fresh products for lobster bait

A number of government staff and researchers are interested in investigating alternative fresh lobster baits.

A considerable quantity of locally caught fish is used for lobster bait (e.g. pilchards and Australian salmon). However, in South Australia, lobster fishermen in the southern zone use carp as bait in preference to the Australian salmon and pilchards used by fishermen in the northern zone. In Tasmania, some lobster fishermen use trevalla heads and frames, while others in Bass Strait use whole carp.

It should be noted however that the use of locally sourced fresh products as bait is occurring in conjunction with the current level of imported baits. That is, supply of bait in addition to that currently used would be required to result in import replacement.

(ii) Measures necessary to develop successful supplies of alternative fresh products for lobster bait

Potential sources of alternative fresh products must be identified and then assessed for their suitability. Sources may include expansion of existing fisheries (e.g. pilchards and Australian salmon), waste products from other fisheries (e.g. by-catch or processing wastes) and/or products derived from terrestrial animals (e.g. abattoir wastes). The main factors which lobster fishermen look for in alternative baits is competitive cost per unit of bait and a capacity of the bait to attract lobster as well as, or better than current bait. However, due to the high prices attainable for lobster, fishermen may pay more for a bait that caught more lobster. Sustainability of the supply is also important, although short term supplies of products will be used by some fishermen if the price of the product is low enough.

(iii) Likelihood of successfully developing alternative fresh products for lobster bait

This is difficult to determine at this stage.

(iv) Time necessary to achieve import replacement

If increased quantities of products already used successfully as lobster bait became available at cost-competitive prices, lobster fishermen are likely to utilise these products immediately.

If suitable alternative fresh products can be identified they are likely to take a season or two of successful testing by lobster fishermen before large scale adoption of the product is likely. This is unless the product substantially outperformed traditional baits.

(v) Likelihood that import replacement will be sustainable

If a successful artificial lobster bait was developed, sustainability of that product depends largely on the security of the resource and its level of adoption by the Rock Lobster industry (e.g. a fishery waste product may become unavailable due to the collapse of the fishery or alternative markets being developed for the product).

(vi) Likelihood of industry adoption of alternative fresh products for lobster bait

A number of lobster fishermen already use local fish products for lobster bait, including: pilchards, Australian salmon, carp, bony bream and trevalla heads and frames. Therefore, a cost-competitive source of alternative fresh bait which fishermen could be convinced was successful in attracting lobster into pots is likely to be used by the industry.

(vii) Level of import replacement

Individual alternative fresh products are only likely to achieve partial import replacement.

(viii) Compatibility with other industry and government strategic priorities

Alternative fresh products, if available in sufficient quantity may also be suitable as future ingredients in an artificial lobster bait or feed should such products be successfully developed.

7. BENEFITS

This study primarily assisted the Task Force and the Working Party to develop a policy framework for the importation of aquatic animals and their products and in making specific recommendations to both the MCFFA and ARMCANZ.

Through the deliberations of the Task Force, the beneficiaries will therefore include all sectors of the aquaculture industry, ornamental fish industry, commercial and recreational fisheries and the stockfeed industry that are dependant on aquatic imports. This includes industry members, government officials and researchers. It is impossible to determine the extent of these benefits at this stage. This will be determined by the level of import replacement required by specific industries (determined by detailed Import Risk Analysis) and the level of support given to pursuing recommendations relating to import replacement options.

8. INTELLECTUAL PROPERTY AND VALUABLE INFORMATION

N/A

9. FURTHER DEVELOPMENT

As recommended in the Task Force Report, Government, Industry and Funding Organisations should support research and/or development of products to reduce the dependency of Australian industries on imported aquatic animals and their products. This is especially important for those industries where a detailed Import Risk Analysis identifies that specific imports pose an unacceptable risk of disease and/or pest introduction and establishment. However, in several cases this research and development is important in its own right irrespective of the importation issue. Key areas for R&D support include: artificial feeds for farmed tuna, artificial craypot baits, aquatic animal meal replacements and development of the Australian aquarium fish farming industry.

10. STAFF

Dr. Steve Percival (Aquaculture Development and Veterinary Services P/L) had the primary responsibility for drafting this report, however the final version was a compilation of the views expressed by the broad range of people including: industry members, government officials, and researchers as well as members of the Working Group and Task Force on Imported Fish and Fish Products. Dr. David Cox (DPIE, Canberra) played a key role in collating most of the comments received by the Working Group and Task Force on the original draft.

11. FINAL COST

Total Cost of the Project - $9,440