AGRICULTURE FISHERIES AND FORESTRY - AUSTRALIA, CANBERRA ACT

A NATIONAL AQUACULTURE DEVELOPMENT STRATEGY FOR INDIGENOUS COMMUNITIES IN AUSTRALIA

FINAL REPORT – MARCH 2001

BY

Chan L. Lee
Fisheries WA
And
Steve Nel
Makaira Pty Ltd

FISHERIES
WESTERN AUSTRALIA

The views expressed and recommendations given in this report are those of the consultant Dr C. Lee and his associate, Mr S. Nel, and not necessarily those of the Agriculture Fisheries and Forestry – Australia (AFFA), Canberra or Fisheries WA; and neither AFFA nor Fisheries WA accepts responsibility for any advice or information contained herein.

CUSTOMER
FOCUS
WESTERN AUSTRALIA

Contents

ACKNOWLEDGEMENTS

This report is the result of a 12-month consultancy study managed by Dr C. Lee, Fisheries WA and Mr Steve Nel, Makaira Pty Ltd. It was commissioned by Agriculture Fisheries and Forestry – Australia (AFFA), Canberra, with funding provided from Fisheries Resources Research Fund (FRRF).

We wish to thank FRRF for funding this consultancy and the many stakeholders in the country who provided constructive comments and have helped in bringing this study into successful completion. Special thanks need to go to the Aboriginal and Torres Strait Islander Commissioner (ATSIC), Canberra, which helped AFFA defined the aims and objectives for this study.

During the consultancy study, we visited all states and territories to conduct public workshops and meetings and many ATSIC and other offices with involvement in indigenous aquaculture development. We wish to express our sincere thanks to all the organisations and people who hosted our visits and in particular, the following people for assisting in organising these workshops and meetings:-

- Mr Peter Petersen and Ms Michelle Trainor, Queensland Department of Primary Industries;
- Ms Helen Carpenter, NSW Fisheries;
- Mr Geoff Gooley and Mr Anthony Forster, Fisheries Victoria;
- Mr John Dwyer, ATSIC, NT and Dr Rex Pyne, NT Department of Primary Industry and Fisheries;
- Mr Luke Bowen, Indigenous Land Corporation, Adelaide, S.A.;
- Mr Steven Clark, South Australian Research and Development Institute;
- Mr Wayne Beswick, ATSIC, Tasmania; and
- Mr Warren Alexander, ATSIC, WA.

Their support and interest made the workshops and meetings more productive and rewarding for all concerned.

We also wish to acknowledge the many useful and constructive submissions provided by numerous organisations and individuals. These people and organisations provided valuable knowledge and insights to many issues related to indigenous aquaculture for which we are grateful.

Finally, we wish to acknowledge the support of Mr Peter Rogers, Executive Director of Fisheries WA for permitting Dr Lee to carry out the consultancy, to Mr Glen Hurray, AFFA for his assistance and to Dr Greg Maguire and Mr Kevin Carhart of the Fisheries WA Research Division for their contribution towards the management of this consultancy.

Executive Summary

Introduction

Many Australian Indigenous communities have expressed a strong interest in aquaculture. The industry is culturally in harmony with the lifestyles and skills of Indigenous people and often well suited for development in isolated coastal and inland areas where many Indigenous communities are located. At the *Aquaculture Beyond 2000* workshop held in Canberra on 23-24 August 1999, a vision was expressed that, by 2010, the aquaculture industry in Australia would be achieving annual sales of $2.5 billion. Indigenous Australians have the opportunity to become recognised stakeholders in aquaculture and influence the development of the growing industry, by entering into it at its present early stage of development.

Many factors, however, currently impede the participation of Aboriginal people in aquaculture and their aspirations to use the industry for economic advancement, employment opportunities and food production.

In keeping with its leadership role in fisheries and aquaculture in the Commonwealth of Australia and its interest in establishing a national action plan for aquaculture development, the Commonwealth Department of Agriculture Fisheries and Forestry - Australia ("AFFA") decided to fund this national study into Indigenous involvement in aquaculture. The objectives for this study were developed jointly with the Aboriginal and Torres Strait Islander Commission ("ATSIC").

The principal objectives of this study are to:

- develop a national strategy and management framework for accelerating the involvement of Australia's Indigenous communities in aquaculture; and
- recommend a strategic plan to increase the economic independence and food-production capabilities of Indigenous communities in the country through involvement in aquaculture.

In achieving the above objectives, the study also elevates the profile of aquaculture as an industry that could provide significant benefits to Indigenous Australians, most notably by helping communities achieve economic independence, providing employment opportunities and food security for isolated communities.

The study involved a comprehensive, transparent, five-stage consultative process, which entailed the:

i. nation-wide notification of the study and call for submissions from stakeholders and any other interested parties;

ii. running of a series of workshops in all states and territories, to allow all interested parties the opportunity to be fully informed of and contribute to the study and its objectives;

iii. evaluation of all submissions and preparation of the draft report;

iv. consultation on the draft report, by making it available to all stakeholders, to provide an additional opportunity to comment on the proposed strategy to date; and

v. preparation of the final report, after taking into account all the comments provided on the draft report.

Planning for Aquaculture Development

There is a need for a strategic development framework that deals specifically with Indigenous aquaculture, because there exist several factors distinct to Indigenous communities and interests that have not been dealt with in other national aquaculture planning strategies. These distinctions include the traditional ownership by Indigenous people of significant areas of coastal and inland areas well suited for aquaculture, the poor success rate generally associated with Indigenous aquaculture projects and other social and economic needs of people often living in remote areas for an industry compatible with their lifestyles and cultural requirements.

This document deals with aquaculture mainly at a national level; however, one of the outcomes of the study should be the implementation of recommendations that take development planning to the level of individuals and communities, with a high level of involvement by state and territory government authorities. For it to be effective, this indigenous aquaculture development strategy needs to be implemented by relevant federal and state authorities working in partnership with each other, and with ATSIC. An important premise on which several of the key recommendations provided in this study are based is the development of a process by which federal and state agencies involved in aquaculture can operate in such a partnership. The most appropriate entity through which the requisite liaison can be undertaken to achieve this level of partnership is the proposed ATSIC Aquaculture Unit, which would work closely with state and federal aquaculture agencies. The study also acknowledges that the strategies for aquaculture development, and the means by which they would best be implemented, will differ according to the varying needs and cultures of indigenous communities throughout the country. It will be an ongoing task of the proposed ATSIC Aquaculture Unit to make the necessary allowances and cater for this factor.

Planning for Indigenous aquaculture development nationally requires consideration of numerous factors and issues, most of which were identified through the consultation process. To allow them to be dealt with and incorporated logically into the strategy, these issues were divided into six main categories. They were then incorporated in that format into the National Aquaculture Development Strategy and dealt with accordingly.

Biogeographic Regions for Aquaculture

The regions used to achieve the objectives of this strategy are defined according to common biogeographic features rather than by political, administrative or other boundaries. Biogeographic divisions were considered more suitable because:

- the selection of species and production systems best suited for Indigenous aquaculture is governed mainly by site conditions and features, which, by definition, are broadly similar within any given region;
- from technical and scientific perspectives, to ensure the optimum and sustainable use of limited resources, integrated development planning is best based on ecosystems or regional biogeography; and
- political and administrative boundaries have little to do with the natural processes that influence and are influenced by aquaculture development.

The four biogeographic regions used for this project are the Wet Tropical Region, Dry Tropical Region, Eastern Temperate Region and Western Temperate Region. Chapter 3 describes and provides a description of the main features of these regions.

The National Aquaculture Development Strategy

Aquaculture development has the potential to significantly benefit many Indigenous communities. To be successful, aquaculture has to take place with the active participation of Indigenous communities and accommodate their social, cultural and economic requirements. The development of Indigenous aquaculture could play an important role in areas such as:

- providing new employment opportunities in remote areas;
- leading to the economic and financial independence of communities;
- arresting and reversing the movement of people from communities;
- increasing food production and achieving a level of self-sufficiency and food security;
- supplementing and replacing capture fishery production; and
- increased development through opportunities arising from aquaculture development.

The National Indigenous Aquaculture Development strategy contemplates activities that are best undertaken at either national or regional levels, deals with six main development areas, describes relevant development principle and models, and identifies sources of advice and funding. It then presents 28 recommendations, including an implementation strategy. An important part of national planning is some consideration of suitable species for aquaculture and the use of production systems compatible with species and sites.

Some of the various national and regional activities necessary for aquaculture development have been carried out as part of this study; others will need to be undertaken in the future as the industry develops. These activities will:

- define objectives and set strategic targets, at both national and regional levels;
- identify and evaluate resources and constraints to development, at a regional level;
- make supply and demand projections, at a regional level;
- define specific projects, at a regional level;
- establish means for project monitoring and reporting, at a regional level;
- develop a programme to implement the development strategy, at a national level;
- develop a suitable education and training programme, at a national level; and
- develop suitable research, extension and support programmes, at a national level.

The factors and issues that influence Indigenous aquaculture development and identified during this study were divided into six categories, which form the logical elements of the strategy. They are:

i. industry development;
ii. physical factors and the environment;
iii. biotechnical factors;
iv. commercial and legal factors, including funding;
v. education and training; and
vi. social and cultural factors.

Section 2.2.2 of the study explains the process by which these categories were developed. Section 4.3 elaborates on each of these categories and provides a discussion of and rationale for the relevant development strategies that evolved through the consultancy.

Summary of Recommendations

The 28 recommendations provided in this study are summarised below. A more detailed rationale for these recommendations is provided in section 5.2 of this study.

The recommendations are categorised according to the six main elements of the development strategy enunciated in this study, *viz*.: industry development; physical factors and the environment; biotechnical factors; commercial and legal factors; education and training; and social and cultural factors.

Industry Development

To achieve the objectives of this strategy, implement its recommendations and expedite the involvement of Indigenous communities in aquaculture, a small steering committee should be established.

Recommendation 1

Establish a small and highly-focused 'Aquaculture Steering Committee' to implement the recommendations provided in this study.

There is a need for the establishment within ATSIC of a specialist unit with the skills and experience necessary to provide advice, help develop funding applications and otherwise promote Indigenous aquaculture development. The proposed Aquaculture Unit will also need to interact with the Commonwealth and state agencies involved in indigenous aquaculture development.

Recommendation 2

Establish within ATSIC a small and specialised unit with significant aquaculture skills and experience.

Indigenous aquaculture development planning should be undertaken within the context of planning for the overall economic development of communities and regions.

Recommendation 3

Explore the options that exist to integrate development planning strategies for Indigenous aquaculture with planning for other complementary activities in the region.

Effective consultation by Commonwealth, state and territory agencies with Indigenous people and their meaningful participation in all stages of the planning processes are essential prerequisites for successful Indigenous aquaculture development in each of the identified biogeographic regions.

Recommendation 4

Consider the establishment of a working group or committee, comprising representatives of the state, ATSIC, regional councils and community members, to represent Indigenous aquaculture interests in each of the identified biogeographic regions.

A multi-species hatchery (MSH) satisfies many of the key technical and social requirements for successful aquaculture. MSHs should be strategically located in the biogeographic regions to provide focal points and stimuli for Indigenous aquaculture development.

Recommendation 5

Contemplate the best means whereby one or more multi-species hatcheries could be established in each of the biogeographic regions identified in this study and the means whereby appropriate synergies could be developed between them and existing Commonwealth and state aquaculture agencies.

Where an MSH is deemed too advanced or unsuitable for development for Indigenous aquaculture, a demonstration farm, comprising a small-scale commercial production unit that applies and demonstrates technology as well as providing employment and training opportunities, could be implemented. Demonstration farms would be able to show hatchery and growout procedures under commercial conditions and serve to stimulate Indigenous and investor interest in aquaculture as well as provide resources for research, development and training at a practical level.

Recommendation 6

When appropriate, demonstration farms could be established in selected regions.

Given the high-risk nature of aquaculture and the difficulties inherent is establishing viable farms, proponents should be made fully aware of the need for a long-term commitment to any proposed project.

Recommendation 7

Communicate to proponents the need for and encourage long-term commitments from individuals or communities interested in becoming involved in commercial aquaculture.

Physical Factors and the Environment

The proper identification and assessment of the relevant features of proposed sites is critical for successful aquaculture.

Recommendation 8

For any proposed aquaculture project, ensure a thorough assessment is carried out of the selected site to assess its physical, biological and ecological features and evaluate the relevant economic and social factors.

All parties involved with Indigenous aquaculture planning and project development should be made aware of the significance of culturally sensitive sites and the environmental concerns to Indigenous people. Ensure that appropriate methods are employed to eliminate or mitigate any adverse environmental effects.

Recommendation 9

Ensure that, for any proposed aquaculture project, culturally sensitive areas are not disturbed and due emphasis is placed on environmental management and sustainability.

Indigenous people consider the ability of aquaculture to provide seed stock to restock depleted fisheries an advantage. Relevant opportunities should be explored where there is evidence the fishery is depleted and will not recover through a simple reduction in fishing intensity.

Recommendation 10

Explore the feasibility of using aquaculture to re-stock or enhance depleted fisheries and the means by which this practice could be most effectively established.

Biotechnical Factors

Species considered suitable candidates for Indigenous aquaculture and for which culture technology is being, or has been, developed should be identified.

Recommendation 11

For each of the biogeographic regions, identify species that may be suitable for Indigenous aquaculture and on which relevant research and development is taking place.

A key requirement for Indigenous aquaculture development will be the availability of culture technologies that suit the conditions under which communities will be operating. Research institutions should be encouraged to focus efforts on and accommodate the requirements of Indigenous communities in relation to aquaculture development. Opportunities for collaboration between Indigenous aquaculture development and Commonwealth, state fisheries and research organisations such as the Australian Centre for International Agriculture Research (ACIAR)should be explored. . Linkage with regional agencies such as the Network of Aquaculture Centres in Asia-Pacific (NACA) and the International Center for Living Aquatic Resources Management (ICLARM) involved with indigenous aquaculture development should be encouraged and developed.

Recommendation 12

In collaboration with existing Commonwealth, state, territory and regional research institutions, establish a means of focusing as well as extending research and development efforts on the special requirements of Indigenous communities.

Existing technology and research results need to be adapted to suit the conditions under which Indigenous communities practise aquaculture. Effective means of transferring suitable technologies need to be derived and practised, possibly by the proposed ATSIC Aquaculture Unit deriving some collaborative links with organisations such as state and territory fisheries, CSIRO, ACIAR, ICLARMand NACA.

Recommendation 13

Establish a means of translating the outcomes of research and development from national and regional institutions into practices that can be transferred to and realistically applied by Indigenous people to aquaculture projects.

Commercial and Legal Factors

The establishment and maintenance of a national business network is considered an important component of any aquaculture development strategy and needs to be established for Indigenous aquaculture. The ATSIC Aquaculture Unit proposed in recommendation 2 should be entrusted with the responsibility of developing a national business network.

Recommendation 14

Establish a national business network to develop and maintain links between Indigenous people or communities involved in aquaculture and the commercial aquaculture industry.

An important component of this strategy is the identification of industry parties interested in becoming involved in developing joint commercial opportunities with Indigenous Australians. A register of potential non-Indigenous participants in commercial opportunities afforded by the development of Indigenous aquaculture should be established by the proposed ATSIC Aquaculture Unit.

Recommendation 15

Develop a register of commercial institutions, organisations and individuals interested in becoming involved in the development of Indigenous aquaculture.

Organisations and working groups should be formed to unite and represent Indigenous individuals and communities with a common interest in the development of commercial aquaculture.

Recommendation 16

Establish a clear and transparent process that actively solicits support from the public and relevant industries for Indigenous aquaculture to become major industry stakeholders.

Recommendation 17

Encourage the formation of organisations that represent Indigenous communities with common interests in aquaculture development. Establish a working group within each organisation to expedite the identification of suitable aquaculture land that could be developed.

Organisations/people should be identified that can offer mentoring services to prospective Indigenous aquaculturists, to provide suitable business and technical advice.

Recommendation 18

In each of the biogeographic regions, identify organisations and people who could act as mentors to communities interested in developing aquaculture.

To enable prospective Indigenous members and communities to identify and take advantage of the various services, funding schemes and programmes for aquaculture development initiatives, a prospectus should be developed that identifies all the relevant bodies. The ATSIC Aquaculture Unit proposed in recommendation 2 should develop a suitable document, which could be compiled in conjunction with the national business network proposed by recommendation fourteen.

Recommendation 19

Develop a detailed document that identifies all organisations that might provide services, programmes and funding for Indigenous aquaculture development initiatives and projects.

The range of services, loans and grants that may be available through ATSIC, the processes the agency uses to assess applications, and the time it takes to do so, need to be clearly documented to enable applicants to have a clear understanding of these processes. The ATSIC Aquaculture Unit proposed in recommendation 2 should develop the flow chart for the funding process.

Recommendation 20

ATSIC should develop a flow chart that clearly illustrates its funding process and shows the relevant time lines for funding aquaculture projects.

Clear benefits and higher success rates are associated to the development of larger projects that involve groups of people and communities. To encourage and support the development of aquaculture projects involving groups of people and communities, ATSIC should make it known that strong preference for funding would be given to such collaborative approaches.

Recommendation 21

Through its regional offices and in its relevant brochures, ATSIC should make it known that it would give strong preference to funding aquaculture projects involving groups of individuals and communities.

Government decision-making processes related to Indigenous aquaculture development need to be identified and reviewed to enable unrealistic impediments to be expedited or removed. Existing legislative practices considered to adversely affect the development of Indigenous aquaculture should similarly be identified and the regulations considered onerous to Indigenous groups highlighted. A strategy should then be developed to deal with these identified issues and overcome the difficulties.

Recommendation 22

Document and review the decision-making and legislative processes currently in use by Commonwealth, state and territory governments in respect of Indigenous aquaculture and suggest solutions where they might be needed.

The apparent lack of understanding between Indigenous people and Commonwealth, state and territory government agencies in respect of regulatory requirements and funding processes needs to be improved. Similarly, an atmosphere of co-operation and trust needs to be fostered between communities, the private investment sector and government, as well as between and within communities.

Recommendation 23

Encourage and foster co-operation, interactions and mutual trust between Indigenous communities, regional councils, ATSIC, all funding bodies, the private sector and all Commonwealth, state and territory regulatory bodies.

Education and Training

To cater for the special needs of Indigenous people, it would be appropriate to consider the establishment of dedicated, nationally-accredited Indigenous training courses, based on currently available and accredited National Seafood modules. The training courses should include vocational training offered by TAFE colleges as well as the more formal training offered by universities and their integration with short-term, on-farm traineeships and work experience.

Recommendation 24

Consider the establishment of a dedicated, nationally accredited Indigenous training course based on currently available and accredited National Seafood modules.

Indigenous people seeking to become involved and develop a career in aquaculture are frequently uncertain about the educational and training prerequisites. For such people, it would be helpful to have access to a document or prospectus that clearly outlines the possible career paths and opportunities in the industry as well as describing the education and training requirements.

Recommendation 25

To provide the necessary guidance for Indigenous people who wish to follow a career path in aquaculture, prepare a document that clearly explains the training and education opportunities that exist, as well as some details about education and training requirements and opportunities.

Due to a lack of Indigenous projects, Indigenous people who have undergone some form of education or farm training often cannot practice their skills. To allow them to gain experience, a programme should be developed that helps place trained Indigenous people in a working environment, mainly in the existing aquaculture industry.

Recommendation 26

Develop links with TAFE Colleges, other relevant institutions and industry organisations that can provide skills-based training courses for Indigenous people and where appropriate, provide traineeships to the people to attend the course

Recommendation 27

Develop a job-placement programme to place trained Indigenous people in commercial aquaculture projects.

Social and Cultural Factors

In many cases, non-Indigenous organisations, who may welcome equity participation by Indigenous people in commercial aquaculture, have little or no experience of the relevant social and cultural issues. To facilitate business negotiations between Indigenous people and aquaculture companies, a document needs to be developed that identifies unique social and cultural issues and provides a set of guidelines dealing on doing business with Indigenous people. This document should clearly refer specifically to aquaculture and could be based on similar, existing documents that deal with other industries. In conjunction with ATSIC, the proposed Aquaculture Unit should be involved in developing the document.

Recommendation 28

Prepare a document that provides an outline of how to do business and develop projects with Indigenous communities, with specific reference to aquaculture.

1. INTRODUCTION

1.1 Background and Objectives

Aquaculture is one of the world's fastest-growing food-production sectors. The world's aquaculture industry has grown rapidly over the last 10 years: in 1996, the total production of all aquatic species reached an estimated 34.12 million metric tonnes, worth over US$46.5 billion. This represents increases over 1995 figures of about 11.0% and 6.2%, respectively, for quantity and value (Rana and Immink, 2000). The ability of the aquaculture industry to produce food and generate employment and revenue is clearly illustrated by this rapid expansion. Since 1994, aquaculture has grown at an average annual rate of nearly 10%, compared with 1.6% and 3% for the wild-capture fishery and livestock meat respectively. The proportion of total aquatic production that is cultured is also increasing. Aquaculture provided 20 percent of global fisheries production and 29 percent of food fish in 1996 (Fig. 1). For cultured finfish and shellfish, the annual contribution to total production rose from 13% in 1990 to 22% in 1996. So, almost a quarter of finfish and shellfish consumed are produced by aquaculture. For food fish, the figure is over 25% (Rana and Immink, 2000). In 1996, about 15 million tonnes of aquaculture production , originated in freshwater, nearly 10 million tonnes were produced in marine environments and about 1.6 million tonnes in brackish water environments. The production of aquatic plants in 1996 amounted to 7.7 million tonnes (FAO, 1998).

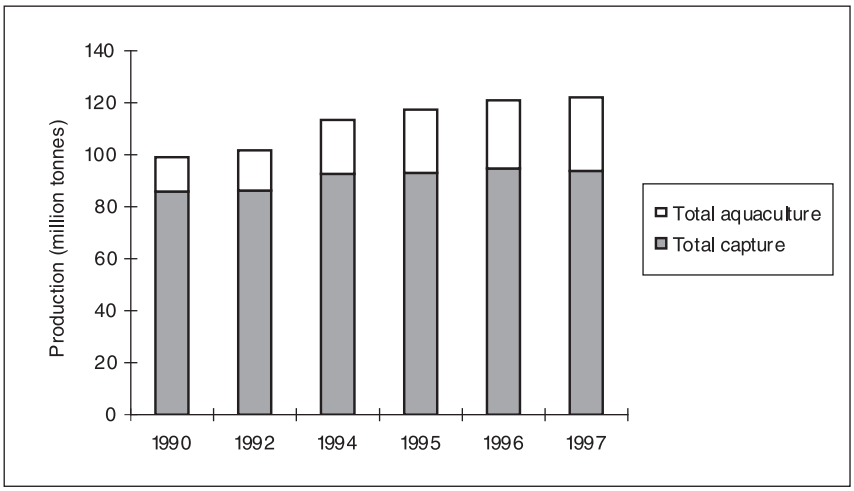

Figure 1 Total global production of captured and cultured aquatic products 1990-97 (FAO 1998). The 1997 data are preliminary.

Similar proportional growth has been recorded in Australia, where production in 1998/99 reached A$602.1 million (ABARE, 2000).

At the *Aquaculture Beyond 2000* workshop held in Canberra and arranged by the Commonwealth Department of Agriculture Forestry and Fisheries - Australia ("AFFA") on 23-24 August 1999, a vision was expressed that, by 2010, the aquaculture industry in Australia would be achieving annual sales of $2.5 billion. This represents a four-fold increase from current production.

Indigenous Australians have the opportunity to become stakeholders and develop a significant shareholding in aquaculture by entering into the industry while it is still at a relatively early stage of development. Early entry into the industry as a legitimate stakeholder would also ensure recognition and a voice in its development.

Many Australian Indigenous communities have expressed strong interest in actively participating in aquaculture. The industry is growing rapidly and many Aboriginal people possess a natural affinity for fishing and related activities. Culturally, aquaculture is in harmony with the lifestyles of Indigenous people and well suited for development in isolated coastal and inland areas, where many Indigenous communities are located. However, many factors currently hinder the participation of Aboriginal people in aquaculture and their aspirations to use the industry to provide employment opportunities and economic advancement.

The development of aquaculture to grow food products for consumption or sale requires adequate funding and experienced, trained personnel, both of which are lacking in most communities. The Indigenous population in Australia is made up of Aboriginal and Torres Straits Islander people. The 1996 Australian Bureau of Statistics census data indicated that there were 372,100 Indigenous people in Australia comprising 2.0% of the total population. Table 1 provides a breakdown by state and territory of the numbers of Indigenous people living in Australia and the proportion of the population they represent. ATSIC and the Department of Primary Industries and Energy (1997) estimates that about one-third of Australia's Indigenous population lives in isolated rural areas where there are few prospects for employment or economic advancement. For these people to be involved in and to take up the opportunities that may be offered by aquaculture, a strategic approach needs to be adopted before long-term benefits may be realised.

Table 1. Estimated Indigenous resident population in Australia (source: Australian Bureau of Statistics, 1996).

State and territory	Indigenous population (,000)	Proportion of population that is Indigenous (%)	Proportion of Indigenous people in each state and territory
New South Wales	106.3	1.7	28.6
Victoria	22.6	0.5	6.1
Queensland	100.5	3.0	27.0
South Australia	21.3	1.4	5.7
Western Australia	54.1	3.1	14.5
Tasmania	14.7	3.1	4.0
Northern Territory	49.6	27.3	13.3
ACT	3.0	1.0	0.8
Total Australia	372.1	2.0	100

Interest in developing aquaculture projects for the purposes of growing food products, for both consumption and sale, and creating employment among Indigenous communities has increased markedly in recent years. In most instances, aquaculture projects have been funded and implemented in different communities on an *ad hoc* basis without specific, long-term goals being targeted or training programmes established and followed through. In addition, these projects often have not been initiated and driven by communities, but by consultants or other outside interest groups. For Indigenous people to participate successfully in aquaculture and related ventures, a strategy is needed that entails a whole-of-government approach by involving the Aboriginal and Torres Strait Islander Commission ("ATSIC") and the governments of the Commonwealth, states and territories in co-operation with the private sector. For Indigenous communities to become major aquaculture stakeholders, various conditions have to be met. These include, but are not limited to the:

- identification of the interests of the communities involved;
- identification of the aquaculture-oriented biogeographical features of relevant regions;
- identification of suitable species and production systems; and
- contemplation of the requisite training, funding and infrastructure development needed to ensure success.

The final critical ingredient is the need to take time to liaise with Indigenous stakeholders, talk to communities and to attend their management committee meetings. The time spent in establishing clear and direct links with communities is highly beneficial, as it will ensure the establishment of more robust projects with higher chances of success. It will be equally important to show Indigenous people and communities what aquaculture is; this can best be achieved through visits to demonstration farms, which can either be established for that purpose or use existing, commercial operations willing to cooperate.

AFFA plays a leadership role in fisheries and aquaculture in the Commonwealth of Australia and has an interest in establishing a national action plan for aquaculture development. In keeping with its role and interest, AFFA funded this national study into Indigenous involvement in aquaculture, a decision that is strongly supported by ATSIC. The objectives for this study were developed jointly between AFFA and ATSIC.

The principal objectives of this project are to:

- develop a national strategy and management framework for accelerating the involvement of Australia's Indigenous communities in aquaculture; and
- recommend a strategic plan to increase the economic independence and food-production capabilities of Indigenous communities in the country through involvement in aquaculture.

To achieve the objectives of the project, this report will:

- provide overviews of the aquaculture-oriented biogeographic features of the regions where Indigenous communities may become major stakeholders in a sector of the aquaculture industry;
- identify suitable regions, species and production systems that can be implemented;
- for selected species, provide overviews of the relevant culture technologies, their status and suitability for implementation;
- identify and evaluate factors that may influence the growth, direction and future prospects for aquaculture development;
- make recommendations in relation to an overall aquaculture development strategy and management framework, their implementation and, where appropriate, specific targeted development projects for the sector across the country;
- develop strategies, including education and training, to increase economic opportunities in aquaculture and related activities for Indigenous communities;
- establish meaningful milestones for evaluating the success of Indigenous aquaculture projects; and
- identify sources of support and funding available for the development of aquaculture by Indigenous communities in the country.

1.2 Current Status of Indigenous Involvement in Aquaculture

The current involvement of Indigenous Australians in aquaculture is very low. Operating Indigenous aquaculture projects are presently found mainly in Western Australia, the Northern Territory and Tasmania; other projects in various states and territories are currently in the conceptual or early planning stages.

In Western Australia, Indigenous involvement in aquaculture is mainly through the establishment of the Kimberley Aquaculture Aboriginal Corporation ("KAAC") and its multi-species hatchery ("MSH") near Broome, which will produce the seed stock needed by licensed aquaculturists located throughout the Kimberley region. Other

small pilot projects involve culture trials with finfish in inland areas affected by saline water. In the south of the State, an Indigenous group has an interest in an operating abalone hatchery.

In the Northern Territory, a major project that proposes to culture barramundi in offshore cages is being developed by a large Australian company in a joint venture with the Indigenous Tiwi people on Bathurst Island, to the north of Darwin. Other projects in the Territory involve several smaller projects on the mainland, growing species such as barramundi, marine prawns and pearl oysters.

In Tasmania, an Indigenous group has an interest in an operating Pacific oyster farm and hatchery. There is strong Indigenous interest in the development of aquaculture projects growing Pacific oysters and other candidate species considered suitable on some of the offshore islands.

At a site near the mouth of the Tweed River in New South Wales, a major sea-water pumping facility is being established to prevent the build-up of silt. The project is considered to offer significant potential for the establishment of Indigenous aquaculture projects.

Similarly, in Victoria and South Australia, pilot indigenous aquaculture projects are under consideration for implementation. In the latter case, at least one community had been involved in the grow-out production of edible oysters.

Past and present experience demonstrates that, in Indigenous aquaculture, individually-funded projects have usually failed. Similarly, stand-alone, community-based projects have had little chances of succeeding. While it has been difficult to obtain objective information, it is evident that the failures have been due to a variety of factors that include inadequate planning, support and training processes. Some projects have failed simply because the regular supply of seed stock was not possible.

In addition to other obstacles, individual communities have had to deal with myriad problems. To be successful, it is clear that people need to go through a good training process and, in the early stages of project and industry development, target species that are reasonably simple to grow and for which the culture technologies are well known. For example, the Broome MSH, described as a development model in this document, has selected trochus, a marine mollusc that inhabits tropical reefs, as its first target species. Trochus is not a demanding species. The hatchery production of the mass quantities of seed stock is relatively simple and, once stocked on a reef, growout is uncomplicated because the stocked trochus do not require daily feeding or a high level of management. It is thus a good "learning" species suited to culture by Indigenous communities living in the remote Dampier Peninsula region of the west Kimberley. The culture of trochus will be followed by the production of other, more demanding species such as tropical abalone, black tiger prawn and finfish. Similarly, there are less demanding species in other states and territories, namely redclaw and cherabin in the Northern Territory and yabbies in South Australia.

1.3 The Consultative Process

The study was conducted in an open and transparent manner. Designed to provide stakeholders and other interested parties three separate opportunities to comment on and contribute to the study, the consultative process followed a logical series of five steps, which are summarised as follows.

i. Notification of the Study and Call for Submissions
   Advertisements and news about the study were placed in the *Koori Mail*, the *Australian* national newspaper, *Austasia Aquaculture Magazine* and the Fisheries WA website. The advertisements provided an outline of the study and its objectives in addition to calling for submissions by stakeholders and any other interested parties.

Numerous radio interviews on ABC regional and regional radio stations were also conducted to publicise the commencement of the study and call for submissions.

ii. National Workshops

At least one workshop was held in each of the Australian states and territories. The purpose of the workshops was to allow all interested parties the opportunity to be fully informed of the study and its objectives and to provide a forum in which the various issues influencing Indigenous aquaculture development could be identified and discussed. These workshops were co-ordinated and jointly held with the respective state ATSIC offices with support provided by the Fisheries departments, departments of Primary Industries, and in some instance the Indigenous Land Corporation ("ILC") and the Aboriginal Affairs departments ("AAD"). Table 2 provides details of the location and times of each of the national workshops.

iii. Evaluation of Submissions and Preparation of the Draft Report

Ample time was allowed for interested organisations or individuals to provide comment by way of written submissions. All the written submissions received, as well as the issues raised during the national workshops and meetings, were taken into account during the preparation of the draft report.

Table 2. Details of workshops held during the consultative process.

State/territory	Location	Date	Duration (d)	Participants (no.)
Queensland	Brisbane	9 December 1999	1	10
Queensland	Cairns	10 December 1999	1	12
		11 August 2000	0.5	13
New South Wales	Sydney	13 December 1999	1	7
Victoria	Snobs Creek	15-16 December 1999	2	33
ACT	Canberra	20 December 1999	0.5	8
Northern Territory	Darwin	1 February 2000	1	11
		9 August 2000 1	0.5	2
Tasmania Launceston		21 February 2000	1	22
Tasmania	Bicheno	22 February 2000	0.5	12
South Australia	Adelaide	24-25 February 2000	2	34
Western Australia	Broome	20 March 2000	1	17
Western Australia	Albany	23 March 2000	1	23

iv. Consultation on the Draft Report

The draft report was widely distributed and made available to all stakeholders, to provide any interested groups or individuals with a third opportunity to comment on the proposed Indigenous aquaculture development strategy to date.

v. Preparation of the Final Report

The final report was prepared after taking into account all the comments provided on the draft report.

2. PLANNING FOR AQUACULTURE DEVELOPMENT

2.1 Preamble and General Principles

The following definition of aquaculture is used by the Food and Agriculture Organisation ("FAO") of the United Nations Organisation (FAO, 1988).

> *Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding and protection from predators. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms that are harvested by an individual or corporate body who has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms that are exploitable by the public as a common property resource, with or without appropriate licences, are the harvest of fisheries.*

The term *aquaculture* is generally used to describe all types of aquaculture, whether in fresh, brackish or sea water. Aquaculture production systems are generally described according to their main features; that is, according to whether they are located onshore or offshore, the water type used, water flow characteristics and the type of culture unit used (Appendix 1). Aquaculture does not include the culture of terrestrial plants in hydroponic systems or the culture of basically-terrestrial animals. Due to fundamental differences in development and management, aquaculture is considered different from fisheries. It should also be noted that, in Australia, crocodile farming is not considered aquaculture.

Aquaculture has the potential to make a significant contribution to the food security, economic independence and employment opportunities of Indigenous communities in Australia. In addition to providing a food-production capability, aquaculture can also play an important social role in providing Indigenous people in remote areas with the potential to develop a livelihood that is sustainable, in tune with the environment and consistent with human and natural resources.

This study presents a national strategy for aquaculture development for Indigenous communities that broadly fits within the framework of the *National Strategy on Aquaculture* (Working Group on Aquaculture, 1994).

There is a clear need for a development strategy that deals specifically with Indigenous aquaculture. Many aquaculture development factors outlined in the *National Strategy on Aquaculture* are common to all prospective participants, including Indigenous Australians, and many of the key issues identified in it are similar to those raised during the course of this study. However, in terms of access to suitable resources and opportunities to participate in aquaculture, there are some factors unique to Indigenous communities and issues specific to Indigenous interests. While it could be argued that the inclusion of Indigenous aquaculture interests is implicit, The *National Strategy on Aquaculture* neither mentions nor deals with these specific factors and issues.[1] Similarly, Aquaculture Beyond 2000: *Changing Direction Workshop* (Hussey, 1999) makes no mention of Indigenous aquaculture as an industry sector. *Australia's Oceans Policy* (Anon., 1999) proposes involving Indigenous people in the use, conservation and management of marine resources but the link with aquaculture is somewhat tenuous. The Oceans Policy document does propose building the capacity of Indigenous people to use marine resources for new commercial activities but does not refer specifically to aquaculture, nor does it specifically mention Indigenous interests in the section dealing with aquaculture. Notwithstanding these omissions, it should be noted that the importance of Indigenous aquaculture development has been recognised by the Commonwealth and state

[1] It is worth noting that the *National Aboriginal and Torres Strait Islander Rural Industry Strategy* (ATSIC and the Department of Primary Industries and Energy, 1997) specified in its action statement number 2.10 that the National Aquaculture Strategy should recognise the interests of Indigenous commuities.

and territory governments, most of which now specifically include Indigenous interests in their planning and consultation processes. These attitudes are exemplified by the publication of documents such as *Opportunities for Aquaculture in Aboriginal Communities* (Department of Primary Industry and Fisheries, 1999).

The distinctions between Indigenous aquaculture and the current industry, particularly in respect of development and strategic planning, include, but are not necessarily limited to:

- traditional ownership by Indigenous people of significant areas of coastal and inland areas well suited for aquaculture;
- the presence of numerous communities in remote, isolated locations;
- the small size characteristic of individual community groups not being conducive to vertical integration; and
- compelling social and economic reasons for the development of industries compatible with the culture, lifestyles and requirements of Indigenous communities.

Further, throughout the consultation process, with very few exceptions, Indigenous people and organisations were strongly supportive of a strategy that contemplates and deals specifically with Indigenous aquaculture issues and interests.

This consultancy report, *A National Aquaculture Development Strategy for Indigenous Aquaculture in Australia*, recognises and incorporates the features unique to Indigenous Australians. It embodies the principles enunciated by the *National Aboriginal and Torres Strait Islander Rural Industry Strategy* (ATSIC and the Department of Primary Industries and Energy, 1997) in respect of the development of Indigenous aquaculture enterprises, viz.: to provide technical support to Indigenous communities wishing to practise aquaculture and assist the planning and establishment of such enterprises.

The strategy adopts a long-term perspective to development. It deals with activities at the national and state levels, such as identifying funding sources and co-ordinating the work being undertaken in the different regions. The national strategy covers all the regions identified for the study, provides an overview of needs and requirements and integrates the various components.

In developing a national plan, due to the size of Australia, account needs to be taken of the varying biogeographical factors in the different areas, particularly temperature, rainfall, humidity, evaporation, soil and water resources, drainage and topography. The division of the country into specific regions according to biogeography is discussed and undertaken in chapter three.

Conceptually, there are four basic levels that will ultimately be involved in aquaculture development: national, state, regional and community. This document deals with aquaculture predominantly at the national and state levels. It is anticipated, however, that one of the outcomes of the study will be the implementation of recommendations that take into account the necessity of taking planning to the level of individual families and communities. Ultimately, in consultation with the respective states and territory agencies responsible for aquaculture development, each of the major biogeographic regions described in this study may derive its own aquaculture development plan, formulated according to the specific features of that region but according to a format common to all regions. These regional plans may involve the subdivision of the main biogeographic regions into smaller sectors or zones. They may also entail the identification of specific projects for each sector or community, according to resources and needs.

2.2 Identification of Critical Factors

2.2.1 Factors Influencing Successful Aquaculture Development

For aquaculture projects to be successful, particularly in the more remote areas where there are significant number of Indigenous people or communities, it will be essential to:

- ensure Indigenous communities are provided with and have ready access to information that will enable them to determine or identify what aquaculture projects they want;
- ensure Indigenous communities are consulted and fully support projects that might be proposed by others;
- select the right species, or combination of species, according to carefully-defined criteria (such as growth rate, food conversion efficiency, culture technology and marketing);
- for products destined to be sold to generate income, consider marketing factors and the requirements of the market place;
- select the optimum site according to carefully-defined criteria (encompassing water quality, topographic and hydrographic features and the availability of necessary infrastructure);
- produce a realistic business plan;
- secure sufficient capital and establishing a proper financing structure;
- have a suitable operating plan;
- establish and practise proper husbandry techniques such as feeding schedules and health and hygiene programmes;
- establish a suitable broodstock and seed production programme;
- properly manage the operations, particularly the monitoring and control of operating costs and establish a suitable risk management programme; and
- ensure a suitable level of training and support is available to the projects.

These factors should form the framework around which individual aquaculture projects are structured.

Several key factors commonly lead to the failure of aquaculture projects and hence aquaculture development (Nel, 1996). These are:

- initial business plans that project unrealistic growth rates and returns on investment;
- undercapitalisation;
- poor selection of species;
- poor site selection;
- inadequate culture technologies and inappropriate selection of production systems;
- poor financial management; and
- inadequate market research and unforeseen decreases in market prices.

Many of these factors have contributed to the reasons why Indigenous aquaculture projects have failed in the past. The following, additional factors were identified in the study through submission by stakeholders.

- A group of Indigenous scientists who prepared a submission for this study cited one of the main reasons for failure of Indigenous aquaculture projects as the communities not being treated as an equal partner and not being able to contribute their traditional knowledge of the local environment and ecological processes.

- A separate group attributed previous Indigenous aquaculture project failures to the use of inappropriate technologies, inadequate training and little consideration of how the management and operations would fit into the cultural practices of the communities.

The recommendations provided in this study take into account the factors identified during the study as being critical for the successful development of Indigenous aquaculture.

2.2.2 Critical Factors Identified from the Consultative Process

The information contained within this section constitutes a synopsis of the views and opinions expressed by stakeholders and other interested parties during the consultation process, either during regional workshop meetings or by way of written submissions.

More than 20 submissions were received from various organisations and individuals throughout Australia. The submissions raised issues similar to those provided during the course of the 11 public meetings held throughout the country. Few of the issues relevant to Indigenous aquaculture development raised throughout the consultative process were unique to a particular state or territory; they are almost invariably similar throughout the country. Similarly, several development strategies, audits and reports generated by various organisations have identified constraints to aquaculture development that reflect those raised throughout the consultative process (Tasmanian Department of State Development, 1998; Aquaculture Committee, 1997; Working Group on Aquaculture, 1994).

With few exceptions, strong support was expressed for the development of the Indigenous aquaculture development strategy, particularly in respect of its objectives to increase employment and the financial and economic independence of communities. This support expressed was occasionally unequivocal, but frequently conditional upon several key issues, predominant among which were the need for community consultation and participation in the development of Indigenous aquaculture and the need for some Indigenous ownership.

The benefits of aquaculture in respect of employment and the compatibility of the industry with the lifestyles of many Indigenous communities were also frequently noted. Many respondents and participants recognised that the affinity many Indigenous people have with aquatic resources and their traditional skills constitute a valuable resource for aquaculture development. Some common concerns involved environmental issues and the need to ensure that any detrimental effects of proposed aquaculture projects on the environment should be avoided or minimised.

It was clear that, for Indigenous aquaculture to succeed, the driving force for its development needs to come from within communities, not government or other groups, since the latter option may be seen as setting up projects that would inevitably fail.

All of the issues raised during the regional meetings and in submissions were considered within the context of this national strategy. Most have been incorporated in this document; however, those considered incorrect, irrelevant or otherwise contrary to the objectives of the strategy have not. The following examples are provided of the latter.

- A proposal in one submission suggested that Indigenous aquaculture production be restricted to onshore, recirculating systems because these were said to be the only method of avoiding (unspecified) risks inherent in marine-based fish farming. This premise is both incorrect and impracticable, so, for the following reasons, the proposal was considered no further. Generally, recirculating systems in aquaculture are successful only for some high-value, fresh-water species cultured under conditions where flow-through systems might be restricted, such as where the species is cultured in an area remote from its natural range. Recirculating systems for marine species have not yet been proven commercially viable. Further, recirculating systems usually

require a very high level of capital investment and high levels of technical skill to operate. They would not be suitable for aquaculture in remote areas.

- Issues such as traditional fishing rights and the rights-of-access by Indigenous people to the wild-capture fishery are not relevant to this aquaculture development strategy and were not included as any of its objectives. Consequently, these issues were not included in the study.
- The issue of the intellectual property possessed by Indigenous people was raised and is briefly dealt with in this document; however, the treatment of this issue is not exhaustive since it is an area characterised by often-complex legal processes. In any case, from a purely commercial perspective, it is likely that, in the event of a joint venture, the incoming party would also be likely to possess intellectual property. A commercial agreement for any proposed venture between an Indigenous group and an outside party, whether joint venture or other equity arrangement, would almost certainly require that any corporate entity formed to undertake the project would have exclusive ownership of all intellectual property.
- A proposal suggesting that all Indigenous communities throughout Australia should be included in the consultation process that formed a part of this study, before any document was produced, was not taken up for several reasons, predominant among which was the enormity of undertaking such a task and the sheer difficulty, cost and time that would be involved. Further, consultation at an individual community level was not considered essential to the derivation of a national aquaculture development strategy.

Factors affecting the development of aquaculture by Indigenous communities include various industry and project development, physical, environmental, biotechnical, commercial, legal, education, training, social and cultural matters. These are the factors considered critical for the development, implementation and growth of a successful Indigenous aquaculture industry.

A synopsis of the information generated from the consultative process in respect of each of these categories of issues follows.

Industry Development

There is a need to increase the level of co-ordination between agencies, to ensure optimum use of government funds and that, where different agencies have similar or complementary functions, those functions are carried out in a way that provides maximum benefit to Indigenous people.

In its submission, the Indigenous Land Corporation considered it important to have appropriate expertise and resources within existing or new agencies to assess proposed projects in an efficient and timely manner.

There appears within ATSIC a general lack of expertise to provide relevant advice, help develop funding applications for aquaculture projects and assess applications. This resulted in frustration by communities interested in developing aquaculture projects. In addition to slowing down the approvals process, it may also lead to poorly-informed decisions and ultimately, in many cases, to project failure. There is thus a need for suitably-trained and resourced staff capable of making timely and correct decisions as to the viability of project proposals. ATSIC should consider directly employing staff with these skills.

Within primary industry and fishery departments in all states and territories, there is an apparent lack of extension staff who are trained to provide the support required by existing and prospective Indigenous aquaculturists. It should be noted, however, that in most relevant government departments the number of extension staff dealing with aquaculture is and will probably remain small. Further, as has been the case in Tasmania, the effort put into dealing with marine aquaculture issues by the Government agency has already been greater than the proportion

of the interest by the community in the industry. This has resulted in several key personnel having considerable experience in these matters, if not formal training.

As the consultation process progressed, the concept evolved of having a small, dedicated aquaculture unit within ATSIC. Most stakeholders felt that the formation of a national specialist aquaculture unit within ATSIC would expedite their entry into the industry and enhance the successful outcomes for projects. Such a unit would co-ordinate the funding for aquaculture-oriented projects and provide advice and technical support to Indigenous individuals, communities and organisations. It would also serve the critical function of interacting more directly with government and other relevant agencies to facilitate the licensing requirements for Indigenous aquaculture projects.

Physical and Environmental Factors

Many Indigenous communities, particularly some of those in northern parts of Australia, live in remote areas often with seasonal access. These restrictions impose constraints on the type of product that can be grown and hence the type of aquaculture practised.

The lack of suitable infrastructure and financing was generally seen as an impediment. This is of particular concern in the more remote areas, where the supply of essential inputs to aquaculture ventures may be restricted seasonally. Infrastructure is not as big a problem in the more heavily populated and developed areas of New South Wales and Victoria, which are characterised by significant resource bases, substantial investor interest and major domestic markets.

The impact of aquaculture on the environment was seen as a critical issue and the importance of good environmental management for commercial aquaculture frequently emphasised. Indigenous people want to ensure that the environment in which they live would not be adversely affected by waste products from aquaculture activities. There is a need for groups contemplating aquaculture projects to be made aware of their potential environmental impact as well as the means for avoiding or mitigating negative impacts. Examples were provided by one respondent of situations where no environmental monitoring programmes were being carried out to determine the effects aquaculture activities would have on the environment. This situation is not favoured and it is clear that Indigenous aquaculture development should be characterised by responsible environmental management. It is anticipated that the proposed ATSIC Aquaculture Unit would deal with this matter in close collaboration with state aquaculture agencies, which have clearly defined roles and responsibilities in relation to environmental issues.

The possibility of aquaculture being used to restock depleted fisheries in natural waters is seen as an important and positive attribute of the industry. This practice is considered important, in respect of opportunities that would be thus provided in the areas of marine conservation and protection as well as recreation and tourism.

Biotechnical Factors

The key biotechnical factors in respect of Indigenous aquaculture development are the:

- identification of species suitable for aquaculture at present;
- availability of seed stock for growout;
- selection of suitable production systems; and
- development of culture technology for species targeted for future development.

The identification of species suitable for farming at present was believed to be an impediment to development, particularly in the more remote areas. To overcome the difficulties related to the provision of seed stock, one

Indigenous group in the Torres Strait Islands is contemplating the establishment of a multi-species hatchery to provide stock for growout. The provision of information and appropriate advice concerning the commercial viability of candidate species is particularly important in the more remote areas. The selected species clearly need to be compatible with the conditions that prevail in these areas, particularly in respect of technical and marketing factors.

The range of species currently available and the most suitable for Indigenous aquaculture varies according to location as well as numerous other factors. In Queensland, it was proposed that fresh-water species would be the most suitable for Indigenous aquaculture. In other areas such as Tasmania, marine shellfish species are considered the most appropriate due to experience there suggesting a comparatively low capital cost to establish farms.

Any species and production system selected for a particular aquaculture project must suit the environment, be compatible with the aspirations of the community concerned, the technical expertise, supply of labour, capital and other resources. The use of intensive production systems may not be appropriate for all communities, particularly those located in remote areas with little infrastructure. More extensive or semi-intensive practices may be better suited to these communities. These latter systems, which usually require lower levels of investment and can be managed at lower levels of intensity, are being used by remote communities in other countries, for example in the remote islands of the Pacific Ocean.

For many species that have been considered for aquaculture, commercial development is presently impeded by inadequate or poorly-developed culture technologies and production systems. Lack of suitable technology and inexperienced management are seen as reasons why some Indigenous projects have failed in the past and as an impediment for future proposed projects.

In its submission, the Indigenous Land Corporation considered the identification, development and implementation of culture technology an issue fundamental to Indigenous aquaculture development. It was also considered important that, when required, Indigenous communities can foster new technology.

One submission proposed that, for Indigenous aquaculture to be successful, a polyculture approach should almost invariably be adopted in preference to the culture of a single species.

Commercial and Legal Factors

Indigenous people possess unique knowledge and understanding of their traditional lands and waters. This traditional knowledge and contemporary culture technology may collectively constitute an asset that would promote the development of Indigenous aquaculture projects that are in tune with the environment and the community needs and hence more likely to be successful.

Many Indigenous communities, particularly those living in coastal areas, are traditional owners of the land. This is seen as a significant advantage to development, because the land and its natural resources constitute a major asset that could be used to attract suitable investors and developers.

Aquaculture is invariably considered an important means of increasing the economic independence of Indigenous communities as well as providing an important means of food production, though the emphasis is usually on the former. These factors are linked to the importance of communities being involved in and having a strong influence on the design and implementation of any proposed aquaculture ventures. Aquaculture is seen as an ideal way for Indigenous people to become involved in an industry at its inception and thereby participate in its development.

Aquaculture can be undertaken by Indigenous people either to produce food or for commercial reasons to generate a financial return. These two forms of aquaculture require different business strategies that, by definition, may be in conflict. It is unlikely that both activities could be successfully accommodated within a single community operation.

Some Indigenous groups are developing economic independence through the establishment of profitable commercial enterprises; however, the general lack of formal networks with industry, government and existing commercial aquaculture operations is considered a weakness and hence an impediment to commercial aquaculture development.

Indigenous aquaculture would be unlikely to succeed if undertaken in isolation from the remainder of the industry, which already possesses skills and experience that would be of value to communities. Clearly, the optimum development climate would be a co-operative one. This could best be achieved if other aquaculturists were allowed to develop without being impeded by issues such as land claims. The reasonable avoidance of any sources of disharmony and friction between Indigenous aquaculture and the existing industry is seen as both sensible and pragmatic.

Aquaculture should be seen as a business run for profit.[2] Communities interested in the industry need to carefully consider why they want to enter into it as well as be aware of the financial and environmental risks involved. The main reasons for communities engaging in aquaculture have been identified as providing:

- employment opportunities, particularly for young people;
- opportunities to develop skills;
- financial returns on investment; and
- food for community consumption.

It may be that aquaculture development is simply seen in terms of employment, money or improved lifestyle. The clear identification of these underlying issues and their capacity to be fulfilled are fundamental to success. Aquaculture development in remote areas would almost certainly confer additional benefits on the communities as a result of multiplier effects and the additional support and service industries that would thereby be created.

The issue of intellectual property was raised in submissions and during regional meetings. It was proposed that existing Indigenous knowledge that may be relevant to any proposed aquaculture development should be considered a resource.

With the exception of a few sectors such as pearling, the aquaculture industry in Australia is considered in its early stages of development. Indigenous communities therefore have a unique opportunity to become involved in and contribute to the development of the industry from its inception. Various levels of community involvement in commercial ventures were contemplated. Some groups recognised and were satisfied they would be minority shareholders in large-scale ventures, while others were of the opinion that Indigenous people should have majority shareholdings.

Legislation exists in all states and territories to regulate aquaculture activities. The legislation generally requires proponents to provide, inter alia, evidence of financial capacity and ability to perform before being issued an aquaculture licence, permit or lease. Because the respective Acts make no exceptions or provisions specifically for

[2] It could be argued that aquaculture carried out to grow food for a community should not be considered a business run for profit. However, in the context of this study it may be assumed that this type of venture is profitable from a social perspective, even if revenue is not generated. In any case, the point is probably moot for Indigenous aquaculture, since all interested parties who have so far provided comment have expressed specific interest in undertaking aquaculture as a commercial activity for financial gain.

Indigenous communities, the legislation is considered in one submission to be disadvantageous to Indigenous communities seeking to enter the industry. It is noted in respect of this issue that, while state licensing arrangements might not explicitly include or refer to Indigenous communities, that does not mean that they are excluded. The licensing requirements invariably include and are relevant to all Australians.

The ownership of leases and licences by Indigenous groups varies across Australia. Positive steps have been taken in Western Australia to ensure Indigenous people have opportunities to secure fishing and aquaculture licences; in some cases Indigenous people have exclusive access to some fisheries. Where access to licences or leases may be restricted it would be beneficial to assess the potential demand from Indigenous communities and establish policies to ensure long term access and participation for Indigenous people. These need to take account of native title issues.

Education and Training Factors

The general lack of education, training and skills is almost invariably considered a significant constraint to the development of aquaculture among Indigenous communities. Relevant education and training are considered fundamental to the participation of Indigenous people in aquaculture.

According to species and production system, the level of technology required in aquaculture can be high. Indigenous groups would need special assistance to import and assimilate new technology.

The need for education and training in aquaculture was considered important not only for management and technical purposes but also for planning, to allow Indigenous people to have an involvement in all stages of development and planning processes.

It could be assumed that employment opportunities for Indigenous people do exist in the industry at present; however, at some institutions, present participation in existing training programmes by Indigenous people is low. Advantage should be taken of existing opportunities for Indigenous people to receive suitable training followed by practical experience on operating aquaculture farms. These skills could then be transferred to communities that later become engaged in aquaculture. It will also be important to consider the roles of individuals within communities and how the training is implemented. The tradition in some Indigenous cultures is for the older people to instruct the younger ones and shown them what to do. Aquaculture development entails training young people who would then bring the skills to their communities. To ensure this training process does not adversely affect traditional culture practices and gain the support of the community, it is important to point out to the traditional elders that, even if they are not involved in the actual training, they will perform a role in having the concepts accepted within the community and will have an important involvement in issues such as the approval and allocation of sites for aquaculture development within the community.

The importance was emphasised of involving young people in aquaculture, particularly during the early stages of the development process, so they would be well placed to continue to drive the development of the industry. The benefits of taking a long-term approach in respect of education and training to develop skills were raised. It was considered likely that, realistically, it would take one or more generations for a pool of skills, ranging from high to medium level, to be built up in Indigenous communities. This process of education and training should be accelerated as far as possible.

At the root of greater participation in aquaculture is increased awareness and involvement in training, education and employment within the existing aquaculture industry and other related industries such as food production. The development of Indigenous aquaculture projects for the purpose of providing employment and training will be effective only if Indigenous people are involved in the local industry. The development of programmes to

encourage and support Indigenous participation in aquaculture and other relevant industries and training programmes are a priority.

Social and Cultural Factors

Social and cultural issues form a critical part of any proposal to develop aquaculture in Indigenous communities. To be sustainable and successful, it is essential that aquaculture should not adversely affect or detract from environments upon which communities may be economically or culturally dependent.

The creation of employment opportunities and weaning from the CDEP is invariably seen as a major social issue. There is now increasing pressure on the creation of real employment opportunities in Indigenous communities, particularly as a result of the demand by educated and trained young people, who wish to return to their communities. In many cases, it is believed that trained young people would return to their communities to live if there were reasonable employment opportunities. Many people firmly expressed the view that they would be prepared to work for a period of two to three years on a project for an amount equal to the CDEP if it had a reasonable chance of succeeding, so they and their children could benefit from it at a later stage.

Indigenous people need to be provided with the means to exercise fundamental responsibilities for their own land, lives and businesses.

Indigenous communities are usually characterised by their individuality and differences. Traditionally, each Indigenous group has its unique customs, language and lifestyle. There is a clear need for any national strategy to be sufficiently flexible to accommodate the diverse communities and situations within the country. Similarly, it would be important for any development strategy to be sensitive to the cultural practices and beliefs of the relevant communities, to make provision for adequate time for consultation with communities and to identify and accommodate specific community needs. The decision-making process used in Indigenous communities for land and water use need to be accommodated in aquaculture planning processes. Land and sea management under Indigenous law is often complex and often decisions are referred to senior elders and traditional owners.

There is a need for any aquaculture project involving Indigenous people to be appropriate for the communities, mainly in terms of how well it fits or can be integrated into their cultural practices. It is clear that different communities would prefer and seek different approaches to aquaculture development, varying from extensive practices that reflect cultural beliefs and values to semi-intensive and intensive systems involving significant capital expenditure and high levels of management and technology (Appendix 1).

While some support was expressed for production systems geared mainly to food production, most of the Indigenous people who attended regional meetings and made submissions clearly preferred a commercial approach to aquaculture, involving more intensive production systems and higher-value species with the capacity to generate a commercial return to the community.

Some concern was expressed about a perceived aim of the study to impose aquaculture schemes onto communities as quickly as possible, with insufficient attention being paid to the needs of communities or their rights to develop at their own rates.

Some cultural activities will always take precedence over aquaculture requirements, often for several days at a time. For example, in the Kimberley, when the 'Law' (an initiation ceremony or rite-of-passage for young people to manhood) is taking place, no other activities are permitted. Other cultural issues that need to be considered include taboos and totems. Due to the importance of these traditional, cultural activities to Indigenous communities, this feature is unlikely to change, so it has to be managed as a component of the management of

any established project. Similarly, some sites with cultural significance may preclude the establishment of aquaculture infrastructure and facilities. In some cases, cultural priorities over land and water areas will rule out aquaculture development.

Cultural beliefs may also influence the selection of species for culture in some instances. Each Indigenous community has what are known as totem species, which are those to which the community has a spiritual affinity and does not hunt.

On separate occasions, the view was expressed that, in the longer term, the trend would be for the CDEP to decline and possibly cease. It was thus imperative that Indigenous people now move to become self sufficient, certainly within one generation.

Harnessing, developing and guiding the human potential in communities will be fundamental to success. There may be a role for mentors, from both within and outside the community. Strategies aimed at developing, within communities, leaders who have the ability to guide community aspirations, expectations and development would be advantageous. The situation where motivation to engage in enterprises or projects is promoted without reference to the communities involved should be avoided.

It was recognised that one of the problems to be overcome would be the fragmentation and conflict that often exists between and within Indigenous communities and family groups.

It is generally true that local communities should have the ability to influence developments that occur in their regions; however, there are cases in which Indigenous people do not necessarily live in an area that is of historical and cultural significance to them and in which they have an interest. In these cases, it will be necessary to balance the views of resident and non-resident people.

2.2.3 Summary of Critical Factors

Table 3 summarises the factors considered critical to Indigenous aquaculture development from the regional meetings and written submissions.

Table 3 Summary of critical factors for the development of Indigenous aquaculture.

Factor	Key issues
Industry development	• A specialist aquaculture unit should be established within ATSIC. • A level of co-ordination is needed between state and federal government agencies to optimise the use of government funds and benefits to Indigenous people. • Resources should be established within ATSIC to facilitate the applications processes and provide an adequate level of support to the developing industry. • State and territory governments need to strengthen the extension service to better assist the fledging Indigenous aquaculture industry and individual projects.
Physical and environmental	• Constraints on species and product type due to seasonal access to some remote areas. • Lack of suitable support infrastructure in some areas. • Management to minimise negative environmental impacts. • Awareness of and means to mitigate or avoid potential negative environmental impacts. • Potential for aquaculture to restock depleted fisheries.
Biological and technical	• Identification of species suitable for aquaculture development at present. • Advice concerning the commercial viability of present and future candidate species. • The availability of sufficient quantities of hatchery-produced seed stock for growout. • Information about the production systems best suited for specific applications and sites. • Provision of suitable technology and management systems. • Research to develop technology for target species for future aquaculture development.
Commercial and legal	• Traditional ownership of land by Indigenous people constitutes a significant asset. • Consideration of traditional knowledge relevant to aquaculture as an asset. • Aquaculture is a way of increasing the economic independence of Indigenous people. • There exists an opportunity to become involved near the start of industry development. • There is a need for the establishment of formal networks with industries and governments. • A co-operative development environment would be mutually advantageous for Indigenous aquaculture and the industry. • Aquaculture is seen mainly as a commercial enterprise that can be run for a profit. • Successful aquaculture projects would have additional, multiplier effects in communities. • The existence of intellectual property relevant to aquaculture needs to be ascertained. • Indigenous ownership as equity partners in projects is essential. • Constraints in existing legislation need to be dealt with to facilitate Indigenous aquaculture.
Education and training	• The lack of education and training is an impediment to industry development. • Relevant education and training are fundamental to success. • Indigenous groups may need special assistance to assimilate some advanced technologies. • Education and training are important to allow Indigenous people to participate in planning processes. • A strategy is needed to provide employment opportunities for Indigenous people in the industry as well as community projects. • Leaders need to be developed within communities. • Young people need to be involved through all development stages, so they can drive the industry in the future.
Social and cultural	• The creation of employment opportunities is a major issue in favour of Indigenous aquaculture development. • Decreasing the dependence by communities on social welfare is seen as critical. • Aquaculture should not adversely impact on environments on which communities are socially or culturally dependent. • The strategy needs to be sufficiently flexible to accommodate the individualities of and differences between communities. • Adequate consultation with communities is essential. • Proposed projects should be compatible with the cultural practices of communities. • Conflict arising from differences within and between communities needs to be overcome.

3. BIOGEOGRAPHIC REGIONS FOR AQUACULTURE

The regions used in this study are defined broadly according to their common biogeographic features rather than by political, administrative or other boundaries. Given the present stage of industry sector development and magnitude of the development strategy proposed by this study, the definition of regions according to natural, biogeographic boundaries is considered the most appropriate. Certain advantages can be associated with the definition of regions according to political or administrative rather than natural boundaries; however, the latter are considered more suitable for achieving the objectives of this development strategy for the following reasons.

- Selection of species and production systems best suited for Indigenous aquaculture will be governed largely by site conditions and features, which, by definition, will be similar within any given region. Regionalisation according to biogeography is therefore the most logical, practicable and efficient for Indigenous aquaculture development.
- Integrated resource management planning, drawing on all the sectors with interests in any particular area, is essential to ensure the optimum and sustainable use of limited resources. From technical and scientific perspectives, for development and research purposes, the requisite level of integrated planning is best based on ecosystems or biogeography of the regions.
- Political and administrative boundaries have little to do with the biological, ecological and environmental processes that both govern and are influenced by aquaculture development. In reality, however, political boundaries, particularly those in relation to the states, will play a major role in influencing Indigenous aquaculture development. For this reason, this study proposes a high level of cooperation and partnership between federal,state and territory government agencies.

Stated simply, in this study, regions are defined according to common biogeographic features rather than by other means because:

- natural features govern the selection of sites, species and production systems; and
- significant development advantages will be associated with the use of common species and production systems in areas with similar natural features.

The development strategy recognises that different areas of Australia have varying ecosystems. Each ecosystem is characterised by sets of physical and biological features, and social and economic factors, that, from an aquaculture perspective, make it suitable for the production of certain species using different production systems. The development strategy provides for this critical issue by defining separate biogeographic regions, which form the basis for regional planning and development activities.[3]

Of necessity for the development of a national strategy, the selected biogeographic regions are few and large in area. These large biogeographic regions might be sub-divided if required at a later stage according to the rate at which industry growth proceeds. In the long term, when the industry sectors within the initial, biogeographic regions begin to mature, new, smaller regional boundaries based on political or administrative boundaries may be implemented if this is considered necessary for further industry growth. In this case, it is anticipated that each of the original biogeographic regions would be divided into smaller areas.

Aquaculture development in any of the biogeographic regions needs to consider the roles and responsibilities of key fisheries agencies in respect of licensing and regulation and accommodate their requirements, particularly in areas of the regions that crossed administrative and political boundaries.

[3] For the purpose of this study, biogeographic features principally include the physical and biological characteristics of a region such as its topography, climate, water type and water quality.

3.1 Definition of Regions

To define the biogeographic regions proposed for this study, the following factors were considered.

- The number of biogeographic regions should be limited. These main regions can be subdivided at a later stage of development if required.
- Each region should encompass inland, coastal and offshore locations.
- Regions should be based primarily on large-scale biogeography, species occurrence and natural distribution. Accordingly, each region would be suitable for common species. No account is taken of production systems that allow species to be grown outside their natural distribution.[4]
- Generally, each region should be characterised by certain common features. These mainly include climate, species, geographical drainage features and water type, quality and quantity.
- Each region should, through its physiognomy, form a recognisable entity.

Previously, macroscopic divisions or regions of Australia have been described separately for coastal and inland areas. Conceptually, for each region to comprise both coastal and inland sectors, this study requires the consideration of both together. Thus, the most logical regional boundaries would be those for which coastal and inland boundaries coincide. This section considers the large-scale features of coastal and inland areas and their compatibility, then defines their boundaries according to the biogeographical features they have in common.

Four basic coastal sectors have previously been described for Australia by Bunt (1987), viz.: tropical arid coasts, tropical humid coasts, warm temperate humid coasts and warm temperate arid coasts. These coastal divisions are based mainly on landforms and geomorphology as well as environmental features.

Australian coastal waters are rich in species, which are distributed according to recognisable patterns (Wilson and Allen, 1987). These distribution patterns are sustained by coastal geomorphology as well as processes such as ocean currents and environmental factors. Broadly speaking, the marine fauna of Australian coastal waters comprise two distinct types, tropical and temperate, separated on the western and eastern coasts by two zones of inter-mixing (Fig. 2). Wilson and Allen (1987) describe these four major zoogeographic zones as the northern Australian region (tropical), southern Australian region (temperate) and western and eastern overlap zones.

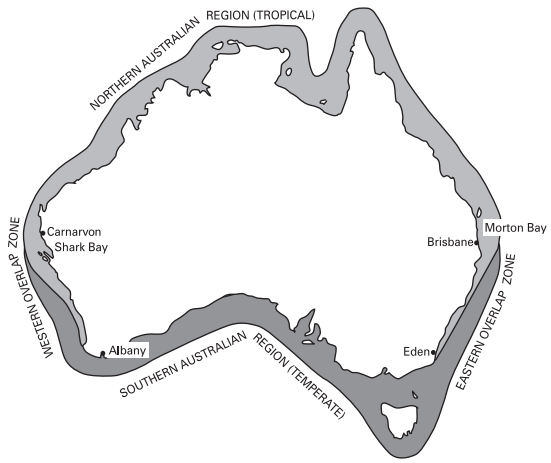

Figure 2 Distribution of tropical and temperate fauna of Australian coastal waters (after Wilson and Allen, 1987).

[4] For example, barramundi, a tropical species, is presently produced by aquaculture well outside the natural range of the species in temperate areas of Australia, using recirculating technology and geothermal water.

The major features of the coastal areas are approximately correlated with some climatic features inland. At roughly latitude 26°S, near both the western and eastern coasts of Australia, there occurs a major climatic distinction. The major change is from winter or non-seasonal rainfall south of that latitude to summer or cyclonic rainfall to the north. Similarly, across the north of the country, rainfall generally decreases towards the west. General subregions according to zoogeographic features are also described by Heatwole (1987). These regionalisation patterns, considered together with the drainage regions, provides a reasonable rationale for the biogeographic regions selected for this study.

In inland areas, the distribution of freshwater fauna is influenced by the boundaries of the various drainage divisions (Fig. 3). The major geographical drainage areas are those described by Merrick and Schmida (1984) and Williams and Allen (1987).

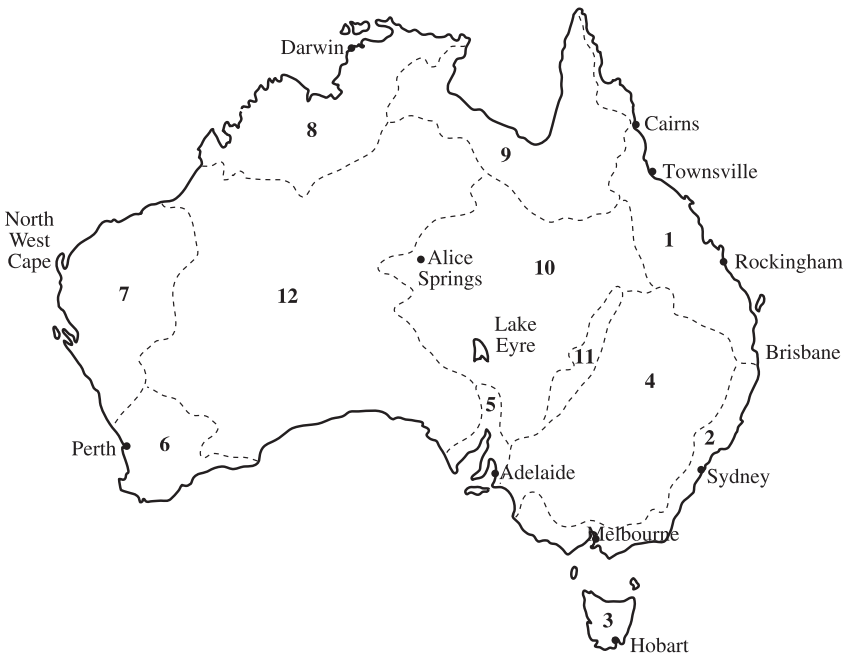

Figure 3 Major Australian geographical features (from Merrick and Schmida, 1984). The drainage divisions are: 1 North-East Coast; 2 South-East Coast; 3 Tasmanian; 4 Murray-Darling; 5 South Australian Gulf; 6 South-West Coast; 7 Indian Ocean; 8 Timor Sea; 9 Gulf of Carpentaria; 10 Lake Eyre; 11 Bulloo-Bancannia; 12 Western Plateau.

Four biogeographic regions are used for this project (Fig. 4):

i. Wet Tropical;

ii. Dry Tropical;

iii. Eastern Temperate; and

iv. Western Temperate.

Because the boundaries of each region are based on biogeographic features, each region may be considered suitable for a given range of species, according to their natural ranges. Given the broad scale of the regions, their limits as they are described in this text are clearly not characterised by an abrupt transition from one species to another; rather, there would be some overlap at the boundaries.

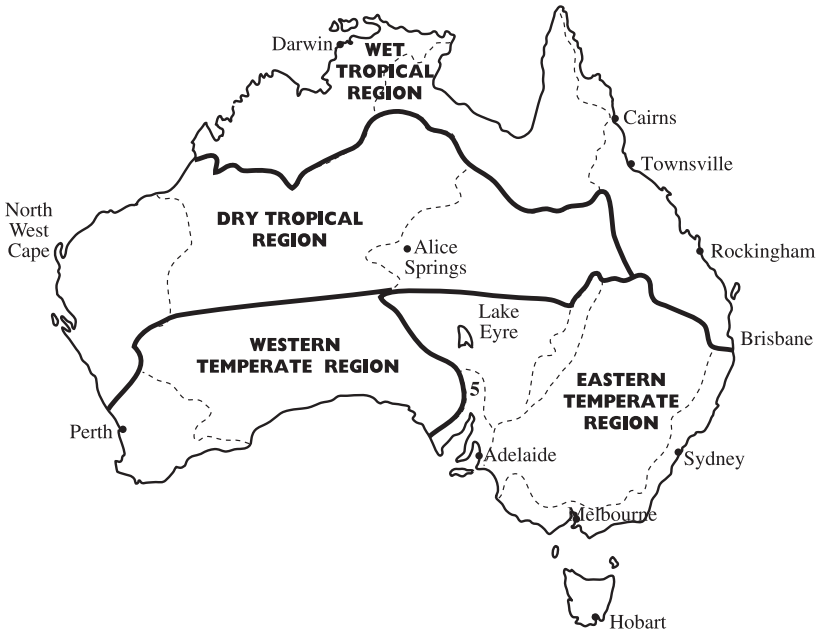

Figure 4 Boundaries of biogeographic regions for the national Indigenous aquaculture development strategy.

Some of the species that might be suitable for Indigenous aquaculture within the various biogeographic regions considered suitable for each region are also listed in appendix 2, together with some brief comment about their attributes and commercial potential. The natural distribution and culture environment identified for each of the species provide some indication of the Region likely to be the most suitable for that species. Appendix 1 provides a reasonably detailed outline of the methods that should be used to select a suitable site, species and production system for aquaculture. The sites and production systems best suited to any particular area will be governed largely by its natural and other resources. Due to the size of each region, the natural ranges of some species may not extend throughout the region. The culture of species outside their natural range, while technically feasible, is often more a question of economic or financial feasibility. In some cases, it may be feasible to culture aquatic species outside their natural range, both within and across regional boundaries. This study contemplates this issue where appropriate but does not deal in any detail with the regulations concerning the translocation of aquatic species within Australia.

Descriptions of the main features of coastal and inland regions of Australia are drawn mainly from Dyne and Walton (1987) and Interim Marine and Coastal Regionalisation for Australia (IMCRA) Technical Group (1998).[5]

The following sections describe the boundaries of the four regions selected for this study together with their main physical, oceanographical and hydrological features.

3.2 The Wet Tropical Region

3.2.1 Regional Boundaries and Internal Divisions

The Wet Tropical Region extends eastwards along northern Australia from Broome to Cape York, encompassing the Gulf of Carpentaria, then southwards to Brisbane.

The coastal areas of the Wet Tropical Region encompass the northern part of Canning, King Sound, Kimberley, Cambridge-Bonaparte, Anson-Beagle, Van Diemen Gulf, Coburg, Arnhem-Wessel, Groote, Pellew, Carpentaria, Wellesley, Karumba-Nassau, West Cape York, East Cape York, Wet Tropic Coast, Lucinda-Mackay Coast, Shoalwater Coast and the northern part of Tweed-Moreton. Inland, the region encompasses the Timor Sea, Gulf of Carpentaria and North-East Coast drainage divisions (Fig. 5).

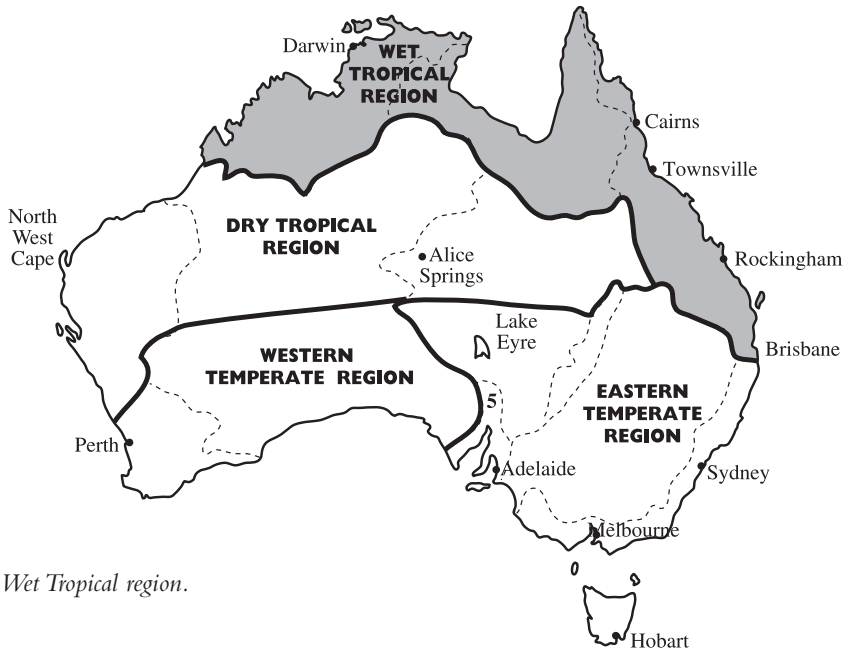

Figure 5 The Wet Tropical region.

3.2.2 Main Features of Coastal Areas

The Wet Tropical Region comprises a large area with many significant coastal features, which include King Sound, the remote coasts of the Kimberley and Northern Territory, Cambridge Gulf, the Gulf of Carpentaria, the Great Barrier Reef and its islands off the coast of north Queensland, Fraser Island and Moreton Bay.

The northern part of Canning includes the Dampier Peninsula. This coast and King Sound, a wide, open gulf, are characterised by a very high tidal range that can exceed 11 m. The beaches and headlands of Canning change in King Sound to a low-relief western shore, very wide tidal flats on the southern shore in the upper reaches and

[5] Offshore regions not adjacent to the coast, such as Oceanic Shoals and Central Reef, have not been included in the following descriptions of these regions, since their development for aquaculture is impracticable and considered unlikely in the immediate future.

wide mangrove areas in the bays of the eastern shores. To the north, the landforms change into the varied rocky shores, mud flats and mangrove areas of the Kimberley coast, a prominent feature of which is the Buccaneer Archipelago.

Cambridge-Bonaparte encompasses the waters of Joseph Bonaparte Gulf, a large marine gulf that contains Cambridge Gulf, into which flow the Ord, Pentecost and Durack rivers, and estuaries of the Keep, Victoria and Fitzmaurice rivers. The low-profile shores of this area extend into Anson-Beagle, which has sandy coasts with low cliffs in its southern part and the drowned river valleys forming Darwin and Bynoe harbour area. The coastlines of Van Diemen Gulf, which adjoins Anson-Beagle, comprise low, estuarine flood plains with narrow mangrove fringes and intermittent fringing reefs backed by well-developed mangrove forests. The Daly, Finniss, Adelaide, Mary and Alligator rivers flow into these areas. The sea waters in all these areas are generally very turbid as a result of large tidal ranges and significant wet-season river discharges.

Coburg and Arnhem-Wessel extend across the northern part of the Northern Territory. The coastlines of these areas comprise numerous bays, inlets and sandy beaches. The tidal range increases from a moderate 2-3 m in the east to about 3-5 m in the west at Arnhem Bay. Mangroves occur along creeks and in deeper bays and there are several coral reefs in the usually less turbid sea water.

Groote, Pellew, Carpentaria, Wellesley, Karumba-Nassau and West Cape York comprise a variety of landforms from rocky coasts to alluvial plains and intertidal flats. Mangroves occur in most coastal areas. The tidal range is low to moderate in this area and the water relatively turbid. West Cape York features significant fresh water input from coastal wetlands. The only coral reefs in the southern part of the Gulf of Carpentaria occur in its upper reaches.

East Cape York and Wet Tropic Coast and Lucinda-Mackay Coast have landforms that include muddy and sandy substrates, shoals, reefs and mangroves in varying concentrations. The tidal range increases from low in the north to high in the south. The southern area includes the Whitsunday and Cumberland island groups. Shoalwater Coast comprises large bays and big, coastal islands with a high tidal range. Most shores in this area are sandy. The northern part of Tweed-Moreton that lies within the Wet Tropical Region is characterised by a relatively narrow continental shelf and extensive sandy beaches separated by rocky headlands. Fraser Island is a prominent feature of the area.

3.2.3 Main Features of Inland Areas

Inland in the Wet Tropical Region, the Timor Sea division includes most of the Kimberley Region of Western Australia and the northern part of the Northern Territory. This area includes the Kimberley Plateau and the more dissected plateaux of the Northern Territory. Alluvial plains characterise much of the coastal areas. Inland, the topography predominantly features tablelands, rugged ridges and flat alluvial plains. Further east, the broad, flat coastal plain of the Gulf of Carpentaria rises inland to Arnhem Land and the Barkly Tablelands in the west and south and to the northern part of the Great Dividing Range to the east.

The North-East Coast division comprises the catchments of the Great Dividing Range in a broad band along the east coast from Cape York Peninsula in the north to the southern border of Queensland. The area contains a variety of vegetation from tropical rainforests to relatively dry eucalyptus woodlands.

With the exception of Lake Argyle in the Kimberley, lakes are rare in the Timor Sea division. The most important aquatic features are permanent rivers and their associated wetlands.

The Gulf of Carpentaria division includes the coastal rivers of the north-eastern part of the northern territory and those of northern Queensland, which drain into the gulf. Hydrological features are mainly characterised by relatively large, intermittently-flowing rivers, most of which have large deltas and tidal flats near their mouths. Smaller creeks are usually permanent. Due to the flat coastal plain, saline estuarine water can penetrate some distance up the rivers.

Many of the streams of the North-East Coast division are relatively short, with high initial gradients, high annual discharges and seasonally-variable flows. Gradients decrease towards the coast, where many of the rivers flow into large estuaries supporting extensive mangrove systems. In the Cape York area, there are numerous lagoons that dry up during the winter months.

3.2.4 Climate

The climate of the Timor Sea, Gulf of Carpentaria and northern part of the North-East Coast divisions is tropical, with hot, wet summers and warm, dry winters. Rainfall in both areas is predominantly monsoonal but also associated with tropical cyclones and ranges from about 1,500 mm in the north to less than 300-400 mm in the south. The more southern part of the North-East Coast division is typically tropical to sub-tropical, with hot wet summers and cooler dry winters. Monsoonal rainfall is less reliable in this area, which experiences rainfall from south-easterly winds during winter.

3.3 The Dry Tropical Region

3.3.1 Regional Boundaries and Internal Divisions

The Dry Tropical Region extends northwards along the coast from the northern part of the Central West Coast near Geraldton to the Canning Coast, south of Broome.

The coastal areas of the Dry Tropical Region are the northern part of Central West Coast, Zuytdorp, Shark Bay, Ningaloo, Pilbara (nearshore), Eighty Mile Beach and the southern part of Canning. Inland, the region encompasses the following major geographical drainage areas: Indian Ocean; and those portions of Western Plateau and Lake Eyre that lie to the north of latitude 26°S (Fig. 6).

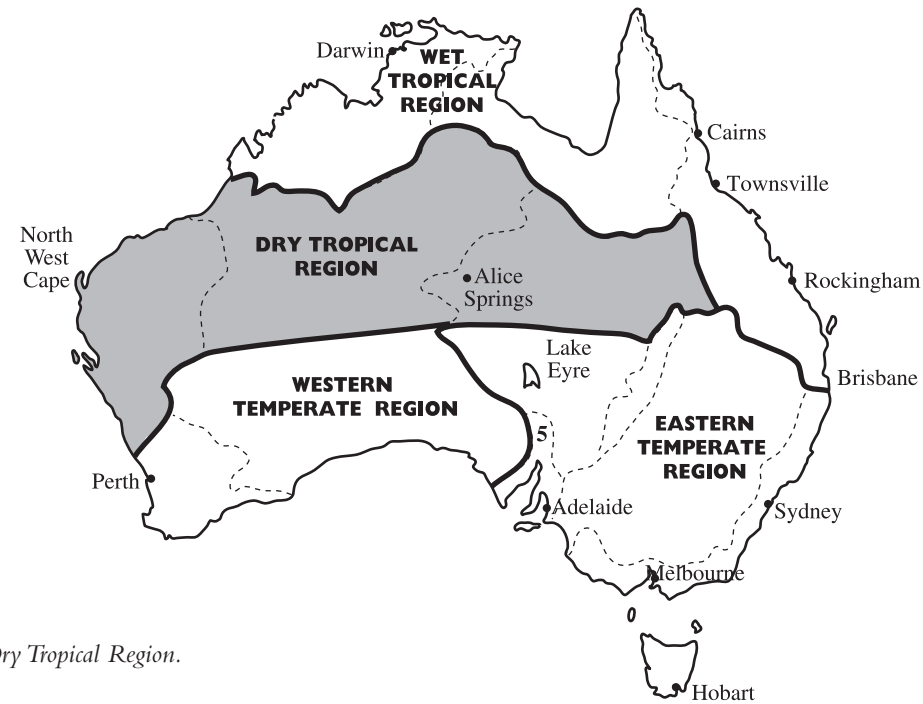

Figure 6 The Dry Tropical Region.

3.3.2 Main Features of Coastal Areas

The most prominent coastal features of the Region are Shark Bay, Ningaloo Reef and Exmouth Gulf. The part of Central West Coast that lies within the Region and Zuytdorp feature a relatively narrow continental shelf and diverse landforms. The wave energy of the coastline increases from moderate in the south to high in the region of the high limestone cliffs northwards from Kalbarri. The limestone reef systems that run parallel to the coasts in these areas are among the largest in Australia.

Shark Bay, the only large marine embayment between Cockburn Sound south of Perth and Exmouth Gulf, has marine and terrestrial environments of high conservation value. Classified as a World Heritage Area, Shark Bay contains some of the most extensive seagrass meadows in the world and provides a rich habitat for marine macroalgae, fishes and invertebrates. Ningaloo represents another area of high conservation value. Ningaloo Reef, a fringing coral reef, is one of Australia's major coral reef systems, is largely pristine and supports a rich and diverse coral reef community.

Pilbara (nearshore) features numerous offshore islands, some of which have fringing coral reefs, and large, intertidal mudflats and sand flats associated with extensive mangrove systems in bays and lagoons. Eighty Mile Beach and the southern part of Canning that lies within the Region feature continuous, wide, sandy beaches and, in the Canning area, various bays and headlands.

The wave energy on coastlines to the south of the North-West Cape is generally medium to high with moderate tidal ranges, increasing from about 0.8 m in the south to about 1.8 m in the vicinity of the Cape. The sea water in these areas is usually very clear and a major feature is the southwards-flowing, warm Leeuwin Current, which passes close to Ningaloo Reef. The Murchison River to the south of Shark Bay floods periodically and can increase the turbidity of the usually-clear sea water in this area. Between the North-West Cape and Broome, coastal waters are more turbid, particularly during periods of spring tides. These coasts are subject to low wave energy and a high tidal range up to 6 m in the Pilbara and 9 m near Broome at the northern limit of the Region. There are some large, seasonal rivers in the Pilbara, but the remaining area to the north-east has no rivers and only a few small, seasonal creeks drain into the sea.

3.3.3 Main Features of Inland Areas

The Indian Ocean division covers rivers draining the central western coast of Western Australia. The terrain is generally rugged and comprises many deeply-dissected plateaux and gorges, flattening to a sandy plain near the coast. The relief is lower towards the southern portion of the division.

The remainder of the inland portion of the Dry Tropical Region comprises those parts of the Western Plateau and Lake Eyre divisions that lie to the north of latitude 26∞S. These very large areas cover much of inland Australia. While some isolated areas of high ground do occur, the most common landforms are flat, sandy or stony plains covered by low scrub or desert grasses. Desert plains, low-lying hills and longitudinal dune systems predominate in the eastern portion. The areas feature large and usually dry salt lakes.

Inland aquatic habitats in the Indian Ocean division typically comprise intermittently-flowing streams and rivers, with some permanent pools. The inland waters are generally fresh but in some areas affected by increasing salinity. Surface waters are rare in the Western Plateau and Lake Eyre area and usually limited to streams and rivers that flow periodically following erratic rainfall.

3.3.4 Climate

The climate of the Indian Ocean division is generally arid to semi-arid, but more Mediterranean-like in the southern portion. Usually low and unreliable, the rainfall is mainly associated in the north with summer cyclones and the south with winter low-pressure systems. The area of the north-west shelf between Exmouth and Broome is prone to severe tropical cyclones. The climate of the areas comprising the more inland, eastern sector of this region is semi-arid to arid, with the low rainfall decreasing towards the western portions. Flooding can occur throughout the Lake Eyre region as a result of sudden downpours that mainly occur during the summer months.

3.4 The Eastern Temperate Region

3.4.1 Regional Boundaries and Internal Divisions

The Eastern Temperate Region extends along the coast from Brisbane southwards to encompass Tasmania, then eastwards to the western coast of the Eyre Peninsula.

The coastal regions of the Eastern Temperate Region are the southern part of Tweed-Moreton, Manning Shelf, Hawkesbury Shelf, Bateman Shelf, Twofold Shelf, Flinders, Freycinet, Bruny, Davey, Franklin, Boags, Victorian Embayments, Central Victoria, Otway, Coorong, St Vincent Gulf, Spencer Gulf, North Spencer Gulf, and Eyre. Inland, it includes the following major geographical drainage areas: South-East Coast, Tasmanian, South-Australian Gulf, Murray-Darling, Bulloo-Bancannia and the portion of the Lake Eyre division south of latitude 26°S (Fig. 7).

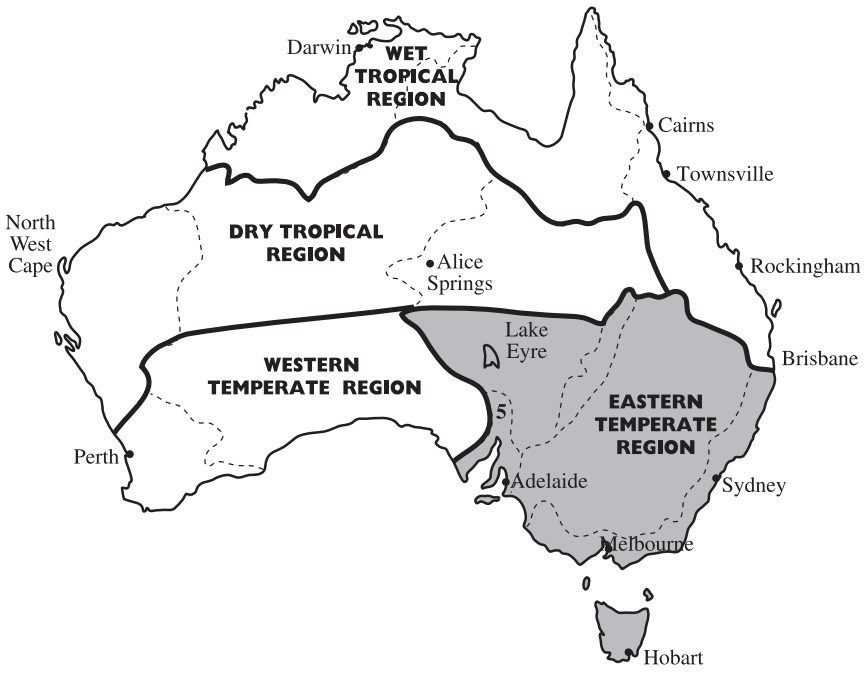

Figure 7 The Eastern Temperate Region.

3.4.2 Main Features of Coastal Areas

The southern part of Tweed-Moreton, Manning Shelf, Hawkesbury Shelf, Bateman Shelf and Twofold Shelf generally have fairly exposed coastlines with few offshore reefs or other features. The slope and extent of the inner and outer continental shelves vary in these areas, the onshore parts of which have sandy beaches divided by rocky headlands and numerous coastal lagoons and bays. The tidal range is moderate throughout these areas.

Flinders features an exposed granite coastline and sandy beaches on Flinders Island. Freycinet has an exposed coastline comprising rocky headlands, sandy beaches and coastal lagoons. Bruny features a fractured coastline with extensive embayments sheltered by islands and peninsulas. Davey, Franklin and Boags all have exposed coastlines comprising rocky headlands between sandy beaches and coastal lagoons. The tidal ranges in the former areas are low to moderate at about 1.0-1.5 m, increasing to a higher range of about 3 m at Boags.

Victorian Embayments include Port Philip Bay, a large embayment fringed by seagrass meadows, rocky reefs and sandy beaches, Western Port Bay, Corner Inlet and Mallacoota Inlet. These bays, inlets and estuaries vary greatly in size and are usually less than 25 m deep. Central Victoria and Otway are characterised by moderate to steep gradients offshore and steep coastal cliffs with few coastal embayments and moderate wave energy. The wave energy decreases to low in Coorong as a result of the offshore gradient changing from steep to flat. In addition to headlands and cliffs, Coorong features an extensive dune barrier complex.

St Vincent Gulf, Spencer Gulf and North Spencer Gulf are semi-confined inverse estuaries with minimal water flowing in from the land. The offshore gradients are shallow and the wave energy low to moderate. The coastlines comprise sandy beaches, dunes, beach ridges and extensive tidal flats. The tidal ranges are low and the waters warm temperate.

Eyre features moderate offshore gradients, a moderate to high energy coastline and low tidal range. The coastline comprises rocky cliffs with numerous headlands and extensive, sheltered, shallow embayments.

The circulation of coastal waters in the eastern part of the Eastern Temperate Region is influenced by the main stream of the East Australian Current, which generates a longshore, southwards flow of warm, tropical water into temperate New South Wales. Ocean currents and tidal characteristics vary in the region of the Bass Strait. The tidal range is between 1 and 3 m off the New South Wales coast, between 2 and 3 m in the Bass Strait and decreases to less than 1 m in the more southern and western areas. The southern coastal area of the Region immediately to the west of Bass Strait is typically higher energy. The waters are cold temperate and characterised by localised upwellings of cold, nutrient-rich water. In the Coorong and Eyre areas, sea water temperatures are transitional warm to cold temperate and the tidal regime remains micro-tidal.

3.4.3 Main Features of Inland Areas

Inland in the Eastern Temperate Region, the South-East Coast division includes the seaward catchments of the Great Dividing Range southwards from the northern border of New South Wales, then westwards through Victoria and to the mouth of the Murray River in South Australia. The area has been extensively modified as a result of settlement, but pockets of rainforest still occur in New South Wales, giving way to the coastal heathlands that extend across Victoria to South Australia. The Tasmanian division may be considered an extension of the South-East Coast division. Much of the area is mountainous and forested, with a high central plateau up to 1,200 m elevation. The comparatively small South Australian Gulf division mainly includes the large gulfs of South Australia. Generally low relief, the landforms of this area include the Mount Lofty and Flinders ranges.

The large Murray-Darling division contains the inland catchments of the Great Dividing Range on its eastern and southern portions. These areas are mountainous and forested with small, fast-flowing permanent rivers and streams. Most of the division comprises flat to undulating lightly-forested or grassy plains with slow, meandering rivers and associated wetlands. The area has been heavily modified by pastoral and other activities. The portion of the Lake Eyre division south of latitude 26∞S, which falls into the Eastern Temperate Region of this study, mainly comprises low-lying and featureless desert plains.

Inland, numerous dune lakes and estuaries occur in the South-East Coast division. Further inland, there occur rapidly-flowing permanent streams, some of which arise from the snowfields of the Snowy Mountains. Many permanent fresh water lakes and rapidly-flowing upland streams occur in the Tasmanian division. The fauna in this area is characterised by a high degree of endemism. The Murray-Darling division features the river system of the same name, which is the longest in Australia and drains nearly one-seventh of the continent. Most of the exploitable water resources of the Murrray-Darling River are committed to pastoral and agricultural use.

The South Australian Gulf division has a few, short, temporary streams and, other than Lake Alexandria on the Murray River, no fresh water lakes of any size. There are numerous large and small salt lakes, one of the largest of which is Lake Torrens. To the north, the portion of the Lake Eyre division features large and usually dry salt lakes, the most notable of which is Lake Eyre, and few rivers or streams.

3.4.4 Climate

The climate of the South-East Coast division is warm temperate in northern New South Wales and Mediterranean in the southern areas. Rainfall is usually reliable, with summer falls in the north and winter and spring falls in the remainder. Average rainfall varies from 1,800 mm in the north to less than 750 mm in the south. In the Tasmanian sector, the climate is cool temperate with high rainfall, most of which falls during winter.

The climate of the South Australian division is Mediterranean in the south-east and semi-arid elsewhere. Rainfall, which mainly occurs during winter, varies from 500 to 750 mm in the south-east and less than 150 to 300 mm in the north. Rainfall is very low and unreliable towards the west. Further north in the Lake Eyre division, the climate is arid to semi-arid with low, unreliable rainfall. Floods can occur as a result of sudden downpours.

The Murray-Darling division experiences climates that range from cool temperate in the upland regions, where the winter rainfall is reliable, to warm and semi-arid on the plains, where rainfall is lower and less reliable.

3.5 The Western Temperate Region

3.5.1 Regional Boundaries and Internal Divisions

The Western Temperate Region extends westwards along the southern coast of Australia from the Eyre Peninsula to Cape Leeuwin, then northwards to the southern limit of the Dry Tropical Region, near Geraldton.

The coastal regions of the Western Temperate Region are Murat, Eucla, WA South Coast, Leeuwin-Naturaliste and the southern part of Central West Coast. Inland, the region encompasses the following major geographical drainage areas: South-West Coast; and the southern portion of Western Plateau that lies to the south of latitude 26°S (Fig. 8).

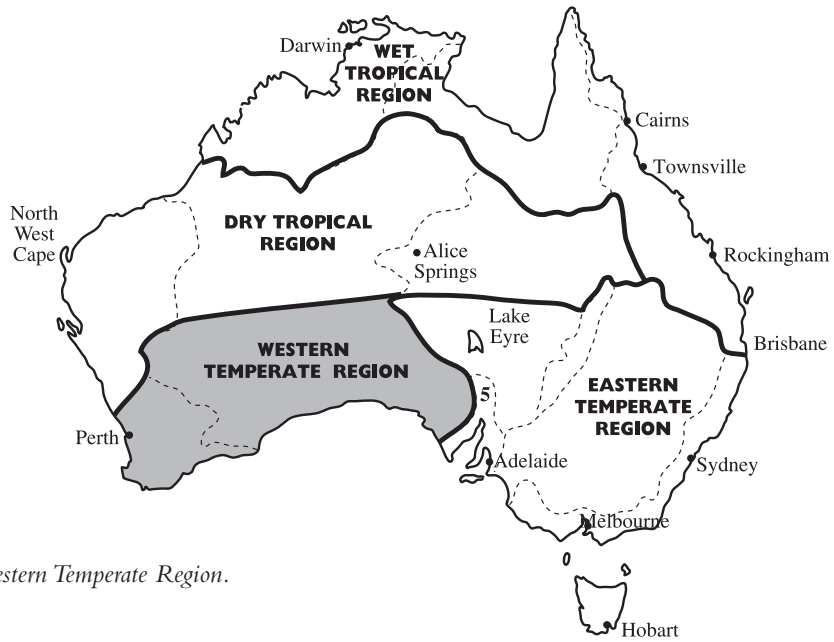

Figure 8 The Western Temperate Region.

3.5.2 Main Features of Coastal Areas

The Murat area features rocky headlands protecting sandy beaches and intertidal flats. The coastline is moderate to low energy and has a shallow offshore gradient. Eucla to the west is similar offshore but is characterised onshore by the high Nullarbor cliffs, rocky headlands and nearshore reefs. There are some beaches and dune barriers. The sea water in these areas is warm temperate under the influence of the Leeuwin Current.

The WA South Coast area features sandy beaches backed by sand dunes between numerous, prominent rocky headlands. There are many sheltered bays and inlets and some, such as King George Sound, provide good shelter. Many rivers and some large estuaries occur in the area. Major coastal features include Princess Royal Harbour and Oyster Harbour near Albany and Wilson Inlet, which supports a significant fishery. The embayments and inlets support extensive seagrass meadows. The coast is high energy and there are numerous, high limestone cliffs. Leeuwin-Naturaliste features similar landforms and has numerous granitic headlands around bays and sandy beaches. The area is subject to high wave energy and a heavy swell affects the shore. A cold inshore current usually runs northwards, in the opposite direction to the Leeuwin Current.

The southern part of Central West Coast features large marine embayments such as Geographe Bay, Cockburn Sound, Warnbro Sound and Jurien Bay. There are several small islands offshore and an extensive limestone reef system. Tropical species commonly occur as far south as Rottnest Island, under the influence of the Leeuwin Current. The area is noted for its very high diversity of seagrasses. The Swan Estuary is large and permanently open and there are numerous other smaller estuaries that open seasonally.

The southern coastline of the Western Temperate Region is subject to high wave energy and generally exposed to heavy swells. The sea water is usually low in turbidity, high in quality and swept by the West Wind Drift. The tidal range is micro-tidal in the eastern part and increases marginally to a maximum of about 1 m to the west. The Leeuwin-Naturaliste coast is swept by a cool, northwards-flowing current during the summer and can in some years be influenced by the Leeuwin Current.

3.5.3 Main Features of Inland Areas

Inland in the Western Temperate Region, the South-West Coast division includes areas drained by rivers and streams that flow to the ocean between Geraldton and Esperance. The most prominent landform of the division is the Darling Escarpment, which represents the western limit of the Western Plateau. The wide, sandy plain that lies between the escarpment and the coast is covered by grasslands and light forests, replaced in the south-western portion by thick eucalyptus forest. The part of the Western Plateau included in the Western Temperate Region mainly include flat plains covered by low scrub.

Inland, permanent streams are common in the South-West Coast division, particularly in its south-western portion. Rivers and streams are comparatively scarce in the areas north of Perth and east of Albany. Seasonally-filled salt lakes are found throughout the area.

3.5.4 Climate

The climate is temperate, with warm, dry summers and cool, wet winters. Rainfall is highest near the coast and decreases inland, with the greatest falls occurring in the south-western corner. The climate in the southern portion of Western Plateau south of latitude 26°S is arid and rainfall low.

4. THE NATIONAL AQUACULTURE DEVELOPMENT STRATEGY

4.1 Introduction

AFFA, ATSIC and the Indigenous people of Australia are the main stakeholders in this study, which was initiated by AFFA with funds provided by the Fisheries Resources Research Fund ("FRRF"). This is a strategic document developed by way of consultation with interested parties throughout the country, to help with the development of Indigenous aquaculture in Australia; it is not intended to be a federal policy document to be imposed on other states and territories. It is anticipated that AFFA and ATSIC will use the document as a basis for developing strategic assistance and funding to Indigenous communities interested in developing aquaculture. This study process can be followed up by AFFA and ATSIC as they consult with relevant state or territory authorities for more advice.

It will be important to ensure this aquaculture planning and development process outlined in this strategy does not create unreasonable or high expectations among Indigenous communities. It is emphasised that the purpose of this study is to provide AFFA and ATSIC with recommendations and a strategy to accelerate the development of aquaculture for interested Indigenous communities, not to generate unrealistic or high expectations. It will also provide a means for communities to streamline the applications and development processes.

The interest for aquaculture development has to come in the first instance from the communities themselves. Further, interest has to be maintained from within the communities, mainly by one or more advocates or "champions" who maintain high levels of interest and continue to drive development projects. At a community level, it is essential for people to be fully aware of what is involved in aquaculture, to have a realistic expectation of the rewards and returns as well as the long term commitment in time and effort needed to achieved successful outcomes.

A major advantage of aquaculture as an industry suitable for Indigenous aquaculture development is that projects are often best suited to those remote areas in which there is presently significant unemployment among local, Indigenous communities. As such, the potential benefits of aquaculture development are enormous. Clearly, as has been frequently emphasised, to be successful, such development would have to take place with the active participation of Indigenous communities and be geared towards and accommodate their social, cultural and economic requirements.

From the information generated during this study, it is apparent that the development of Indigenous aquaculture could play an important role in areas such as:

- providing new opportunities for sustained employment in remote areas, including full-time, part-time and casual jobs;
- allowing skills to be transferred to CDEP staff and interested community members;
- generating income from the sale of aquaculture products leading to economic and financial independence of Indigenous communities throughout Australia;
- arresting and reversing the movement of people from communities;
- increasing food production near consuming centres and achieving self-sufficiency in aquatic products thereby providing food security and improved nutritional status of the population;
- supplementing and replacing capture fishery production, reducing over-exploitation of wild fishery stocks; and
- the overall development of remote areas through commercial opportunities flowing from aquaculture development.

The model considered the most appropriate for aquaculture development for Indigenous communities in Australia is modified from that elaborated by Nash (1995). In respect of Indigenous aquaculture development, this strategy:

- contemplates the activities best undertaken at either national or regional levels;
- deals with six main development areas;
- describes four relevant development models;
- indicates sources of advice and funding; and
- presents recommendations with an implementation strategy.

In its appendices, the document also provides some basic biotechnical information about sites, production systems and the culture of candidate species, to allow proponents some guidance and indicate where additional research may be warranted. The strategic process outlined by this document identifies and links all the issues considered critical for Indigenous aquaculture development.

4.2 National, State and Regional Activities

For the reasons previously elaborated (section 2.1), it is clear that there exists a need for a development strategy specifically for Indigenous aquaculture development. This need was enunciated by Indigenous people throughout the study.

It is also clear that, if it is to be effective, any strategy for Indigenous aquaculture development should also fit neatly within and complement the National Strategy on Aquaculture in Australia (Working Group on Aquaculture, 1994). Accordingly, as stated in section 2.1, the Indigenous aquaculture development strategy proposed by this study is structured to complement and fit within the framework of the National Strategy while simultaneously achieving its own stated objectives. We would anticipate that a high level of co-operation and communication would be developed and maintained between the lead agencies charged with the responsibility of implementing the respective strategies. A proposal to this effect is provided in this study as a part of recommendation 1 (section 5.2).

Various national, state and regional activities will be necessary in the future as part of a comprehensive aquaculture development strategy. Several of these activities have already been carried out as a part of this current study, while others have yet to be undertaken. Some activities such as the co-ordination of industry development, are more effectively undertaken at a national level, while others are more appropriately carried out at a state, regional or community level. Further, many components of the aquaculture development strategy are specific for either national, state or regional activities, while some are relevant to all, albeit at different levels and intensities. Broadly, these activities will:

- define objectives and set strategic targets, including the identification of any necessary policy and institutional changes (at both national, state and regional levels);
- identify and evaluate resources, including consideration of constraints to development (at a state and regional level);
- make supply and demand projections (at a state and regional level);
- define specific aquaculture projects according to regional features and community needs and identify expenditure requirements (at a regional level);
- establish a means for project monitoring and reporting (at a regional level);

- develop a programme to organise, co-ordinate, evaluate and administer the development strategy and projects (at a national level);
- develop a suitable education and training programme (at a national level); and
- develop suitable research and development, extension and technical support programmes (at a national and state level).[6]

4.2.1 National and State Activities

Objectives and Strategic Targets

National, state and regional objectives and targets should clearly be closely integrated. The objectives for the national strategy, broadly described in chapter one, are dealt with in this study.

The allocation of financial resources to identify state and regional projects and to more strategic, national activities, such as co-ordination of research and development ("R&D"), education and training, would be undertaken at the national level. The allocation of resources to specific projects and between the regions would also need to be determined. This document provides an outline of and recommendations for the strategies, policies and institutional arrangements needed to instigate an Indigenous aquaculture industry. An implementation strategy for the recommendations is also proposed.

Policy and institutional changes required for this strategy to be implemented need to be identified. Periodic reviews of national and regional strategies should be undertaken and adjustments need to be made to implement any necessary amendments or changes. It is believed that one of the main strategies needed to achieve the objectives of national Indigenous aquaculture development is the creation within ATSIC of a specialist aquaculture unit. First introduced during the consultation process, this ATSIC Aquaculture Unit is considered the driving force needed to implement the strategies and provide the requisite level of support to Indigenous communities.

Development strategies and their implementation will need to take into account the range of state and national plans that already exist for various industries and that might affect aquaculture. Where necessary, it will be essential to interface with these plans.

Organisation and Control

Of necessity, various federal, state and territory agencies will be involved with the development and growth of Indigenous aquaculture, which will effectively constitute a new aquaculture industry sector in Australia. Effective communication at all levels of development activities will be essential, from federal and state government agencies to ATSIC regional councils, communities and ultimately individual family groups and other stakeholders. To most efficiently integrate the development strategies proposed by this document, particularly in view of the disparate nature of aquaculture projects and Indigenous communities in a nation the size of Australia, a high degree of co-ordination, organisation and control will be essential. For this purpose, to ensure efficient cross-agency activities, it will be necessary to establish a small committee of some form, to integrate the efforts of the various agencies involved in the development effort. It is believed that the proposed ATSIC Aquaculture Unit would be best placed to carry out this role with support from AFFA and should form the core of this committee.

In addition to co-ordinating activities at a national level, the proposed committee would also monitor the ongoing planning activities and their effectiveness. Provision needs to be made in future regional strategy planning

[6] The main difference between national and regional objectives and targets is their timing. National targets are more long-term, while regional targets would be achieved in the short to medium terms.

documents for project monitoring and reporting at regional and local levels. Information provided from these sources would be integrated into other national activities or programmes, such as research and development, to assist with their direction.

The level of organisation and control might vary between regions and projects and the emphasis should be on the imposition of the minimum control necessary for the objectives to be achieved. It will be important to avoid imposing control measures or oversights where they are unnecessary. For example, the Tasmanian Investment Corporation constitutes a model of commercial investment that operates efficiently and effectively with little need for such oversight.

Education and Training

Education and training in relevant aquaculture skills will be necessary to provide communities with the knowledge needed to operate production facilities. Numerous training facilities exist in different states that can develop relevant curricula, if they do not have them already. These factors are dealt with in some detail in this document (section 4.3.5).

Research, Development, Extension and Technical Support

Despite the large amount of aquaculture research that has been carried out over the last three decades, comparatively little has been done on projects with applications specifically to Indigenous aquaculture, or to adapt the technologies to suit Indigenous aquaculture requirements. It is seen as critical to Indigenous aquaculture development that:

- support is given to the planning of research projects that might have direct or indirect applications to Indigenous aquaculture;
- existing research results are translated into an appropriate form ready for utilisation by Indigenous people; and
- at a regional or site level, the results of R & D research are adapted so they are relevant to Indigenous communities and the conditions under which they may be applied. The research required to adapt technologies to suit local conditions can be of short duration, cheap to verify and readily implemented.

The organisation and co-ordination of research and development activities will be undertaken at the national level to ensure that the Indigenous aquaculture industry sector is considered as a whole rather than as several, fragmented parts. It will be essential to ensure, whenever possible, any research undertaken is relevant to the requirements of current and future projects in the biogeographic regions.

Existing institutions such as TAFE, universities and government departments, which have skilled scientific staff and much of the requisite infrastructure, would undertake a significant part of any requisite research. It will be essential to ensure that the research focuses on suitable species at a level of culture technology suited for local conditions and relevant production systems. The technical procedures that need to be developed are those that best fit the social and economic requirements of the respective communities.

Research, development, extension and technical support are considered in the section of this strategy dealing with biotechnical issues (section 4.3.3).

4.2.2 Regional Activities

Objectives and Strategic Targets

As one of the outcomes of this national strategy, it is anticipated that specific regional aquaculture development activities will be encouraged and facilitated. In consultation with the proposed ATSIC Aquaculture Unit, the national steering committee proposed in this document would provide sets of specific, attainable objectives for each region in consultation with regional aquaculture development committees and the relevant state and territory departments covered by the region. It is anticipated that these regional activities would deal with aquaculture development at a community level. The objectives and targets of the regional committee would include the identification and evaluation of aquaculture-oriented resources and the most suitable sites, species and production systems in respect of specific, defined projects. As new projects are identified and formulated, the regional committees could draw on the expertise available from the regionally based extension officer and the relevant state departments. If required, the ATSIC Aquaculture Unit will be ask to provide specialist advice before proceeding with funding applications.

Identification and Evaluation of Resources

This document provides a broad overview and assessment of regional resources suitable for aquaculture in relevant sections of chapter three. It also discusses the species and production systems considered most suitable for each of the identified biogeographic regions.

Future regional work in this regard should focus more on the local level, by providing more detailed information about natural resources of the regions relevant to aquaculture at a local level and an analysis of any existing aquaculture projects, including their progress and constraints to future development. This work should constitute a more detailed inventory of local and regional resources than provided in the national strategy and collate relevant, existing information. Together with the information provided in this national strategy, the work would provide an opportunity to identify any gaps in knowledge or information that may exist and so help identify the type of research and development programmes needed to support industry development and growth among communities interested in developing aquaculture. This work should be carried out on an ongoing basis by the working group or committee in each of the identified biogeographic regions; where necessary, the proposed ATSIC Aquaculture Unit could be invited to attend some of the meetings.

The information compiled in this future work should be focused, relevant and contain sufficient detail to properly identify the aquaculture projects that have the greatest chance for success. Separate sets of resource information should be compiled for each of the major regions in the country.

Supply and Demand Factors

Supply and demand factors refer mainly to the markets for and marketing of cultured aquatic products.[7] These factors operate for products destined either for use by the community as food or for sale to domestic and export markets.

The demand for cultured fish and other aquatic products to satisfy the nutritional requirements of communities will be comparatively simple to estimate; that for products in domestic and export markets will have to be assessed separately and more broadly. Projections of supply and output will be more difficult to estimate at this early stage of industry development, particularly in view of changing costs and improving technologies. However, an early

[7] Although it can be argued that marketing products grown for sale in domestic and export markets is more a national activity, these factors relate directly to the selection of species and hence, in this study, is considered a regional issue.

assessment of supply and demand would be necessary to enable some direction to be provided in respect of the development of the industry sector. A large amount of information in this respect already exists and can be compiled relatively easily. The national and international agencies that undertake these activities and can provide information include:

- Fisheries agencies in Australian states and territories;
- the Australian Bureau of Agricultural and Resource Economics (Canberra, ACT);
- Infofish International (Kuala Lumpur, Malaysia); and
- the Food and Agriculture Organisation of the United Nations Organisation (Rome, Italy).

Identification of Projects

It is not an objective of the national strategy to identify or recommend specific aquaculture development projects. This task should be undertaken during the later derivation of more detailed regional development strategies.

Three main types of project may be considered for various areas or communities within each biogeographic region: pre-project assessment, pilot and production, with pilot projects often also serving as demonstration facilities. Any aquaculture project needs to proceed through a logical sequence of steps in its identification, preparation and implementation. A standard project selection and evaluation procedure is essential for this process, to ensure that the initiation of each successive step is dependent upon the successful outcome of the preceding ones.

Project Monitoring and Reporting

A possible obstacle to development encountered during this study was the difficulty of identifying previous, failed projects and the reasons for the failures. These gaps in information need to be filled, so strategies can be developed and implemented to monitor and report on existing successful and future projects. Unless projects can be monitored and reported on, it will be difficult to set and maintain the standards that are fundamental to success. Aquaculture projects developed in accordance with the national strategy should ideally be monitored and reported on according to a standard system, developed to provide, analyse and evaluate relevant information. This will be critical to ensure that requirements are identified and to provide effective management of project development.

4.3 Critical Factors and Development Strategies

The concept introduced by Nash (1995), that numerous critical factors can influence the implementation of specific aquaculture projects and the growth of the industry in general, applies equally to Indigenous aquaculture. However, while some of the critical factors for successful Indigenous aquaculture development are common to those elucidated by Nash, the development strategies proposed in this study are based predominantly on the critical factors defined during the consultation process. They can be divided into the following six main elements.

i. Industry development.
ii. Physical factors and the environment.
iii. Biotechnical factors.
iv. Commercial and legal factors.
v. Education and training.
vi. Social and cultural factors.

For the purpose of the national strategy, each of these elements focuses on and defines one or more principal activities.

4.3.1 Industry Development

To achieve the objectives of this strategy and implement its recommendations, a small steering committee, consisting of members from ATSIC, ATSIC elected arm, AFFA and, on a need basis invited experts from ILC, CDC, the industry and state fisheries, should be established. The duties of this 'Aquaculture Steering Committee' would include the provision of some oversight and co-ordination of activities as well as setting medium and long term strategic directions consistent with the recommendations provided by this study. It would also liaise at a high level with Commonwealth and state government agencies as required to implement this strategy and generally promote the development of Indigenous aquaculture.

The establishment of a specialised unit within ATSIC will be fundamental to the development of the Indigenous aquaculture industry. Among other skills, the proposed aquaculture unit would possesses the abilities and experience needed to evaluate preliminary applications and provide relevant, ongoing advice in respect of aquaculture development planning and practices. ATSIC should consider the establishment of such an aquaculture group that can perform these and other functions. This ATSIC Aquaculture Unit would have expertise to drive applications, act as a mentor where needed for funded projects and out-source services to consultants where appropriate. It will also provide relevant in-house advice to both ATSIC and Indigenous communities on an ongoing basis. The proposed Unit would also need to develop the expertise to assist Indigenous people deal with the marine and environmental issues relevant to aquaculture.

The need for a centrally-located ATSIC Aquaculture Unit to support regional offices is even more critical because ATSIC is presently undergoing dramatic restructuring in which regional offices are being given far greater autonomy.

Johnson *et al.* (1998) have developed a comprehensive scoping study dealing with the sustainable development of northern Australia. The study deals with issues affecting fisheries production and not specifically those affecting aquaculture; however, it does provides valuable information about the sustainable development of land and water resources in the area and considers the effectiveness of institutions and capacity of regional stakeholders to support the planning of the use and management of natural resources. The proposed ATSIC Aquaculture Unit should consider the study a useful resource and explore options that may exist to integrate the requirements of aquaculture development in northern Australia with the recommendations and proposals contained in the report.

For Indigenous communities, the growth and development of aquaculture may be initiated in a limited number of key centres or foci, then diffused from these key centres to other communities. This concept fits well with the MSH model described later (section 4.4.2).

There is a need for the establishment of joint agency forums to ensure continuing liaison, consistency and synchronisation of approach to aquaculture development in Indigenous communities. The proposed Aquaculture Steering Committee should be entrusted with this task. Given that many state and territory fisheries agencies have already undertaken significant work in this area, it is considered essential that these agencies are included as an integral part of this process. This might also include the forging of links with Regional Development Boards and the formation of strategic partnerships. Many regional development authorities located in different states and territories focus on the development of sustainable commercial and employment opportunities. Links need to be established with these bodies since they have the resources to provide relevant advice and information and have a commercial focus.

Consultation plays a critical role in Indigenous aquaculture development from two perspectives: a thorough consultation process needs to be carried out with communities in respect of the establishment of aquaculture projects in which they may or may not have an equity interest; and Indigenous people need to participate in the

planning processes. Johnson *et al*. (1998) have recognised that, generally, Indigenous communities are frequently asked to respond to development proposals from a poor resource and information base and usually only when the planning process is well advanced.

Each of the biogeographic regions defined in this study should be represented by a group or committee, comprising one person from each of the ATSIC regional councils (the elected arms) and a representative from the ATSIC regional office, to represent the views of Indigenous people at the community and local levels. These regional groups could co-opt regional based staff from state fisheries and other relevant departments, and from the proposed ATSIC Aquaculture Unit to attend meetings when critical aquaculture issues are discussed. In the event that ATSIC is not the only basis for local representation, the proposed committee should include one or more persons who can legitimately act for Indigenous people and communities. For example, for historical and political reasons, ATSIC is not an unchallenged representative of Indigenous people in Tasmania, where alternate organisations for community representation and advocacy exist.

The community level is where most organisations and resources are located, including community councils. Local traditional owner groups are the people who ultimately have a say over the uses to which different land and water areas may be put. A level of organisation is needed to ensure that traditional owners work together with the community and regional organisations and to ensure the consultation process is inclusive of all decision makers.

For Indigenous aquaculture to succeed, the participation of local communities in the planning and implementation processes is essential. Indigenous people are major stakeholders in Australia's coastal areas and, as such, have a legitimate interest in the management of these areas and the resources they contain. Indigenous communities should therefore participate meaningfully in decision-making processes related to these areas. The Commonwealth Coastal Policy (1995; cited in Sutherland, 1996) recognises that Indigenous people "... be recognised as participants in the coastal management process, [sic] and should be able to derive social, cultural and economic benefit from the use of coastal environments in which they have an interest". The importance of Indigenous people being empowered to participate in and influence processes that affect their lives and culture has also previously been emphasised (ATSIC, 1999).

Clearly, participation is important at both the initial decision-making stage and also during implementation of proposed projects. To ensure effective participation, mechanisms conducive to participation in decision-making and benefit-sharing need to be established. These mechanisms can include co-operative organisations and representative groups.

Some of the bureaucratic processes involved with regulating aquaculture are seen by some stakeholders as an impediment to the growth of Indigenous aquaculture. These processes mainly include the length of time it has taken for various licences and permits to be assessed and issued and the scarcity of relevant information reaching the communities about matters such as suitable sites and species for aquaculture. It would be advantageous for a review of government activities and decision-making processes to be undertaken to identify these perceived impediments and determine whether and how the efficiencies of the various processes can be improved. The decision-making process needs to consider issues such as:

- the area available within the estate of a community, clan or family to provide for the needs of aquaculture, taking other uses into account;
- the suitability of the proposed aquaculture project to a particular area owned by a particular group and the involvement in the project by other community groups;
- the downstream effects of aquaculture on the country of other people and how the issue of waste products is dealt with;

- the structure and function of co-operatives that may be developed to undertake aquaculture; and
- ensuring an equitable share of projects by those individuals and communities who wish to participate in aquaculture.

4.3.2 Physical Factors and the Environment

In respect of physical and biological resources, the extensive, semi-intensive and intensive aquaculture of suitable species of finfishes and shellfishes (the latter category includes all aquatic crustaceans and molluscs) has excellent potential to satisfy the social and economic requirements of Indigenous communities in Australia, to generate either food, income or both. Many communities are well placed to become significant producers: they have abundant natural resources and, for some species, access to good technology.

The identification and assessment of sites suitable for aquaculture will be an important issue in the future. Resource information necessary for this undertaking should be compiled and a register produced of sites suitable for development. The physical and biological features of an area being considered for aquaculture should be clearly identified and evaluated in respect of any commercial and competitive advantages they may confer on the proposed venture. Because the proper identification of specific sites is a large and expensive undertaking, this activity should be developed rationally, over the long term and focus predominantly on areas in which Indigenous people have expressed strong interest in aquaculture development. Aquaculture site identification could be undertaken as part of the development of strategic plans developed for specific areas within the biogeographic regions.

A reasonably high level of concern was expressed about the potential for aquaculture to impact on the natural environment and sites with cultural significance. In many cases, these concerns were considered unwarranted due to the existing licensing procedures in respect of environmental protection already in place in many, if not all, states and territories. It is possible, however, that provision needs to be made for areas of special cultural significance that may require a greater level of protection than that required by existing legislation. It could be argued that there might be no need for specific legislation for development that takes place on Indigenous land; however, there is a desire by Indigenous people to have a high level of protection in aquaculture industry development. This is also consistent with the principles of the Environment Policy of ATSIC, which specifically include sustainability and conservation (Sutherland, 1996).

As part of the process for Indigenous communities who would be directly involved in aquaculture development, it will be necessary to ensure that planners, both government and private organisations that may be entering into partnerships with Indigenous people, are aware of environmental and cultural concerns and ensure that appropriate methods are employed to eliminate or mitigate any adverse effects of the proposed project. Emphasis should be placed on risk management strategies, proper management to minimise pollution and the integration into the production system of efficient water treatment equipment and processes.

Given the importance of the sites with cultural significance and the environment to Indigenous people and their aspirations in that regard, the rule-of-thumb for their management should be: *do more than is required and less than is permitted*.

A positive environmental attribute of aquaculture is the ability of the industry to restock depleted fisheries. The means whereby this practice can be best exploited should be explored. A good example is provided by the Broome MSH described later, which has as its main initial objective the restocking of depleted Kimberley reefs with trochus and other reef species, which can be later harvested as part of the traditional wild-capture fishery. In the case of joint ventures, restocking depleted fisheries could form a beneficial and attractive part of an arrangement.

It should be noted that restocking is not always the panacea it seems for depleted fisheries and establishing aquaculture. Sophisticated culture systems are often needed to produce the requisite seed stock and structured release programmes have to be devised, implemented and monitored. The returns in respect of food production and social and economic benefits need to be systematically evaluated.

4.3.3 Biotechnical Factors

Biotechnical issues can be classified according to four main areas:

- selection of suitable species;
- selection of suitable production systems;
- adaptation and application of technology developed for existing and new aquaculture candidate species; and
- extension of research and development results.

Species and Production Systems

Generally, the culture species and production system selected for Indigenous aquaculture in any of the identified regions should be compatible with the physical and environmental conditions of the site and the social and financial requirements of the community.

The species considered most suitable for any particular region or community will vary according to several factors, which include the biological features of the culture site, the biological and other attributes of the species, availability of the requisite culture technology and various marketing factors. Generally, species selected for culture by communities living in more remote areas should yield non-perishable products (as is the case with trochus shell), be hardy (as are several other reef molluscs) or have a high market value, to mitigate the likely-high costs of processing, storage and transportation.

There is a relatively high degree of endemism among Australian aquatic species. This feature of the biota may represent a competitive advantage in the market place that can be exploited. Further, the marketing of selected, high-value aquaculture products grown by Indigenous people may have significant appeal under an appropriate brand name developed for that purpose. Opportunities should be explored for developing a branding image for Indigenous aquaculture products as healthy and natural native foods, which may increase their market appeal and value.

Appendix 1 provides details about and explains the selection criteria that should be considered when evaluating any aquatic species for commercial aquaculture. Appendix 2 provides brief synopses about many of the species presently cultured, or contemplated for aquaculture, around Australia, including marketing features, culture technology, production efficiency and commercial viability.

The production system considered most suitable for different communities will be governed by factors that include the location of the culture site, the availability of necessary infrastructure and services and the availability of the requisite labour. Each proposed Indigenous aquaculture project needs to determine, for the selected species, at the chosen site, the production system that will deliver the maximum control over the culture environment, the maximum efficiency, and the lowest cost of production. The selection and evaluation of aquaculture production systems requires consideration of: location, water type, culture units, water flow, intensity, production capability, scale and integration. Appendix 1 provides information about the various production systems used in modern aquaculture, as well as procedures used when selecting and evaluating suitable sites.

Important components of Indigenous aquaculture planning include the existence of suitable culture technologies and the ability to adapt the technologies to suit local conditions. Problems associated with many aquaculture operations tend to be site-specific, so even well-established technologies will need to be adapted or modified for local applications and tested to ascertain their commercial viability. Further, the type of culture technology and production system for a particular application might vary according to whether the project is managed as a joint venture with experienced industry participants or as a wholly-owned and operated Indigenous operation.

Research, Development and Extension

Many state and territory government agencies are actively undertaking research programmes in aquaculture, in areas such as culture technology for selected species, nutrition and diets and environmental management. It would be advantageous to determine which of the species being developed would be suitable for Indigenous aquaculture.

On a national scale, it will also be important to establish integrated research and development programmes to continue to improve culture and production technologies relevant to Indigenous aquaculture. In Indigenous aquaculture, there is a clear need for a range of technologies to be made available that accommodate the requirements of remote communities in particular. This research and development ("R&D") should also be linked to the type of education and training used for contemporary as well as modified technology. A key issue will be the adaptation of culture technologies to suit the conditions under which Indigenous communities will be undertaking aquaculture. Universities and specialised research institutes, the major sources of research staff should be encouraged to undertake R&D on the adaptation of technologies for Indigenous aquaculture.

Wherever possible, the development of technology should take place with the active participation of Indigenous people. This will help ensure the technology being developed is, in fact, appropriate, rather than it being declared as such by an academic. Indigenous people can contribute by ensuring account is taken of all the relevant cultural issues. Inherent advantages of participation at this level include the training and experience that would thus be gained by Indigenous participants and the increased level of propriety over, and pride in, the system or technology.

Once developed, the technology will have to be transferred to communities. It will be critical to determine an effective means of achieving this technology transfer. In many cases, it is insufficient simply to demonstrate certain activities and procedures. The ideal solution would be for interested community members to work in a 'demonstration farm' to gain hands on experience followed by the provision for a suitably-qualified, trained person to work on the project for a period of at least several months or, preferably, through at least one culture cycle, to ensure the requisite skills are learned. Following this technology transfer, it will be important that communities can call on someone who can provide mentoring and troubleshooting services. These services would be best managed and co-ordinated by the proposed ATSIC Aquaculture Unit. It is anticipated that the extension of technologies to communities will be facilitated principally by extension staff employed by government departments but in time, ATSIC might also have regional extension staff. Suitable extension structures staffed with appropriate numbers of adequately-trained and skilled people will need to be built up. Extension officers will need to be well-trained technicians with the necessary practical experience and proficiency in extension methods.

4.3.4 Commercial and Legal Factors

In respect of aquaculture, many Indigenous people have generally faced several difficulties. In commercial terms, few individuals or communities have access to the capital needed to start up projects, nor do they have links or established relationships with the main players in the industry. If they are to participate in the development of the aquaculture industry and realise their commercial goals and ambitions, Indigenous people need to develop strategies to overcome these barriers. This goal can best be achieved by the establishment of a national business

network for Indigenous aquaculture. It is anticipated that such an aquaculture business network would provide information about key programmes and services offered by the Commonwealth, state and local governments as well as the private sector. The programmes and services referred to would include business advice and planning, training, finance, marketing, mentoring and networking. Good examples of these business networks is provided in *Doing Business: A Policy for Building up the Koori Business Sector* (Koori Business Network, 1999a) and *Open for Business: experiences of Koori business people in Victoria* (Koori Business Network, 1999b). Similarly, an initiative in the Cape York region proposes the establishment of an Indigenous Business Institute.

Indigenous people can enter into aquaculture either by way of joint ventures or other commercial arrangement with existing, established aquaculture companies or in their own right, by raising the requisite capital funding.

Entry into the aquaculture industry by way of joint venture or other equity arrangement requires consideration of what each party in the venture brings to it. Most aquaculture development requires high capital input. In the case of some Indigenous groups, a contribution to a commercial venture would be land and water resources, which should be seen as a significant asset. The fact that much Indigenous land is held under inalienable title has often been taken to mean that it cannot be used to raise capital. Recent analysis from the United States of America and Canada suggests that this need not necessarily be the case (Indigenous Land Corporation, pers. comm.). The unchargeability of inalienable land has been taken to be a fact in Australia to date and the matter has largely been untested. Native land in the USA and Canada is also inalienable but this has not prevented banks there from making loans to native communities. In order to realise the development potential of Indigenous land, it will be necessary for Australian banks and financial houses to become less asset-oriented and move to more creative finance provision models. Access to capital for many Indigenous communities is difficult and often compounded by the perceived complexity of the industry, high failure rates and a lack of appropriate technical input, advice and assessment capability. Where the appropriate planning and assessment is conducted it is essential that there is a co-ordinated and commercially responsive approach to the provision of capital whether it be from Indigenous, commercial or other sources. Support and facilitation of networks to enable linkages and potential joint venture arrangements is required to optimise technical, financial, managerial, and physical resources use.

To stimulate aquaculture development by way of partnerships, it will be critical to increase the national awareness of the potential for joint, mutually beneficial relationships. A framework needs to be established for creating links between Indigenous and other people in this regard. It is considered that, for most cases, the principal factor that could lead to mutually-beneficial, commercial relationships being established is the fact that many communities have access to or own large areas with potential for aquaculture. Other parties may have the expertise and capital. To ensure relationships are fair and reasonable in equity terms, this framework may set down acceptable cultural requirements, commercial standards and protocols.

To identify joint venture and similar commercial opportunities, it may be appropriate for a register of equity partners to be established. Relevant state and territory government development departments and industry organisations could act as brokers in identifying partners by way of joint venture, venture capital or other suitable means. Entering into joint ventures with established business partners has been recognised as a means of enabling Indigenous people to participate in the economic benefits from the commercial utilisation of species (Altman *et al.*, 1997).

It has to be recognised that, to funding bodies, aquaculture is considered a high-risk industry. Accordingly, any feasibility studies and business plans must deal thoroughly with risk analysis and management. The information provided earlier in this study concerning success and failure factors associated with aquaculture projects provide useful means of conducting a comprehensive risk assessment.

One way of Indigenous communities becoming involved in commercial aquaculture is to take advantage of the existing CDEP programme by using it as a business incubator. This is a legitimate use of the CDEP, which has been identified as a tool that should be used for economic development, rather than an end in itself (Department of Employment, Education, Training and Youth Affairs, 1998). The CDEP work force, with a small top-up in salary where possible, provides an opportunity to develop an enterprise to a viable proposition over several years, while the labour costs of project are effectively being subsidised. This scheme would undoubtedly be an added incentive to potential joint venture partners. This strategy would need to be associated with a suitable exit strategy; that is, some means of separating projects from the funding once they become commercially viable in their own right.

The approach to development taken by the Tasmanian Investment Corporation (TIC), which is made up of eight Aboriginal organisations, may be seen as a development model that works. Among other things, the TIC ensures that much of the revenue generated from its projects are re-invested, thereby ensuring growth. If income can be generated from the CDEP programme, it is used to supplement wages.

The supply of seed stock, which is fundamental to successful aquaculture, is dealt with in the relevant section above. The supply of other inputs such as feed and equipment can be equally critical. It may be useful to consider the establishment of a co-ordinated supply network to provide small operators with the buying power normally enjoyed by large producers.

A recent study to identify business opportunities for Indigenous people in several industries including aquaculture was recently undertaken for the Eyre Peninsula region of South Australia (Brain Henson and Associates, 1999). The document provides a useful outline of and explains some of the prerequisites for entering into several existing industries. It would be valuable for the proposed ATSIC Aquaculture Unit to consider the preparation of a more detailed document, which deals specifically with Indigenous aquaculture, the impediments faced by Indigenous people seeking to enter the industry and proposed means to overcome the identified impediments.

Legislation regulating aquaculture development in most states and territories presently involves an extensive public consultation and review process, to which all proposed aquaculture projects are subject. It would be impractical to propose the derivation of separate regulations to accommodate the requirements of Indigenous aquaculture development, as has been espoused in some of the submissions received during the course of this study. Rather, it is proposed that existing legislation affecting Indigenous aquaculture development in each of the regions be identified and each of the regulations considered onerous to Indigenous groups highlighted. A strategy can then be developed to deal with these identified issues and overcome the difficulties.

Indigenous people frequently have knowledge of species and ecosystems occurring in their traditional areas and there is also some evidence of traditional forms of extensive, low-input aquaculture having existed in some communities. The usefulness of this traditional knowledge is probably limited to food production or subsistence-level aquaculture. It is considered unlikely that such traditional knowledge would be applicable to contemporary, commercial aquaculture and, as such, is unlikely to constitute intellectual property with a commercial value. ATSIC and the Department of Primary Industries and Energy (1997) recognise that the traditional skills associated with the construction of enclosures and other structures to hold fish have largely been lost.

From a legislation perspective, suitable legal frameworks are already in place in all states and territories for the orderly, regulated development of aquaculture projects. An issue that may need clarification is the ability of traditional land owners to use Indigenous land held under inalienable title to raise capital for aquaculture development.

4.3.5 Education and Training

The development of human resources will constitute an essential component in the development of Indigenous aquaculture, since the availability of people with hands-on experience will be fundamental to commercial success. Traditionally, skills in Indigenous communities have been passed on from the elder to the younger people; however, in contemporary, rapid-development programmes, it may not be feasible to follow this practice and organised, institutionalised training will be needed for training farm managers and technicians.

Training can be provided in structured courses offered by institutions such as TAFE Colleges and universities, and in on-farm traineeships. The MSH is a good example where both are provided. It would be appropriate to consider the establishment of a dedicated, nationally accredited Indigenous training course based on currently available and accredited National Seafood modules. Such a course would cater for the special needs of Indigenous people. When contemplating training needs, the sometimes-low level of literacy and numeracy among Indigenous people must be taken into account. This is particularly true for target groups living in more remote areas, for whom hands-on field work should form an important component of training. The advocation of training in existing workplaces would clearly be limited in areas where there is no industry so, under these circumstances, provision needs to be made for training opportunities where there is a workplace and an industry.

Indigenous people who may wish to undergo some form of formal training should be able to select a career path from prospectuses that outline existing education and training opportunities that exist at the various TAFE Colleges and Universities in the country. A brief document should be written that clearly explains what exists in this regard and how interested people can obtain and use the information. The document should also elaborate on any employment opportunities that exist where the person could apply and develop his or her skills.

Opportunities to develop aquaculture projects should as far as possible be linked with training, to allow the development of the skills needed by people in the communities to actively participate in and manage aquaculture projects.

Training for Indigenous aquaculture can be divided into two distinct but inter-related issues. The first is the hands-on, practical training that should be a component of the more formal training courses offered by TAFE Colleges. The second involves job placement.

Hands-on, practical training can take the form of traineeships, structured to allow the student to partly work in the field and partly undergo training in a formal training institution. Traineeships need to be established that take into account the requirements of Indigenous people. These skills-based traineeships could be developed through links with the existing industry or through aquaculture projects being developed by Indigenous communities.

The lack of practical training required by many Indigenous people interested in taking up aquaculture is linked to the lack of successful Indigenous projects. Clearly, there is little point in providing training programmes if there exist no projects on which trained people can work to develop their skills. From a long-term perspective, one of the best ways of increasing the skills available to remote communities would be to facilitate the placement of trained, young Indigenous people in existing aquaculture projects, where they could practise and further develop. An important component of a national strategy is therefore to assist in placing trained Indigenous people in a working environment. The work place can include community-based projects as well as employment in the aquaculture industry, with the emphasis on the latter. These skilled people would then be better placed to work in community projects.

It is worth noting that some aquaculture training is already being provided, or is planned, to Indigenous people. Examples include pearl oyster farms in Western Australia, edible oyster farms in Tasmania and South Australia and a planned barramundi farming operation in the Northern Territory.

Where appropriate, through the development process aquaculture skills should be built in communities in conjunction with existing wild fishery requirements. For example, areas in which communities could take tropical rock lobster from the wild-capture fishery could establish onshore tank systems to hold the wild catch. The skills thus developed would provide some grounding in aquaculture.

4.3.6 Social and Cultural Factors

The suitability of aquaculture for the socio-economic development of many Indigenous communities and the compatibility of the industry with the conditions prevailing in the areas in which they live have already been stated. The provision of employment opportunities among remote communities is likely to be one of the most important driving forces for Indigenous aquaculture development. Smaller farms can also be more widely distributed and locally owned, allowing improved distribution of benefits among more widely-dispersed communities. Because smaller-scale aquaculture projects usually provide more employment opportunities than larger farms, per unit of invested capital (Pillay, 1993), planning for aquaculture will need to take into account whether the main objective of any proposed venture is to create employment or develop commercial aquaculture.[8] Clearly, the size and production capability of any proposed projects the main purpose of which are to create employment, has to be adequate to generate the target income and conform to the minimum economic size of the particular production system.

It is likely that significant social benefits will ensue from the establishment of commercially-viable aquaculture projects in which Indigenous communities have a stake. Among other benefits, the opportunity to participate in, and in many cases control, successful aqua-businesses will provide the economic independence necessary to free communities from long-term unemployment and the social welfare system upon which many now depend. Many Indigenous people voiced the opinion that a sense of pride and control generated from commercially-viable businesses could play a major role in regenerating communities, building stronger relationships between communities and provide an important goal for younger people.

The proper consideration and accommodation of social and cultural matters will be critical to the success of Indigenous aquaculture, whether undertaken exclusively by Indigenous people or in partnership with other parties. Any proposed Indigenous aquaculture proposal should ensure adequate communication with community members and its council, traditional owners and any other affected parties. It would be appropriate to document a protocol that could be used as a guideline to ensure that all social and cultural matters are identified and dealt with as required and to the satisfaction of all stakeholders.

It would be valuable for non-Indigenous individuals or organisations contemplating entering into a commercial aquaculture project involving Indigenous people to have information relating to doing business with these communities, particularly if these organisations have no previous, relevant experience. Publications such as Doing Business with Aboriginal Communities: Political Realities and Commercial Opportunities (cite reference) provides pertinent information. The proposed ATSIC Aquaculture Unit should be responsible for the compilation of a similar document that provides an outline of how to do business and develop projects with Indigenous communities, with specific reference to aquaculture. This document would include reference to the key areas of

[8] Within the context of this study, the term commercial or industrial aquaculture is used to describe large-scale, intensive aquaculture operations developed and designed to meet substantial domestic and export market demands. These industrial aquaculture operations are almost invariably characterised by high levels of management and technology and high capital and operating expenditure. An example of industrial aquaculture is the proposed barramundi farming operation in the Northern Territory described in section 4.4.2.

native title, business experience, training, employment opportunities, community attitudes and access to finance and capital. A proposed large-scale barramundi farming industry in the Northern Territory provides a good example of how a joint venture between an Indigenous community and a major Australian feed company with interests in aquaculture can be established. In this instance, the company was able to negotiate for the native title claim to be removed from the site at which the proposed farm was to be located, in return for providing benefits to the communities by way of rent payments, employment, training and, at a later stage, support to the Indigenous people in the development of their own barramundi farm. This low risk approach is a great incentive for the Indigenous people to get involved in an aquaculture project. The advantages of this arrangement to the proponent are that it:

- removes the uncertainty of the native title issue from the project;
- paves the way for free-holding the land and allows a clearer path for bank financing; and
- allows long term planning and development of the project.

4.4 Aquaculture Development Principles and Models

4.4.1 Basic Principles for the Development of Indigenous Aquaculture Projects

The principles elucidated in this section constitute a synopsis of the information generated during the study in respect of the most realistic and practicable means of developing an Indigenous aquaculture project. They are also consistent with the general principles adopted by the WA State Government in planning for Aboriginal economic development (Anon, 1997). They can be used as step-by-step guidelines for Indigenous and non-Indigenous people involved in the planning and development of commercial aquaculture projects.

ATSIC has appointed a business agent in each state and territory to provide advice to the agency. These ATSIC-appointed business agents would be involved in the appraisal, funding and support of any Indigenous aquaculture project seeking ATSIC funding. The business agent would normally be involved in a project at the project Appraisal Phase. It provides professional services that include co-ordination with borrowers, business planners and other involved parties. It would also conduct necessary interviews, undertake evaluations and assessments and make recommendations to ATSIC. The proposed ATSIC Aquaculture Unit will be interacting closely with the business agents in carrying out many of the above functions.

The planning and implementation of Indigenous aquaculture projects can be divided into two main stages, viz. project formulation and implementation, each comprising a number of steps.[9]

Project formulation involves:

- initial consultation and planning;
- identification;
- preparation; and
- appraisal.

Project implementation involves:

- implementation; and
- evaluation.

[9] The proposed steps for the planning and implementation of Indigenous aquaculture projects is modified from the aquaculture project cycle initially described by Shang (1990) and Makaira *et al*. (1997) and used by Lee (1998) for the development of a southern bluefin tuna aquaculture industry in Australia. By adding elements that cater for some features unique to Indigenous Australians, it is considered an appropriate model for the development of Indigenous aquaculture.

These steps are discussed in respect of Indigenous aquaculture project development, then summarised in table four.

Initial Consultation and Planning

The initial consultation and planning step starts with an idea formed by a person or group of people about how certain resources may be utilised for aquaculture. Initial consultation between indigenous proponents and planning are critical for the success of any aquaculture project involving Indigenous people. This applies equally for a non-Indigenous group considering entering into aquaculture in partnership with Indigenous people and for Indigenous people entering into aquaculture independently.

The initial planning and consultation process needs to take into account all the issues identified in this study as critical for success. The key elements of this process are considered as follows.

- Level of interest.
  To be successful, aquaculture projects need to be developed in response to existing interest by Indigenous communities to be involved. The level of participation by Indigenous people in the preliminary project proposal needs to be taken into account.
- Consultation with Indigenous participation.
  Indigenous individuals, families, elders, communities and the elected community council need to be consulted at the beginning of the planning process to ensure the needs of the community are identified and met. They should consider matters such as social and business values, and preferred forms of ownership or joint ownership and management of any proposed ventures.
- Planning.[10]
  Indigenous people need to be fully involved in the planning process from its inception. The planning process needs to take into account issues such as the level of participation in the project, training, employment opportunities, the impact of the proposed venture on the social and cultural needs of the community and potential environment impacts if any. The planning process should identify one or more key Indigenous people or "champions" who would drive the project. Project development may take up to two years or more before funding is approved and the project commenced. Without these "chanpions', success is unlikely to be achieved.
- Recognition of unique circumstances.
  This element needs to take into account the location of the Indigenous community involved in the project, its specific circumstances and aspirations and the particular interests of individuals.
- Practical support programmes.
  Practical support programmes need to be planned from the beginning of the planning stage to ensure the education, training and extension requirements of Indigenous individuals participating in the project will be met.

Identification

The project identification step builds on and advances the aquaculture project beyond the initial concept. This step involves the preparation of a schedule or programme that clearly defines the work necessary for the

[10] In this context, the term *planning* is used to describe the initial planning of the project with specific reference to the requirements of its Indigenous participants. It therefore considers issues such as social and cultural factors as opposed to the planning and design of particular physical projects components. The latter factors are considered in the *Preparation* part of the overall planning process.

identification, preparation and appraisal of the project and assigns responsibilities. The main outcome of this step is the preparation of a preliminary feasibility study, which:

- identifies the main participants in the project, its proposed organisational and management structure;
- identifies the precise location of the site, based on detailed site selection investigations, and the results of any bioeconomic modelling work that may have been carried out;
- identifies the main activities of the project, including product identification and the selection of suitable candidate species and production systems;
- provides preliminary financial projections, including an outline of capital and operating costs and anticipated returns; and
- provides an assessment of risks and contingency planning.

A decision to proceed to the next step, viz. project preparation, is then made according to the findings of the preliminary feasibility study.

Preparation

Preparation is the more formal stage of project formulation. Its objective is to produce a detailed feasibility study, including a business plan, which documents a full description of the project, its anticipated outcomes and an assessment of its likely impacts on the environment and other areas. The essential components of the study and business plan include:

- a precise outline of project structure, ownership and management arrangements;
- a definition of project objectives and products;
- results of detailed site investigations and other studies commissioned earlier;
- an overview of operations including technical procedures, selected species, culture technologies, production systems and infrastructure;
- the design of individual project components;
- sales and marketing information;
- determination of the social and cultural effects of the proposed project;
- determination of the environmental effects of the proposed project; and
- a detailed analysis of financial feasibility, including various projected or pro-forma financial statements such as profit-and-loss statements, cash flow analyses and balance sheets.

The planning and design of any proposed Indigenous aquaculture projects need careful integration of biological and technical information and engineering skills. All planning and design criteria should be properly documented to ensure the objectives are properly understood by all parties, within the budget and continued smoothly in the event of any delays or postponements.

The above consultation and preliminary planning processes should be carried out in consultation with and the support of the local ATSIC project officer, the local state or territory aquaculture officer and other relevant supporting agencies. If needed, the local ATSIC business agent may be involved in providing preliminary advice.

Before sending the project for appraisal, the proponent may wish to consult the proposed ATSIC Aquaculture Unit, which could provide preliminary feedback in respect of the viability of the project, advice about the application and its structure and recommendations about how the project and the application might be improved.

Appraisal

The detailed feasibility study document and business plan are then appraised by the ATSIC business agent and the project either accepted as is, accepted subject to certain amendments or changes or rejected. If accepted without any changes being necessary, the project may then be considered ready for implementation under proper management and with the necessary financial commitments. If some variations or modifications are required, these can be made and the study re-submitted for appraisal.

Implementation

The project implementation step involves recruitment, engineering, construction, procurement and the start of operations. For a project similar in size to the proposed MSH, it will be necessary to appoint a Project manager to manage the design and supervise the construction of the complex proposed for the project.

- Recruitment.
  Involving the recruitment of management and technical staff required to operate the facility, this process begins with the establishment of a recruitment schedule. A project management office should be established and, if any specialist consultants are needed, they are appointed during this stage.
- Engineering.
  Engineering input varies according to the size of the project. It usually involves some final site studies and topographic surveys. The key tasks involve the preparation of detailed engineering drawings for all the elements of the project, including buildings, pumps and pump stations, water delivery and discharge systems, air delivery systems, general pipe work and infrastructure. Tender documents are then prepared.
- Construction and procurement.
  Tenders received from selected companies or contractors are assessed and the necessary contracts issued to the selected tenderer. Construction then proceeds under suitable supervision by project leaders. Construction is usually staged to allow operations to begin as early as possible (for example, facilities to hold broodstock would be scheduled for completion as early as practicable). Equipment and supply lists are prepared and competitive prices sought. Equipment and other items are purchased and suppliers of consumable items selected.
- Start of operations.
  Aquaculture operations start when the facilities are commissioned and all equipment and systems tested. A period in the operations schedule should be allowed to identify and solve start-up or teething problems that may be experienced. After this period, operations would proceed until the full design capacity is reached and the defined minimum performance standards achieved.

Evaluation

At specified times during the life of a project, it should be evaluated and a decision made to continue it, follow it up by expansion, or integrate it with work on other species. If few or none of the objectives have been met, a decision may be made to terminate the project.

A successful project may require planning for some form of growth to ensure its success continues. In this case, the cycle of project development may be re-instituted by formulating a new project or expanding the objectives or capabilities of the original one.

Summary of Project Development Stages

Table 4 provides a summary of the project development stages discussed above.

Table 4. Stages and steps proposed for the development of Indigenous aquaculture projects.

Project development stage		Principal tasks and results	Responsible agencies
Project formulation	Initial consultation and planning	Determination of level of interest, consultation with Indigenous communities and individuals, Indigenous participation in project, planning, recognition of unique circumstances and development of support programmes.	Regional aquaculture working group (WG) and the local "champion", ATSIC project officer and other state agencies
	Identification	Prepare a work schedule for the identification, preparation and appraisal of the proposed project. Produce a preliminary feasibility study.	- Ditto -
	Preparation	Undertake detailed investigations, design of the project and preparation of a detailed feasibility study.	WG, ATSIC regional office and the appointed consultant
	Appraisal	Acceptance of the project or its modification in some way. At this point a decision is made whether to proceed to implement the project.	ATSIC and the ATSIC business agent and the Aquaculture Unit where appropriate
Project implementation	Implementation	Recruitment of staff, detailed engineering design, construction of facilities and procurement of equipment. Start of operations and confirmation that identified minimum performance standards have been met.	WG, appointed staff and Indigenous community representatives
	Evaluation	Ongoing evaluation of the project. Consideration and evaluation of project expansion.	Aquaculture Unit, ATSIC business agent and where need, the Aquaculture Steering Committee

4.4.2 A Development Model: the Multi-Species Hatchery

Almost invariably, aquaculture projects require hatchery-produced seed stock for growout. The few exceptions include species such as mussels, the seed stock for which are acquired through setting collectors or other structures on which wild seed can settle. Hatcheries can be expensive to establish and, particularly if they are required to culture a range of species, usually need a high level of technology. Conceptually, a single hatchery with the ability to produce mass quantities of seed stock for several target species could service the seed requirements for numerous aquaculture projects throughout a very large region. This concept is the basis of a multi-species hatchery ("MSH"), which at the time of writing is under construction near Broome, in the Kimberley region of Western Australia.

The MSH project was initiated to drive the funding and training needs of Indigenous people in the Kimberley who are interested in aquaculture, thereby opening up economic opportunities that would be difficult, if not impossible, for a stand-alone, community-based venture to achieve. The MSH is being driven by the Kimberley Aquaculture Aboriginal Corporation ("KAAC"), a community-based organisation involving representatives from three separate ATSIC regional councils covering the Kimberley region. This co-operative approach allowed the collective resources of the region to be pooled: an agreement was made by KAAC that individual communities

would not lodge funding applications for a period, but rather lodge a single application for the sum required to fund an MSH. This project has succeeded in bringing together communities at a regional level and accelerated interactions and co-operation between agencies at national and state levels. It was able to receive funding from the Commonwealth and WA State government to support its project.

The MSH will achieve more than producing a guaranteed seed supply for selected aquaculture species. When fully developed, it will also provide training and support and thereby help open up economic opportunities that would normally not be achievable for stand-alone projects. In addition to its core activities, the MSH will provide commercial opportunities for local people to generate additional revenue from tourism and other vertically integraded activities such as manufacturing (of mother of pearl buttons) and exporting.

An essential prerequisite for any aquaculture venture is a reliable source of mass quantities of seed stock. By guaranteeing the supply of seed from a hatchery, community-based projects would have the best chance of succeeding. While an MSH could have a variety of purposes, seed production is invariably its key function.

Key elements of the MSH model include:

- the project being driven by, and with participation from, communities;
- co-operation and communication between communities;
- demonstration of the commitment over a period;
- identification and agreement of the requirements of the communities;
- demonstration of widespread regional benefits;
- establishment of proper commercial structures and business entities.

There are many instances where conflict between and within communities have led to the development of individual, family-oriented projects being favoured over community projects. The MSH concept has been shown to be one that brings communities together to work towards a common goal, despite differences that may persist.

KAAC is a non-profit organisation collectively owned by participating communities and membership to which is open to all Indigenous communities and individuals in the Kimberley with an interest in aquaculture. The KAAC owns the MSH, which is considered a resource that belongs to all the participating communities. KAAC will lease the MSH to an independent propriety limited company, which will operate it under the control of a board of management. This management structure has been adopted to ensure that the MSH can be operated independently without any direct intervention by individuals or communities. The management process is a democratic one: KAAC has ownership of MSH but no control over how its daily business is run. MSH elects its own Board of Management to manage its activities. Indigenous communities would have the ability to influence and direct the outcomes they wish to achieve through representation and election to the board of the company.

Profits generated by the activities of the MSH may be distributed between the communities via KAAC or invested in the development of new projects. Aquaculture licences to grow out the seed stock provided by the MSH are applied for and issued to individual families, who can then conduct their independent business as they see fit.

Trochus has been identified as the first species to be produced by the MSH. It is anticipated that, once reseeded, the reefs will be managed so no further seeding will be required. At that time, the MSH will produce other species for sale and growout. For example, the MSH has been asked to produce seed stock of marine prawns for a planned large commercial prawn farm in the east Kimberley. Other candidate species include tropical abalone and KAAC has applied for an aquaculture licence to culture black pearl oysters.

For the concept to succeed, it is essential that a large number of people, representing disparate communities, agree on a single course of action, as has happened in the Kimberley for the Broome MSH. It also requires a supportive ATSIC state office that is innovative and prepared to work closely with other government agencies, especially Fisheries, to bring about the desired outcomes. From the communities, it is equally important to identify "champions" who will persevere and drive the concept through its planning and implementation stages. Experience has demonstrated that some people will invariably drop out of the process, but those that do often retain some interest and maintain contact.

One of the factors needed for the process to succeed is the establishment of a suitable consultative process, which enables the various proponents and other interested parties to meet at regular intervals. In areas such as the Northern Territory, such a consultative process already exists and this may facilitate the development of the concept.

The process developed for the Broome MSH could be applied to other regions in Australia. The MSH concept or model allows the resources of an entire region to be pooled into a single project, thereby increasing the likelihood of success. A critical factor is that, to succeed, the process has to be driven by the communities and several dedicated individuals. The MSH model can be used to establish similar, separate hatcheries in each of the biogeographic regions (Fig 9).

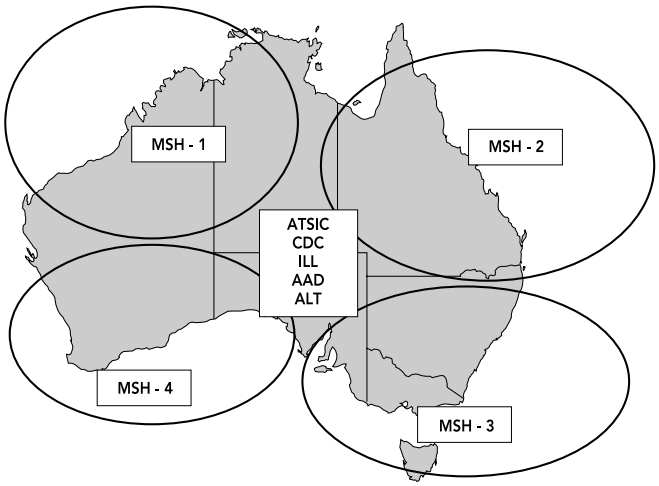

Figure 9
Conceptual Plan for national Indigenous aquaculture development

Ideally, however, there would be a large degree of co-operation and interaction between these hatcheries in areas such as training, technology development and R&D activities.

The MSH model provides one example of a co-operative development undertaken by different Indigenous communities. Another example of a co-operative development is provided by the Tasmanian Investment Corporation ("TIC"). The membership of TIC comprises locality-based Aboriginal groups (on Flinders and Cape Barren islands, greater Devonport and the west coast) and agencies that perform a state-wide function (Aboriginal Child Care, Housing and Women). TIC has achieved commercial growth with the assistance of bodies such as ATSIC and the Commercial Development Corporation. To achieve its objective of future economic independence, TIC has established a balanced investment portfolio that includes aquaculture, through a shareholding in Southern Cross Marine Culture, the largest Pacific oyster producer in Tasmania. The group also proposes to pursue marine aquaculture on Flinders Island. For its ventures, the TIC enters commercial joint ventures with existing operators who have proven skills and experience in the industry. While opportunities for employment and training are actively sought, the emphasis of the co-operative remains strongly commercially-focused.

4.4.3 Joint Venture

The aquaculture industry in many areas is characterised by rapidly-developing technological innovations, particularly for operations producing high-value species under semi-intensive and intensive conditions. Indigenous communities contemplating the culture of aquatic species that need advanced technology and high levels of management and production intensity could develop a project by way of a joint venture with a company that already possesses the requisite technical and management skills.

A joint venture or some other suitable commercial arrangement would usually be based on private money being invested to establish aquaculture projects that includes Indigenous interests. Opportunities to negotiate a joint venture include a part purchase, joint establishment and land-use agreements. Joint venture agreements can be negotiated that provide the required employment and training opportunities for members of the Indigenous community.[11]

The barramundi sea cage project currently being established in the Northern Territory provides an excellent example of a joint venture between a large commercial, company and Indigenous people. At Port Hurd, at Bathurst Island to the north of Darwin, the private company is planning to establish a barramundi aquaculture enterprise that could ultimately produce up to 10,000 tonnes of fish per year (Smith, 1999). The project will provide substantial benefits to the Tiwi people, the traditional owners of the area who are also participating in the project.

ATSIC considers joint venture the preferred model, since it makes provision and accounts for all the key elements considered important for Indigenous aquaculture, such as participation by Indigenous communities. Joint venture development permits the principal asset usually possessed by Indigenous communities, namely the land or water needed as sites for aquaculture, to be considered an asset that can be contributed to a joint venture in return for some equity participation. It also permits the participation of investors who would usually be expected to contribute the requisite funding, management and technical skills.

The proposed ATSIC Aquaculture Unit would play a leading role in collaboration with ATSIC's Business Agent in all the technical and commercial aspects leading up to and during the establishment of such a joint venture. The activities of these bodies would include due diligence and proper assessment and evaluation of the proposed project before any joint venture or other commercial relationship is entered into.

4.4.4 Managed Farm

As its name suggests, a managed farm is one established and managed on behalf of one or more owners or investors by an entity established for that purpose. Following the initial investment, farms are set up, staffed and operated by a company for a management fee, which comprises an agreed proportion of the revenue raised from the sale of product.

This is an innovative means of initiating aquaculture projects; however, it may be limited to specific cases. A company currently developing a managed farm has estimated an up-front investment in the order of $5 million, with no return on investment for three to four years (Eyre Regional Development Board, pers. comm.). Once established, the annual income from the managed farm has been estimated at close to $5 million. With operating costs running at about $2.1 million, this would result in an annual profit of about $2.9 million. If this profit was used to pay off debt, the proponents of this managed farm believe the operation would be debt-free by the seventh year of operations.

[11] The MSH and joint venture development models are not necessarily mutaully exclusive. For example, it would be reasonable to propose a development model based on an MSH established through a joint venture arrangement

It is emphasised that the above projections are for a specific project in a given location. Managed farms may present good development opportunities for Indigenous aquaculture, but the returns would vary significantly according to location, target species, production system and marketing factors and trends.

4.4.5 Demonstration Farm

Demonstration farms may present development opportunities by integrating community development and enterprise development. An example would be the establishment of commercial projects by joint government and commercial interests. Once the project reached the stage when it can survive without further assistance, other interests can relinquish their interests according to a previously-defined exit strategy, leaving the operation in the hands of Indigenous interests. This system has worked successfully in Chile.

Demonstration farms could be established with the support of state and federal governments to demonstrate the viability of selected aquaculture species and production systems relevant to Indigenous aquaculture. Such a facility would allow determinations to be made about projects that have the best chance of succeeding and determine what inputs are required. They would also provide a training base and encourage the formation of partnerships between different Indigenous communities and between Indigenous people and the aquaculture industry. Effectively, these demonstration facilities constitute aquaculture business incubators that present a solution to problems faced by Indigenous people who want to become involved in aquaculture but lack the requisite skills and resources. They are best established as dedicated, commercial businesses that also provide training.

On a smaller scale, a regional council may wish to establish a small demonstration farm for its communities to 'wet' their hands and exposed them to the nature and requirements of taking up aquaculture. Such a farm could be used as a training and resource centre and an economical means of educating the people who are serious about taking up aquaculture activities.

4.5 Sources of Funding and Assistance

Federal, state and territory government agencies have established various bodies concerned with the economic development of Indigenous Australians. Section 4.5.1 provides some basic information about these organisations, the conditions under which they operate and the funding they may provide for Indigenous aquaculture development. Section 4.5.2 provides additional information about various grant and loan funds administered by other agencies concerned with economic development generally but for which some Indigenous aquaculture development projects may be eligible. It should be noted that, in addition to providing various forms of financial assistance, these agencies can provide general advice in respect of business planning and project development.

Many funding schemes, services and other forms of assistance are available for aquaculture and general business development in Australia. The following sections provide a reasonably-detailed list of some relevant funding schemes and services, including some details about eligibility. The information is not exclusive. For example, there are numerous schemes that provide financial and other incentives for creating employment opportunities, establishing businesses and developing basic business skills. Additional information about these can be obtained by entering the Commonwealth Government website entitled Business Entry Point and following the relevant prompts. The web site address is: www.business.gov.au. Contact addresses for the funding agencies identified in the following sections are provided in appendix three.

4.5.1 Agencies Involved in Indigenous Economic Development

The Aboriginal and Torres Strait Islander Commission (Commonwealth)

ATSIC is the principal organisation in the Commonwealth portfolio of Aboriginal and Torres Strait Islander Affairs. Other independent statutory authorities set up under the ATSIC Act (or amendments to that Act) are the:

- Aboriginal and Torres Strait Islander Commercial Development Corporation (CDC);
- Torres Strait Regional Authority (TSRA); and
- Indigenous Land Corporation (ILC).

Set up in March 1990 and based in Canberra, the CDC operates on a commercial basis and engages in enterprise activities on behalf of Aboriginal and Torres Strait Islander joint-venture partners. TSRA was set up in July 1994 and is based on Thursday Island. The organisation performs functions similar to ATSIC within the Torres Strait region. Established in June 1995 and based in Adelaide, the ILC assists Aboriginal and Torres Strait Islander people acquire and manage land in a sustainable way to provide cultural, social, economic and environmental benefits for themselves and for future generations.

ATSIC has various funding programmes and schemes to assist with the development of commercial enterprises for Indigenous people (ATSIC, 1994). The CDC invests in and helps the development of significant commercial projects for Indigenous groups, in accordance with sound business principles. The CDC may provide opportunities by participating in joint ventures and by providing consulting, facilitation and support services, the ultimate objectives of which are to promote the financial independence of Indigenous people.

ATSIC's Business Development Programme provides funding and advice to Indigenous communities for projects that include aquaculture. Two types of services are offered:

- Business Support, which includes professional business and marketing advice, mentoring and facilitation of access to other public and private sector services; and
- Business Finance, which is tailored to the needs of specific business proposals and provides loan funding for defined projects.

The funding programmes and services provided by ATSIC that are the most relevant to aquaculture development are described briefly as follows.

- The Indigenous Small Business Fund ("ISBF") is a joint initiative between ATSIC and the Commonwealth Department of Employment, Workplace Relations and Small Business ("DEWSB"). The ISBF is available to large companies or Indigenous corporations and usually targets the bigger projects. Individuals applying for funding under this scheme apply directly to ATSIC and corporations to DEWSB.
- Business Finance provides loan funds to help Indigenous people establish working businesses and usually targets smaller or individual projects.
- The Community Development Economic Program ("CDEP"), which provides employment opportunities for Indigenous people in community projects, as an alternative to social welfare payments.
- Fast Track Loans, which provide smaller amounts up to $12,500 to individuals.

Funding programmes are subject to change; for example, grant funds, such as those awarded to the MSH project in Broome, are no longer available. Currently, funding is available by way of loans at commercial rates. Under some circumstances, ATSIC will consider other funding strategies such as part loan and part grant. To be successful,

projects would almost certainly need to involve several communities; individual projects are unlikely to receive support.

The business support funding offered by ATSIC is available to Indigenous individuals, organisations and corporations for:

- feasibility studies;
- development of business plans;
- training of management and employees;
- provision of valuations, technical expertise and legal aid;
- marketing programmes; and
- mentoring and monitoring.

Project funding, which is different from normal business funding, may also be available to Indigenous individuals, organisations and corporations for business-related initiatives where projects are considered to be exceptional, for the public good, and benefit a region, or at least more than one community group or organisation. The MSH provides a good example of this type of project funding.

ATSIC also has a role in co-ordination and can provide assistance in the formation of regional boards and committees.

All inquiries and applications for funding should be directed in the first instance to a project officer stationed in the respective ATSIC clusters, which considers the eligibility of applications. If considered ineligible, the applicant is advised accordingly; if eligible, it is forwarded to ATSIC's Business Agent for processing. A recent ATSIC publication entitled Good Business or Just a Good Idea, which provides an information kit for project proponents and a means of self-assessment, is now available from ATSIC offices and worth consulting by prospective aquaculturists intending to lodge applications for financial and other assistance.

Aboriginal Affairs Departments (States and Territories)

All states and territories have Aboriginal Affairs departments or their equivalents. From time to time, funding may become available through these departments; however, their funding programmes are usually limited and they are best suited to provide advice.

Generally, the roles of these departments and agencies are to help Indigenous people to access suitable services and facilities, co-ordinate the delivery of services by governments to include Indigenous people and support the interests of Aboriginal people in matters of land, heritage and culture.

The Indigenous Land Corporation (Commonwealth)

The Indigenous Land Corporation (ILC) is a statutory authority established by the Commonwealth to assist Indigenous people acquire and manage land in a sustainable way, to provide economic, environmental, social and cultural benefits. The ILC has two functions, namely land acquisition and land management on existing Indigenous-held land.

The ILC acts in accordance with sound business principles whenever it performs its functions on a commercial basis. In undertaking its functions the ILC is required to give priority to:

- ensuring that as far as is practicable, Indigenous people derive social or cultural benefits as a result of the performance of the ILC's functions

- ensuring that it has access to necessary skills and resources required to perform its functions, and
- maximising the employment of Indigenous people and the use of goods and services provided by businesses owned or controlled by Indigenous people.

The core business of the ILC is land acquisition and addressing dispossession, not economic development. However, the Act, which allows both the acquisition and management of land, enables the ILC to act commercially and to engage in business relating to land. Consequently, the ILC considers the furthering of economic development consistent with its core business.

The ILC's stated policy priorities are directed at sustainability and facilitating access to other funding programmes in view of its own very limited resources. The ILC sees its major immediate role in land management as assisting landholders to identify and achieve more appropriate land uses consistent with their cultural, social and economic objectives. The approach the ILC adopts to assess proposals to undertake aquaculture will be the same as that taken for other enterprise or project activities.

The Office of Aboriginal Economic Development (Western Australia)

The Office of Aboriginal Economic Development (OAED) is a division of the Western Australian Department of Commerce and Trade, which has programmes aimed at stimulating the environment in which businesses operate. The OAED is the lead agency for the State Government in Aboriginal Economic Development. Its overall aim is to support and encourage the establishment, development and management of enterprises owned by and that employ Aboriginal people. The OAED achieves its goals through financial and other services, which encompass business development, client development and industry development. The business development and industry development services are considered most relevant to Indigenous aquaculture.

Business development includes advisory and planning assistance in areas that are potentially very useful to Indigenous aquaculture proponents. Services include identifying joint venture partners, working with Indigenous people through joint venture negotiations, providing assistance with identifying and approaching various commercial as well as government organisations that are potential sources of funding.

Through the Indigenous Economic Development Scheme, which, to some extent, mirrors ATSIC's Support Services, the business development service also provides financial support and planning for improvement of Indigenous enterprises in areas such as business planning, marketing, mentoring, management training and the provision of financial and legal advice. Client-based business planners also assist with the costs of placing business expertise within Indigenous corporations with a clear enterprise focus and a suitable track record.

Industry development programmes are supported by the Industry Planning Fund, the objective of which is to create opportunities in key industry sectors. Classically, these sectors have mainly included tourism and mining, but could equally be applied to aquaculture.

4.5.2 Other Funds, Services and Funding Bodies

The funds and services provided in this section are those available to all industry stakeholders and for which Indigenous aquaculture development initiatives and projects may be eligible.

Rural Industries Research & Development Corporation (RIRDC) (Commonwealth)

The RIRDC manages and funds priority research and translates results into practical outcomes for industry development. RIRDC has a charter to foster new industries and target high-priority, generic, issues facing rural industries. RIRDC has three core businesses, namely: fostering the development of prospective and emerging new

industries; managing research and development investments for established industries; and addressing strategic cross-sectoral issues facing the rural sector.

To be eligible for funding, projects need to demonstrate: relevance to the objectives of the RIRDC; economic benefit; scientific rigour and viability; likelihood of potential benefits; environmental sustainability; provision for the transfer of knowledge; research and development resources available and those required to fund the proposed project.

Fisheries Research & Development Corporation

The Fisheries Research & Development Corporation ("FRDC") was formed as a statutory corporation in July 1991, according to the Primary Industries and Energy Research and Development Act 1989. A national organisation, the FRDC is responsible for planning, funding and managing R&D programmes and facilitating the dissemination, adoption and commercialisation of the results of research and development. As such, it is well placed to provide significant assistance to the development of Indigenous aquaculture.

Australian Centre for International Agricultural Research (ACIAR) (Commonwealth)

ACIAR funds collaborative research in agriculture and aquaculture between scientists in Australia and developing countries, within the context of Australia's overseas aid program. Projects focus on problems of mutual relevance and benefit to Australia and the developing countries concerned. An Australian research organisation is commissioned to manage each project. Within projects ACIAR provides opportunities for training of developing country nationals. ACIAR produces a large number of corporate and technical publications relating to project initiatives and outcomes.

Project proposals need to respond to the expressed research needs and priorities of developing countries, be directed at important problems of national or regional significance and involve significant participation by developing country scientists. They should also use recognised Australian research competence, be of mutual benefit and complement other international research activities.

Strategic Partnerships with Industry - Research and Training (SPIRT) Scheme (Commonwealth)

The SPIRT scheme encourages collaborative research between universities and industry organisations, commercial enterprises or public sector organisations (except research bodies specifically funded by Commonwealth or State governments to carry out research). SPIRT has the following three elements that may be included separately, or combined, in research.

- Collaborative research projects, especially those involving collaboration between universities and industry which have the potential for economic and social benefit for Australia;
- Australian Postgraduate Awards (Industry) (APAIs), involving research training for a student to undertake a research project and gain either a Masters research degree or a Ph.D.
- Australian Postdoctoral Research Fellowships (Industry) (APDIs), in which researchers can apply for a Postdoctoral Research Fellowship to enable them to undertake the role of Chief Investigator for a collaborative research project with an industry partner.

Industry Partners may be private and public sector industry organisations and commercial enterprises; private non-profit organisations; or state and Commonwealth agencies which are not primarily funded for research.

Projects must usually involve a high level of collaboration with eligible industry partners; demonstrate the development of new university-industry links, or significant enhancement of existing links; and be undertaken by Chief Investigators employed by an Australian university.

AQUAPLAN (Commonwealth)

AQUAPLAN is a strategy that outlines objectives and projects to develop a national approach to emergency preparedness and response and to the overall management of aquatic animal health in Australia. As part of AQUAPLAN, the department's National Office of Animal and Plant Health has produced an Australian Aquatic Animal Disease Identification Field Guide to help raise public awareness of the importance of aquatic animal disease management. The Field Guide provides information about diseases and organisms that threaten Australia's aquatic animal industries.

All those involved in the Australian aquaculture industry are eligible to participate.

Export Market Development Grant: AUSTRADE Financial Support (Commonwealth)

The Export Market Development Grant aims to encourage the development and expansion of export markets for Australian products. It provides a partial reimbursement of specified promotional and marketing expenses to small and medium Australian exporters who are seeking and developing export business. Grants are 50% of eligible expenditure exceeding $15,000 pa and up to a maximum of $200,000 per year.

Grants are available to any Australian individual, partnership, association, co-operative, statutory corporation or trust that have spent at least $20,000 on specified export marketing activities and have a total income of less than $50 million and export income of less than $25 million. Claimants need to register with Austrade by 30 June and pass a Grants Entry Test. Applications must be lodged by 30 November.

The Department of Commerce and Trade (Western Australia)

In addition to the OAED, the Department of Commerce and Trade has several other divisions that can provide assistance to Indigenous aquaculture development. These include Industry Development, Industry Services, Regional Development, Infrastructure and Science and Technology. The OAED can be used by Indigenous people to gain access to these development assistance programmes.

The Industry Development Division runs a range of business improvement and export development programmes. Eligibility for funding depends on the time for which the business has operated and its viability. Funding is usually on a 50% basis. A business planning service that requires no contribution from the client is offered under ATSIC's Support Services or the Department's Indigenous Economic Development Scheme. Other schemes are a Business Visit Scheme, which provides assistance to visit overseas markets relevant to the proposed business, and an Export Marketing Support Scheme, which provides assistance in areas such as trade exhibitions and industry missions. These are relevant to aquaculture in developing markets.

The Industry Services Division includes overseas offices, which can be used by aquaculture enterprises to assist market entry for goods and services.

The Regional Development Division runs a range of programmes and services aimed at projects with a wide regional economic benefit. The Regional Initiatives Scheme, which supports regional economic development and job creation, has been used by Indigenous clients for feasibility study work and capital expenditure. The scheme may be relevant to aquaculture development projects.

The Infrastructure Division operates a Regional Headworks Scheme, which is potentially very useful for aquaculture development. The scheme provides for connection to essential services such as electrical power, potable water, sewerage and telecommunications. Businesses are eligible for funding by way of interest-free loans or grants.

The Science and Technology Division runs the WA Innovation Support Scheme, which is potentially useful for Indigenous aquaculture projects. The scheme supports businesses to undertake research and development leading to the production of internationally-competitive products or processes with commercial prospects.

Pre-Feasibility Study Program (Western Australia)

Up to $20,000 provided on a dollar for dollar basis may be offered to assist companies contract professional accredited consultants to undertake pre-feasibility studies to develop new and value-adding projects to increase export opportunities or replace imports. This program is provided through the Department of Commerce and Trade.

Projects must involve the establishment of new or pioneer manufacturing, value adding or advanced technology industries with a minimum project capital investment of approximately $2.5 million for metropolitan projects and approximately $1 million for regional-based projects. The projects must be substantially oriented towards export, import replacement or value adding.

Aquaculture Business Development Program (South Australia)

The Aquaculture Business Development Program provides targeted, strategic funding allocations to assist establishing and expanding non-tuna aquaculture businesses. It assists marine and fresh water aquaculture businesses in South Australia with capital and ongoing operating expenditure. In addition to helping develop businesses in an industry sector identified as having good growth potential, the program aims to facilitate the expansion of the requisite work force and increase employment opportunities. To these ends, the program targets new and expanding businesses in the non-tuna aquaculture industry.[12]

Funding is available in 1999-2000, for regions in which aquaculture is considered viable, through The Business Centre in South Australia.

Department of Industry and Trade (South Australia)

The Department of Industry and Trade provides business assistance funding targeted primarily at value adding. This funding would not be available for production-related research or commercial activities, but may provide funding in areas such as the development of export processing works or more specific value-adding processes such as cryovac packaging works. The amount of funding available is non-specific.

Department of Industries and Business (Northern Territory)

The Department of Industries and Business administers the Financial Incentives Scheme, which provides incentives for businesses being established in the Northern Territory. The principal criterion of the scheme is that it does not provide assistance for businesses that may compete with existing operations. The funding that may be provided is limited to reimbursement of an amount up to 10% of the capital expenditure of the project, by way of subsidising grants over a three to five year period.

[12] The tuna industry is specifically not eligible for this funding programme because it has already received significant government assistance.

Department of State Development (Queensland)

The Queensland Department of State Development provides grants and loans for large operations the total cost of which exceeds $2 million, provided they provide significant employment opportunities and are not limited to primary production. For example, an operation that includes production as well as processing or other form of value adding may be eligible.

Seafood Services Australia (Queensland)

Seafood Services Australia is a joint industry and government initiative. The organisation provides support to the Australian seafood industry in the post harvest area. Services include the provision of:

- literature searches and information packages in areas such as handling, processing, aquaculture and marketing;
- advisory and consulting services to the seafood industry;
- liaison between food researchers, industry and funding bodies to identify research priorities and review and disseminate research results;
- project planning and financial assistance for targeted near market R & D on products and processes;
- networking between seafood businesses to develop commercial opportunities;
- food safety and research materials available to the seafood industry; and
- information and materials to facilitate the uptake of food safety and quality.

Assistance is available to anyone with an interest in the seafood industry on a free, fee for service or publication or financially assisted basis depending on the service requested.

Product Assessment, Development and Management Services (Victoria)

The Victorian Innovation Centre provides product assessment, development and management services for industry to develop, manage and commercialise new products and technologies. Services include regular seminars, individual consultations, product and opportunity assessments, a personal mentoring service and help with all aspects of the innovation process.

All individuals and groups involved in the development and commercialisation of new products are eligible.

Co-operatives Formation Assistance (New South Wales)

The objective of the program is to assist the promoters of proposed co-operatives with advice about the relevant legislative requirements and the completion of the requisite incorporation documentation. Assistance includes answering written, telephone and face-to-face enquiries, referrals to other agencies, occasional seminars and workshops and the provision of the necessary documentation in the form of a Formation Kit.

Assistance is available to any individual or group wanting to form a co-operative under the Co-operatives Act 1992 (NSW).

Women in Business Mentor Program (New South Wales)

The Women in Business Mentor Program links women who are establishing their business with experienced business owners in non-competing industry sectors so that they can share knowledge and experiences to boost confidence and success. The program emphasises the importance of people learning from each other by setting up networks of women in business to provide role models for new female entrepreneurs.

The mentors and proteges are women who have been in business for less than two years and at least five years respectively. The program is designed for women who derive their main income source from the business.

Environment Guidelines (Queensland)

The service provides assistance by way of relevant advice and guidelines about how to meet the environmental requirements and criteria laid out under Queensland legislation.

There are no specific eligibility criteria. Environmental protection legislation incorporates statutory environmental protection policies that will set environmental values and strategies for achieving them. The environmental guidelines are consistent with these objectives.

Invest Australia - Feasibility Study Fund (states and territories)

Grants of up to $50,000 are available towards undertaking feasibility or pre-feasibility studies to assess the commercial viability of a significant new enterprises. Given the eligibility criteria for this scheme, it is likely that only aquaculture applications based on value adding would be considered. Commonwealth funding is based on matching the funding provided by a state or territory Government.

Generally, studies must assess the commercial viability of new private-sector investment proposals with an initial capital investment of at least $10 million, but special consideration may be given to projects involving less capital investment. The applicant must provide evidence of indicative financial support from a state or territory government. Project proponents must at least match the combined funding of Commonwealth and state or territory governments.

Business Tasmania: Small Business Program (Tasmania)

The program provides a range of business information, advice, contacts and referrals that focus on helping business proprietors develop their management skills. It provides advice about matters such as bookkeeping, marketing, guidance on business planning and access to relevant information. Seminars on key small business issues are available free of charge.

The service is available to all existing or prospective businesses and the general public and is provided through selected Business Tasmania offices and Enterprise Centres throughout Tasmania.

Small Business Centres, Business Enterprise Centres and Regional Development Commissions and Boards (States and Territories)

Small business centres, business enterprise centres and regional development commissions and boards located throughout Australia are well placed to provide assistance with the development of economic and employment opportunities. These organisations are usually non-profit. Some are government agencies, others are partially funded by but independent of government. They are involved in matters such as providing business advice and sourcing funding for projects, particularly in regional areas. These organisations are generally well placed to provide advice in the establishment and operations of businesses and in the formation of suitable partnerships with industry.

4.5.3 Mining industry and private companies

Many mining companies located in remote regions of the country are often supportive of indigenous business activities. The potential of these organisations providing funding and in-kind support (such as machinery for pond

construction and road infrastructure) for aquaculture development are good and indigenous communities should explore this avenue of support wherever possible.

4.6 Implementation

The key strategy for implementing the recommendations provided as a result of this study is contained in Recommendation No 1 in section 5.2.1, which proposes the establishment of a small, focused steering committee to implement the remaining recommendations according to a schedule that it will derive.

Any future initiatives that arise as a result of this study should continue to be developed with reference to and ideally within the context of other relevant strategies, such as the National Strategy on Aquaculture in Australia (Working Group on Aquaculture, 1994). For example, most states were funded to develop an Aboriginal Fishing Strategy, which as its main objective aims to increase opportunities for Indigenous people to participate in both traditional and commercial use of fish resources, including aquaculture.

It will be important to measure the effects of the implementation of the Indigenous aquaculture development strategy. The outcomes should be measured against key business and employment indicators. These include:

- the number of aquaculture businesses initiated;
- the number of people owning or participating in profitable aquaculture businesses;
- the proportion of the Indigenous population earning income from new and established aquaculture businesses; and
- the number and proportion of Indigenous people in part-time and full-time employment in aquaculture projects.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 General Conclusions

The purpose of this national aquaculture development strategy is to help and support Indigenous communities interested in aquaculture development. It is not intended to solicit or to encourage support for aquaculture development in Indigenous communities in the country. AFFA and ATSIC, the main stakeholders in this study, will use it as a basis for developing strategic assistance and funding to Indigenous communities interested in developing aquaculture. Throughout the consultation process, it has been emphasised that interest for aquaculture development has to come in the first instance from the communities themselves and not be imposed upon them. Further, interest has to be maintained from within the communities, by strong advocates of the concept.

To succeed, Indigenous aquaculture has to be driven by Indigenous people, with the support of public and private organisations as appropriate. In turn, to be thus driven, aquaculture projects have to be developed, not only in consultation but also in partnership with the relevant communities. The need for Indigenous ownership, by equity, joint venture or other commercial arrangement, is paramount. These may be considered the critical ingredients of successful and sustainable Indigenous aquaculture development.

5.2 Recommendations

5.2.1 Industry Development

To achieve the objectives of this strategy, implement its recommendations and expedite the involvement of Indigenous communities in aquaculture a small steering committee should be established.

The steering committee should include a representative from AFFA, ATSIC, ATSIC elected arm and, on a need basis, invited experts from the ILC, CDC, the industry and state fisheries.

The principal tasks of the steering committee will be to:

- review the recommendations provided in this study to place them in order of priority and establish a schedule for their implementation;
- implement the recommendations by allocating tasks according to the schedule;
- liaise as required with relevant Commonwealth, state and territory governments to promote and implement the strategy; and
- on an ongoing basis, provide oversight and co-ordination of activities.

To optimise the use of limited resources, maximise efficiency and take advantage of any possible synergies that may exist, we would anticipate a high level of co-operation and communication would be established between the proposed steering committee, the ATSIC Aquaculture Development Unit (see recommendation 2) and the various Commonwealth, state and territorial agencies charged with the responsibility of implementing the National Strategy on Aquaculture in Australia (Working Group on Aquaculture, 1994).

Recommendation 1

Establish a small and highly-focused 'Aquaculture Steering Committee' to implement the recommendations provided in this study.

From information generated through the consultative process, there is a clear need for the establishment within ATSIC of a specialist unit that has the skills and experience necessary to provide advice, help develop funding applications and assess preliminary applications for aquaculture projects. The option of commissioning consultants

to undertake the activities and duties of the proposed ATSIC Aquaculture Unit was contemplated but rejected for several reasons that included:

- the clear need for a dedicated unit that could identify requirements and develop the skills and experience needed to achieve the objectives of this study;
- the need for a high level of professional management and continuity that would be impossible if all the tasks were to be out-sourced;
- various problems that might be encountered with out-sourcing;
- the possible loss of historical data and information; and
- the possible vested or conflicts of interest that could occur if consultants were used exclusively.

Nothwithstanding these comments and given the magnitude of its duties, we would expect that the proposed ATSIC Aquaculture Unit, where appropriate, would outsource a proportion of these activities and duties.

The main duties of the proposed ATSIC Aquaculture Unit would be to:

- work directly with the ATSIC state commercial units and ATSIC appointed Business Funding agents in all states and territories to assess aquaculture business plans; the unit should also have the power to reject applications at its discretion;
- help the ATSIC Business Funding Unit assess business plans and support funding for good projects;
- undertake work on an ongoing basis to identify and document opportunities, including the identification of impediments and the means that can be used to overcome them, for Indigenous people seeking to become involved in aquaculture;
- compile a register of consultants and other professional people, organisations and institutions throughout the country who can be called on from time to time to provide specialist advice and services;
- develop a standard system for monitoring and reporting on all Indigenous aquaculture projects to provide, analyse and evaluate relevant information; and
- on a broader scale, help regional committees and working groups to prepare aquaculture development strategies or recommend suitable consultants for this work where necessary (a large amount of information in this regard already exists in many state agencies, so it will be critical for the ATSIC Aquaculture Unit to interact closely with the states and territories and ensure appropriate linkages are established between Indigenous aquaculture development and other relevant state and Commonwealth strategies).
- take up a mentoring role to various Indigenous groups involved or seeking to become involved in aquaculture;
- act as a conduit, reference point and source of information for all Indigenous aquaculture projects;

Other activities of the proposed Aquaculture Unit could include:

- help provide technical and other advice to current and prospective Indigenous aquaculturists;
- help assess and evaluate preliminary project proposals and applications from individuals, communities and regions; where possible, help with strengthening applications considered to have potential or recommend a suitable consultant for the task;
- ensure that aquaculture business proposals make adequate provision for a transfer of technology if required, by allowing for a person with the requisite skills and experience to work on the project for a suitable period;
- assist regional councils to hold discussions with Indigenous communities to gauge the current level of interest in aquaculture within each of the biogeographic regions identified in this study;

- help compile a detailed list of candidate species for each of the biogeographic regions, including a detailed reference list for species considered a high priority for Indigenous aquaculture development;
- help compile the resource information necessary for identifying and evaluating sites suitable for aquaculture development in each of the biogeographic regions;

Recommendation 2

Establish within ATSIC a small and specialised unit with significant aquaculture skills and experience.

Development in aquaculture and compatible industries such as recreation and tourism are likely to be interdependent and can be mutually beneficial. The tourism industry is experiencing quite rapid growth and more people are becoming increasingly interested in the environment (through so-called eco-tourism) and in experiencing Indigenous cultures. These circumstances may provide an excellent opportunity for Indigenous aquaculture projects to capitalise on additional revenue generated from tourism. Indigenous aquaculture development planning should therefore be undertaken within the context of planning for the overall economic development of communities and regions. Integrated economic development planning is particularly important in respect of the use of limited resources and infrastructure requirements.

Recommendation 3

Explore the options that exist to integrate development planning strategies for Indigenous aquaculture with planning for other complementary activities in the region.

Effective consultation with Indigenous people and their meaningful participation in all stages of the planning processes are essential prerequisites for successful Indigenous aquaculture development. To ensure these prerequisites are met, it is proposed that Indigenous people in each of the biogeographic regions defined in this study are represented by a group or committee, comprising the following individuals:-

- one person from each of the regional councils within the biogeographic region;
- a representative from the ATSIC regional cluster office;
- a representative from the state or territory Fisheries or Primary Industries department; and
- on a need basis, the chair of the local Indigenous council and traditional owners, and other funding/supporting agencies within the biogeographic region.

This committee will represent the views of Indigenous people at the community and regional levels. A level of organisation is needed to ensure that community councils work together with the elected and government arms of ATSIC to lead the community and regional organisations and to ensure the consultation process is inclusive of all decision makers. These regional groups would be supported, where required, by the proposed ATSIC Aquaculture Unit.

Through its existing programmes, ATSIC should provide the requisite assistance and support for the formation of these proposed regional committees or representative groups. The main objectives of these proposed representative groups include:

- participating directly in any aquaculture-oriented decision-making processes involving the interests or participation of Indigenous people;
- representing the interests of Indigenous people in the planning processes; and
- bringing communities together to form common development strategies.

Recommendation 4

Consider the establishment of a working group or committee, comprising reprersentatives of the state, ATSIC, regional councils and community members, to represent Indigenous aquaculture interests in each of the identified biogeographic regions.

A past impediment to the development of Indigenous aquaculture has been the lack of seed stock. The multi-species hatchery ("MSH") being built in Broome provides an excellent model for development, because it accomplishes many of the key technical and social requirements for successful aquaculture, such as the provision of seed stock, training facilities and consensus between communities. One or more MSHs strategically located in each of the biogeographic regions would provide a focal point and stimulus for Indigenous aquaculture development. MSHs located in each of the biogeographic regions could be linked to institutions such as TAFE and Fisheries or Primary Industries departments to create significant synergies in respect of joint resources and support that would otherwise not be available or attainable. This strategy could enhance the presence of Indigenous aquaculture as a significant force in the national aquaculture industry.

This proposal does not limit the number of MSHs that may be placed in each biogeographic region. Of necessity, the biogeographic regions proposed by this study are large in area. Each region is likely to encompass groups with interests in different types of aquaculture or locations with physical and biological features suited to different species. In either of these events it would be reasonable to predict a single biogeographic region might accommodate two or more MSHs.

On an ongoing basis, the proposed ATSIC Aquaculture Unit would consider how various technical, management and operational efficiencies and synergies could be achieved by integrating the activities of all the MSHs. The unit could provide the leadership necessary to bring about this development.

In the event that a MSH is not possible at the current stage of aquaculture development in a given region, another development model proposed for Indigenous aquaculture is a demonstration farm, which would comprise a small-scale commercial production unit that applies and demonstrates technology as well as providing employment and training opportunities. In essence, the concept is that of a small-scale MSH. Such a farm could possibly be developed in regions where the MSH model is deemed unsuitable or too difficult to implement; it would be best jointly developed with the local Fisheries/DPI offices or other relevant supporting institutions such as TAFE. Examples of early models of such farms could be seen in South Australia and Western Australia.

Demonstration farms could play a critical role in Indigenous aquaculture development by providing resources and facilities that show Indigenous aquaculturists not only hatchery but also growout procedures that can be adopted and modified for use in various areas. Demonstration farms can be either purpose-built, or use existing, commercial facilities.

The means by which MSHs and demonstration farms could be funded need to be elaborated on by the proposed ATSIC Aquaculture Unit in collaboration with the steering committee (recommendations 1 and 2) and relevant funding agencies.

Recommendation 5

Contemplate the best means whereby one or more multi-species hatcheries could be established in each of the biogeographic regions identified in this study and the means whereby appropriate synergies could be developed between them and existing Commonwealth and state aquaculture agencies.

Recommendation 6

When appropriate, demonstration farms could be established in selected regions.

Indigenous aquaculture development will only occur if it is wanted by the communities and driven by dedicated Indigenous stakeholders. The difficulties of starting and successfully operating a commercial aquaculture venture should never be under-estimated and even well funded projects with experienced staff frequently fail. The industry is usually considered "high-risk" by investors. To build a successful and sustainable aquaculture industry requires a long-term commitment by the proponent or proponents, an understanding of the difficulties that will inevitably arise. The presence of one or more "champions" who will drive the project through its various development stages is critical to the success of the project. Consequently, where champions are identified, their potential should be nurtured and supported.

Recommendation 7

Communicate to proponents the need for and encourage long-term commitments from individuals or communities interested in becoming involved in commercial aquaculture.

5.2.2 Physical Factors and the Environment

One of the precepts for aquaculture to be successful is the selection of a site that satisfies the biological requirements of the target species and the financial and management requirements of the operators. The proper identification and assessment of sites is therefore critical. The physical, biological and ecological features of a site being considered for aquaculture should be clearly identified and evaluated in respect of any commercial and competitive advantages they may confer on the proposed venture. Relevant economic, financial and social factors also need to be evaluated to ensure the proposed venture will satisfy the cultural and other requirements of the Indigenous people involved. This recommendation will of necessity be influenced by state and territory planning and legislation; for example, in Tasmania, potential sites will have to be designated or capable of being designated as marine farming zones in the relevant marine farming development plan.

Recommendation 8

For any proposed aquaculture project, ensure a thorough assessment is carried out of the selected site to assess its physical, biological and ecological features and evaluate the relevant economic and social factors.

As a consequence of the recommendations provided in this strategy, it is anticipated that Indigenous people as well as government agencies would be involved in planning processes for aquaculture development taking place on Indigenous land. These parties, together with private organisations considering entering into partnerships with Indigenous people for the purpose of aquaculture, should be made aware of the environmental concerns, including cultural sensitivities in some Indigenous areas, and aspirations of Indigenous people and ensure that appropriate methods are employed to eliminate or mitigate any adverse cultural and environmental effects of the proposed project.

The cultural and environmental management components of aquaculture planning strategies for large-scale developments and individual projects should include detailed plans that assess the potential cultural and environmental impact of proposed ventures. Risk management strategies need to be developed that:

- identify sacred sites within the proposed aquaculture areas;
- minimise nutrient discharges;
- integrate into the production system efficient water treatment equipment and processes; and
- mitigate any adverse effects that might permanently damage the environment.

Recommendation 9

Ensure that, for any proposed aquaculture project, culturally sensitive areas are not disturbed and due emphasis is placed on environmental management and sustainability.

Indigenous people consider an advantage of aquaculture to be its ability to provide seed stock to restock depleted fisheries, an example of which is provided by the current project in the Kimberley to initially restock depleted reefs with trochus, followed by giant clams and tropical abalone. Such stock enhancement work is expected to re-establish on reefs a self-sustaining population of "Indigenous food species" that can later be harvested on an ongoing basis as part of the traditional wild-capture fishery for the species. The financial support that might be required for the initial stocking of such systems, at least until they become self-sustaining, could be obtained by applying for the relevant grants and assistance details of which are provided in section 4.5.

Recommendation 10

Explore the feasibility of using aquaculture to re-stock or enhance depleted fisheries and the means by which this practice could be most effectively established.

5.2.3 Biotechnical Factors

Many institutions in different states and territories are undertaking aquaculture research and development programmes. The species considered suitable for Indigenous aquaculture and for which culture technology is being, or has been, developed should be identified.

Recommendation 11

For each of the biogeographic regions, identify species that may be suitable for Indigenous aquaculture and on which relevant research and development is taking place.

A key requirement for Indigenous aquaculture development will be the availability of culture technologies that suit the conditions under which communities will be operating. In respect of ongoing research and development work that may be applicable to Indigenous aquaculture, institutions should be encouraged to focus efforts on and accommodating the requirements of Indigenous communities.

To ensure relevance and avoid problems invariably inherent in transferring technologies, the adaptation of culture technologies would be undertaken principally at a regional facility such as an MSH, or at the site of the proposed aquaculture venture. The extension of technologies to communities and practices thus developed would be undertaken mainly by extension staff employed by government departments. These extension officers and other staff should be culturally aware and specific courses could be established in this regard.

Recommendation 12 implies that suitable extension structures staffed with suitable numbers of adequately-trained and skilled people will be established by the relevant agencies. It may be necessary to make provision for a suitably-qualified, trained person to work on the project for a suitable period, to ensure the requisite skills are learned. These R & D services would be best co-ordinated regionally with support provided by the proposed ATSIC Aquaculture Unit.

Recommendation 12

In collaboration with existing Commonwealth, state, territory and regional research institutions, establish a means of focusing as well as extending research and development efforts on the special requirements of Indigenous communities.

Frequently, in Indigenous aquaculture, there exists a void between the results of research and development work and the realistic application of those results to commercial projects. Existing technology and results of current research should be adapted to suit the conditions under which Indigenous communities practise aquaculture. It will be critical to determine an effective means of achieving an effective and practicable technology transfer to communities and to provide troubleshooting services on an ongoing basis.

Recommendation 13

Establish a means of translating the outcomes of research and development from national and regional institutions into practices that can be transferred to and realistically applied by Indigenous people to aquaculture projects.

It is emphasised that recommendations 12 and 13 should not be interpreted as suggesting a new round of funding specifically for Indigenous aquaculture research, but rather the appropriate translation and implementation of existing research and development work and aquaculture technology.

5.2.4 Commercial and Legal Factors

Few Indigenous individuals or communities have established links with the commercial aquaculture industry or with other Indigenous communities involved in aquaculture. The establishment and efficient maintenance of such a network will be an important component of any aquaculture development strategy. A national business network should therefore be established for Indigenous aquaculture.

The establishment of an Indigenous aquaculture network could be based initially on examples provided in *Doing Business: A Policy for Building up the Koori Business Sector* (Koori Business Network, 1999a) and *Open for Business: Experiences of Koori Business People in Victoria* (Koori Business Network, 1999b). The main purposes of the proposed Indigenous aquaculture business network would be to:

- exchange information in respect of aquaculture project development and operations;
- provide information about key programmes and services offered by the Commonwealth, state, territory and local governments and the private sector;
- compile a register of information about business advice and planning, training, finance, marketing, mentoring and networking.

Such a network would be best established and coordinated by the proposed ATSIC Aquaculture Unit.

Recommendation 14

Establish a national business network to develop and maintain links between Indigenous people or communities involved in aquaculture and the commercial aquaculture industry.

Identified impediments to the development of Indigenous aquaculture are the lack in many communities of sufficient capital, relevant skills and experience. Entering into joint ventures with industry partners has been recognised as a means of enabling Indigenous people to participate in the economic benefits from the commercial utilisation of species (Altman et al., 1997). Accordingly, an important component of the strategy will be the identification of organisations and individuals interested in becoming involved in developing joint commercial opportunities. A register of potential non-Indigenous participants in commercial opportunities afforded by the development of Indigenous aquaculture should be established. Potential joint venture partners should ideally be able to demonstrate their awareness of and ability to deal with cultural differences.

Such a register would be best established by the proposed ATSIC Aquaculture Unit.

Recommendation 15

Develop a register of commercial institutions, organisations and individuals interested in becoming involved in the development of Indigenous aquaculture.

Relevant state and territory government agencies together with industry organisations could act as brokers in identifying partners by way of joint venture, venture capital or other suitable means. Such partners would include, but not be limited to, venture capital companies, specific private-sector companies and banks or similar organisations that can provide debt capital financing. This process should be followed by the active solicitation of support for Indigenous aquaculture and take local circumstances into account.

Recommendation 16

Establish a clear and transparent process that actively solicits support from the public and relevant industries for Indigenous aquaculture to become major industry stakeholders.

From information generated from the consultation process, it is clear that, in many areas, there are several Indigenous individuals and communities who have a common interest in the development of commercial aquaculture for the purposes of economic development, creating employment opportunities and providing other social benefits. It would be beneficial for organisations to be formed to unite and represent these people. The approach to development taken by the Kimberley Aquaculture Aboriginal Corporation and the Tasmanian Investment Corporation are exemplary in this regard.

Recommendation 17

Encourage the formation of organisations that represent Indigenous communities with common interests in aquaculture development. Establish a working group within each organisation to expedite the identification of suitable aquaculture land that could be developed.

Mentoring is seen as a valuable tool in contemporary business practices. Many government agencies and private organisations offer mentoring services to provide suitable business and technical advice to new businesses and thereby optimise the chances of success.

Recommendation 18

In each of the biogeographic regions, identify people who could act as mentors to communities interested in developing aquaculture.

Various programmes and schemes, a summary of which is provided in section 4.5 of this study, are available that provide a range of services and funding for aquaculture development initiatives. To enable prospective Indigenous aquaculturists to take best advantage of these services and programmes, a detailed prospectus that identifies all the bodies that may provide funding for Indigenous aquaculture projects should be developed. The prospectus should include details of the services offered, their requirements and eligibility criteria for each of the funding bodies. It is noted that recommendation 19 is compatible with the ILC's co-ordination database. The proposed document should be updated regularly and possibly made available through the establishment of a website.

Recommendation 19

Develop a detailed document that identifies all organisations that might provide services, programmes and funding for Indigenous aquaculture development initiatives and projects.

ATSIC is the lead agency that through its business programme provides services and funding for Indigenous Australians. There has in the past been some confusion about the range of services, loans and grants that may be available through ATSIC, the processes used by that agency to assess applications and the time it takes to do so. It would be beneficial to applicants to have a clear understanding of these processeses. The proposed ATSIC Aquaculture Unit could be delegated to carry out this task.

Recommendation 20

ATSIC should develop a flow chart that clearly illustrates its funding programs and process, and shows the relevant time lines for funding aquaculture projects.

There has been a high failure rate for small projects involving individual people and communities, partly as a result of isolation and lack of training and expertise. Clear benefits are associated to the development of fully resourced and well planned projects that involve groups of people and communities. To encourage and support the development of aquaculture projects involving groups of people and communities, ATSIC should make it known that strong preference for funding would be given to such collaborative approaches.

Recommendation 21

Through its regional offices and in its relevant brochures, ATSIC should make it known that it would give strong preference to funding aquaculture projects involving groups of individuals and communities.

Some government decision-making processes are considered by individuals to impede the development of Indigenous aquaculture. These are generally considered to include the often-protracted licensing processes and the lack of information about basic aquaculture development practices available to the Indigenous communities. For these processes to be expedited and unrealistic impediments that may exist to be removed, it will be necessary for them to first be identified and reviewed. The most practicable means of streamlining the processes can then be proposed to the relevant agencies. Existing legislative practices considered to adversely affect the development of Indigenous aquaculture should similarly be identified and each of the regulations considered onerous to Indigenous groups highlighted. A strategy should then be developed to deal with these identified issues and overcome the difficulties.

Recommendation 22

Document and review the decision-making and legislative processes currently in use by Commonwealth, state and territory governments in respect of Indigenous aquaculture development and suggest solutions where they might be needed.

Generally, there appears to be a lack of understanding between Indigenous people and various government agencies in relation to the legislation and regulations applying to aquaculture development. Similarly, the understanding among Indigenous communities about the ATSIC funding processes appears poor. These problems are usually compounded by a lack of co-operation, interaction and trust between separate communities and families. It would be appropriate to encourage between these agencies and groups a greater degree of understanding and trust, without which cohesive industry development will be difficult if not impossible.

Recommendation 23

Encourage and foster co-operation, interactions and mutual trust between Indigenous communities, regional councils, ATSIC, all funding bodies, the private sector and all Commonwealth, state and territory regulatory bodies.

5.2.5 Education and Training

Training for aquaculture is currently provided by institutions such as TAFE Colleges and universities, which offer structured courses, and in on-farm traineeships. It would be appropriate to consider the establishment of a dedicated, nationally accredited Indigenous training course based on currently available and accredited National Seafood modules. Such a course would cater for the special training needs of Indigenous people. The MSH provides a good example of a formal training course being linked with on-farm practical work.

Recommendation 24

Consider the establishment of a dedicated, nationally accredited Indigenous training course based on currently available and accredited National Seafood modules.

Indigenous people seeking to become involved and develop a career in aquaculture are frequently uncertain about the educational and training prerequisites. For such people, it would be helpful to have access to a document or prospectus that clearly outlines the possible career paths and opportunities in the industry as well as describing the education and training requirements.

In addition to clearly explaining the various education and training opportunities available and considered best suited for the various levels of skills required for aquaculture, the prospectus should elaborate on employment opportunities that exist and may be available to people once they have completed their education and training.

Recommendation 25

To provide the necessary guidance for Indigenous people who wish to follow a career path in aquaculture, prepare a document that clearly explains the training and education opportunities that exist, as well as some details about education and training requirements and opportunities.

To optimise opportunities for Indigenous people in skills-based traineeships, links need to be developed between TAFE Colleges or other institutions, which have the capacity to deliver the requisite formal training components, and industry projects that can provide the requisite level of practical, hands-on training. In many cases, Indigenous people who have undergone some form of education or training cannot practise their skills because there exist few Indigenous aquaculture projects. The lack of training is thus linked to the lack of projects. An important component of a national strategy is therefore to assist in placing trained Indigenous people in a working environment, which mainly includes employment in some of the main aquaculture industries, such as those growing marine prawns and barramundi. This would allow trained but inexperienced Indigenous people to develop their skills and gain valuable experience in an operating project and place them in an advantageous position.

Recommendation 26

Develop links with TAFE Colleges, other relevant institutions and industry organisations that can provide skills-based training courses for Indigenous people and where appropriate, provide traineeships to the people to attend the course

Recommendation 27

Develop a job-placement programme to place trained Indigenous people in commercial aquaculture projects.

5.2.6 Social and Cultural Factors

The importance of early involvement by and negotiation with traditional owners and affected communities in any aquaculture proposal is essential to ensure due attention is paid to accommodating the social and cultural issues that are often unique to Indigenous people. In many cases, non-Indigenous organisations have no experience of these matters in respect of doing business with Indigenous people and may therefore be perceived as insensitive. It would be advantageous and appropriate to document a set of guidelines that could be used to facilitate business negotiations between Indigenous people and the aquaculture industry. The proposed document would ensure that all social and cultural matters are identified and dealt with as required and to the satisfaction of all stakeholders and promote the advantages of doing business with Indigenous people.

Recommendation 28

Prepare a document that provides an outline of how to do business and develop projects with Indigenous communities, with specific reference to aquaculture.

The proposed ATSIC Aquaculture Unit should be responsible for overseeing the compilation of the proposed document. This document would include reference to the key areas of native title, business experience, training, employment opportunities, community attitudes and access to finance and capital. It would also highlight the advantages of developing aquaculture businesses with Indigenous people, such as access to valuable coastal and other land that could be used to locate projects. There is a precedent to a mutually-beneficial situation that can arise, in which a native title claim can be removed from the site at which a proposed farm can be located, in return for providing benefits to the communities by way of lease payments, employment, training and, involvement or equity in the project. This arrangement is considered commercially attractive because it removes the uncertainty of the native title issue from the project, could pave the way for free-holding the land and allows a clearer path for bank financing.

REFERENCES

Altman, J.C., L.M. Roach and L.E. Liddle, 1997. Utilisation of native wildlife by Indigenous Australians: commercial considerations. Centre for Aboriginal Economic Policy Research, The Australian National University, Canberra ACT.

Anon., 1997. Aboriginal economic development in Western Australia: a strategy for responsive Government services and programs. Government of Western Australia.

Anon., 1999. Australia's oceans policy: specific sectoral measures. Commonwealth of Australia.

ATSIC, 1994. Commonwealth programs for Aboriginal and Torres Strait Islander people in rural industries. Aboriginal and Torres Strait Islander Commission, Commonwealth of Australia, Canberra ACT.

ATSIC and the Department of Primary Industries and Energy, 1997. National Aboriginal and Torres Strait Islander rural industry strategy. Prepared by ATSIC and the Department of Primary Industries and Energy, Commonwealth of Australia, Canberra, ACT.

ATSIC, 1999. Regional autonomy for Aboriginal and Torres Strait Islander communities. A discussion paper prepared by Aboriginal and Torres Strait Islander Commission, Commonwealth of Australia, Canberra ACT.

Aquaculture Committee, 1997. National strategy on aquaculture: Implementation review. Prepared by the Aquaculture Committee on behalf of the Standing Committee on Fisheries and Aquaculture. DPIE Fisheries Policy Branch, Canberra, ACT.

Aquaculture Development Council, 1997. Aquaculture planning in Western Australia. Part A: Synopsis and Review. Aquaculture Development council of Western Australia and Fisheries Western Australia.

Australian Bureau of Statistics, 1996. Population distribution, Indigenous Australians.

Bridgewater, P.B., 1987. The present Australian environment B terrestrial and freshwater. pp 69-100. In G.R. Dyne and D.W Walton (eds), 1987. Fauna of Australia. General Articles. Canberra: Australian Government Publishing Service Vol. 1A.

Bunt, J.S., 1987. The Australian marine environment. pp 17-42. In G.R. Dyne and D.W Walton (eds), 1987. Fauna of Australia. General Articles. Canberra: Australian Government Publishing Service Vol. 1A.

Department of Employment, Education, Training and Youth Affairs, 1998. Pathways to the future: international Indigenous economic development conference. Executive Summary of the Proceedings of the conference, Darwin, Australia, September 1997. Department of Employment, Education, Training and Youth Affairs, Canberra, ACT.

Department of Primary Industry and Fisheries, 1999. Opportunities for aquaculture in Aboriginal communities. Fisheries Division, Department of Primary Industry and Fisheries, Darwin, Northern Territory.

Dyne, G.R and D.W. Walton (eds), 1987. Fauna of Australia. General Articles. Canberra: Australian Government Publishing Service Vol. 1A.

Eyre Regional Development Board, 1997a. Aquaculture site selection. Book Two, Eyre Peninsula Aquaculture. Primary Industries South Australia (Fisheries) and Eyre Regional Development Board.

Eyre Regional Development Board, 1997b. Aquaculture species selection. Book Three, Eyre Peninsula Aquaculture. Primary Industries South Australia (Fisheries) and Eyre Regional Development Board.

FAO, 1998. The state of world fisheries and aquaculture. Documentation Group Cataloguing in Publication Data. FAO, Rome.

Heatwole, H., 1987. Major components and distributions of the terrestrial fauna. pp 101-135. In G.R. Dyne and D.W Walton (eds), 1987. Fauna of Australia. General Articles. Canberra: Australian Government Publishing Service Vol. 1A.

Brain Henson and Associates, 1999. Regional economic study and identification of business opportunities in the Eyre Peninsula area. Prepared for Aboriginal and Torres Strait Islander Commission, Canberra, ACT.

Huguenin, J.E. and J. Colt, 1989. Design and operating guide for aquaculture seawater systems. Elsevier Science Publishers B.V., Amsterdam, The Netherlands.

Husey, 1999. Aquaculture beyond 2000: changing direction workshop. Proceedings prepared by ACIL Consulting, ACIL House, Canberra ACT.

Interim Marine and Coastal Regionalisation for Australia Technical Group, 1998. Interim marine and coastal regionalisation for Australia: an ecosystem-based classification for marine and coastal environments. Version 3.3. Environment Australia, Commonwealth Department of the Environment. Canberra.

Johnson, A.K.L., S.G. Cowell, N.R. Loneragan and G. Dews, 1998. Sustainable development of tropical Australia: R&D for management of land, water and marine resources scoping study. A report to Land and Water Resources Research and Development Corporation and Fisheries Research and Development Corporation. CSIRO Tropical Agriculture, St Lucia, Queensland, and CSIRO Marine Research, Cleveland, Queensland.

Koori Business Network, 1999a. Doing business: a policy for building up the Koori business sector. Aboriginal Affairs Victoria, Department of Human Services, Melbourne, Victoria.

Koori Business Network, 1999b. Open for business: experiences of Koori business people in Victoria. Aboriginal Affairs Victoria, Department of Human Services, Melbourne, Victoria.

Lee, C.L., 1998. A study on the feasibility of the aquaculture of the southern bluefin tuna (Thunnus maccoyii) in Australia. Agriculture Fisheries and Forestry B Australia, Canberra, ACT.

Makaira Pty Ltd, SRM Pty Ltd and Toronto Lane Pty Ltd, 1997. Aquaculture project development. Book nine, Eyre Peninsula Aquaculture. Primary Industries South Australia, Adelaide SA, and Eyre Regional Development Board, Port Lincoln SA.

Merrick, J.R. and G.E. Schmida, 1984. Australian freshwater fishes, biology and management. School of Biological Sciences, Macquarie University, NSW, Australia.

Nash, C.E., 1995. Aquaculture sector planning and management. Fishing News Books, Blackwell Science Ltd, Oxford.

Nel, S., 1996. Investing in aquaculture B an emerging aquabusiness. In: ABARE 1996, OUTLOOK 1996: Proceedings of the National Agricultural and Resources Outlook Conference, vol. 1, Commodity Markets and Resource Management, ABARE, Canberra.

Pillay, T.V.R., 1993. Aquaculture principles and practices. Fishing News Books, Blackwell Sciences Ltd. Oxford.

Rana, K. and A. Immink, 2000. Trends in global aquaculture production: 1984-1996. Fishery Information, Data and Statistics Service (FIDI), FAO Fisheries Department.

Shang, Y.C., 1990. Aquaculture economic analysis: an introduction. Advances in World Aquaculture, Volume 2. Managing Editor, P.A. Sandifer. The World Aquaculture Society, Baton Rouge, Louisiana.

Smith, I. (ed.), 1999. NT barramundi sea cage pilot project to proceed. Northern Territory Seafood Council News: 2(1), 1-4.

Sutherland, J., 1996. Fisheries, aquaculture and Aboriginal and Torres Strait Islander Peoples: studies, policies and legislation. Consultancy report commissioned by the Department of the Environment, Sport and Territories. Canberra, ACT.

Tasmanian Department of State Development, 1998. Tasmanian industry audits: a shared vision. Agriculture, Aquaculture, Fishing, Food and Beverages Audit Report. Department of State Development, Hobart, Tasmania.

Williams, W.D. and G.R. Allen, 1987. Origins and adaptations of the fauna of inland waters. pp 184-201. In G.R. Dyne and D.W Walton (eds), 1987. Fauna of Australia. General Articles. Canberra: Australian Government Publishing Service Vol. 1A.

Wilson, B.R. and G.R. Allen, 1987. Major components and distribution of marine fauna. pp 43-68. In G.R. Dyne and D.W Walton (eds), 1987. Fauna of Australia. General Articles. Canberra: Australian Government Publishing Service Vol. 1A.

Working Group on Aquaculture, 1994. National strategy on aquaculture in Australia. Prepared by the Working Group on Aquaculture on behalf of the Standing Committee on Fisheries and Aquaculture. DPIE Fisheries Policy Branch, Canberra, ACT.

APPENDIX ONE: Aquaculture Practices

Three major elements characterise, and are fundamental to, all commercial aquaculture practices. They are the site at which the project is located, the species under culture and the production system. Each of these elements is characterised by a set of selection criteria, which varies mainly according to the financial and management requirements of the aquaculturist and the biological requirements of the fish.

The elements are interdependent: if aquaculture is to be practised at a given site, the physical and biological features of that site will generally influence the selection of one or more species and production systems. Conversely, if a particular species is selected for culture, the physical and biological requirements of that species will influence the choice of a suitable site and production system. Further, the selection of a target species will be governed to a large degree by the culture technology available, seed supply, its market price and the destinations to which the species is to be sold.

These elements are elaborated in the following sections, with specific reference to their applications to and implications for Indigenous aquaculture.[13]

Sites for Indigenous Aquaculture

Because production is significantly influenced by the characteristics of the site at which the production takes place, the selection of a site with the most favourable features will be of critical importance for successful aquaculture. Generally, the optimum sites will be those that best satisfy the biological requirements of the target species and the financial and management requirements of the aquaculturist.

When assessing potential sites, aquaculture proponents will usually need to distinguish between critical factors (that is, those that must be satisfied for the project to succeed) and less important factors, for which viable, economic solutions might exist. The different site features that can affect the viability of commercial aquaculture at any given site need to be considered individually as well as collectively. For example, under favourable biological conditions, some physical site deficiencies might be acceptable; however good physical site conditions may not compensate for poor biological conditions.

For Indigenous aquaculture projects to be established and operate successfully, sites that satisfy the critical requirements of the target species and the aquaculturist will need to be available in the vicinity of the communities. These sites will have to be selected according to appropriate and carefully-defined criteria. The major site-selection criteria used for commercial aquaculture encompass physical features; biological and ecological features; economic factors; and social and legal factors (Shang, 1990; Pillay, 1993; Huguenin and Colt, 1989).

[13] Some of the information provided in the sections of this document dealing with the suitability of sites and species for Indigenous aquaculture development ar modified from information provided in Aquaculture Development Council (1997) and Eyre Regional Development Board (1997a, 1997b).

Physical Features

The physical features relevant to aquaculture site selection are:

- location and size (the physical or geographical position of the site and the area it occupies);
- topography and hydrology[14] (described by contours and elevation above mean sea level, the water flow characteristics and, for offshore sites, the depth of the sea bed); and
- soil, vegetation and climate.

Sites for proposed Indigenous aquaculture development projects will almost invariably be located near community centres. Sites will be located throughout Australia in offshore, coastal and inland areas. For Indigenous aquaculture in Australia, coastal, onshore sites are likely to predominate, due to the large number of communities inhabiting coastal areas, the generally-abundant aquatic resources and the availability of compatible species. Some offshore aquaculture will also take place on nearshore reefs and in nearshore waters. Onshore aquaculture will also be practised in inland areas remote from the coast.[15] The size of individual projects will vary according to the species under culture and the production system used. For example, a farm growing marine prawns in a semi-intensive system can occupy over one hundred hectares of water surface area but one growing abalone under intensive conditions on a land-based system less than one hectare.

Optimum sites selected for Indigenous aquaculture will have topographical and hydrological features favourable for and compatible with the requisite production system. Topography and hydrology are particularly relevant to water supply and discharge systems, the development and operation of which can have a significant impact on capital and operating costs. Aquaculture is usually water-intensive; the quantity of water available and the various methods of its economical supply and discharge need to be examined critically and in detail when selecting a site. The topography and hydrology of sites selected for Indigenous aquaculture will need to permit the establishment of efficient and cost-effective water supply and discharge systems. For Indigenous aquaculture, factors relevant to water supply and discharge will mainly include the definition of the water source, the quantity of water available and the determination of an economic and efficient supply and discharge system.

Clearly relevant only to onshore systems, soil characteristics and vegetation type are important site-selection determinants when semi-intensive ponds are to be constructed, but less critical where the proposed production system is more intensive. Meteorological information about wind direction and strength, average monthly air temperatures, rainfall, evaporation, humidity and storm and flooding events also help with the site selection process.

Biological and Ecological Features

The biological and ecological features relevant to aquaculture site selection are:

- water quality (physio-chemical parameters include temperature, salinity, turbidity, dissolved oxygen, pH and the concentration of pollutants such as heavy metals);
- the environment (the effects of the environment on aquaculture as well as those of aquaculture on the environment);
- parasites and predators (aquatic protozoan or metazoan parasites and predators that could threaten aquaculture operations); and
- pollution and history of usage (existing and possible future sources of pollution and contamination).

[14] For the purpose of this study, the term *hydrology* is used to describe the contours of the sea or lake bed as well as the properties of the water supply and its movement.

[15] For the purpose of this study, the term *coastal* is used to describe those onshore and offshore areas that are subject to and influenced by coastal processes.

The water quality at Indigenous aquaculture sites throughout Australia will vary considerably, from the warm, turbid coastal waters off the northern coast to the clear, cold waters off the southern coast. Inland waters will also vary not only in temperature but also in salinity and chemical variables. Water quality is usually the single most important factor that governs the ultimate success of aquaculture. For much of the anticipated Indigenous aquaculture development, most of the water-quality parameters will be predetermined by the location of the site. For all cases, it will be essential to ensure that the target species are amenable to commercial aquaculture under the water quality conditions prevailing at the selected site.

Temperature, which affects growth rate and influences parameters such as oxygen solubility, food conversion efficiency and fish health, is a major factor influencing the commercial viability of an aquaculture operation. The water temperature characteristic of a potential aquaculture site should be suitable for the species being considered for culture and within the desired range for the growing season.[16] Waters can be roughly classified according to their salinity, which can vary from zero in fresh water to above 300 g/L in hypersaline water.[17] As with temperature, each species is characterised by having optimum and maximum salinity ranges, so the salinity of the water at a given site will govern the selection of species suited for that site. Turbidity, which results from dissolved and suspended substances in the water, will also influence the selection of suitable species. Waters with similar temperatures and salinities but different turbidity might not be suitable for similar species; barramundi, for example, will tolerate turbid water but many reef species will not.

Aquaculture systems usually constitute an integral part of the environment: onshore, flow-through systems generally drain into and so can affect rivers, lakes and coastal areas, while offshore, open systems can affect coastal and oceanic areas. Accordingly, the contemplation of Indigenous aquaculture development at any site needs to take into account not only the effect a polluted environment may have on the proposed aquaculture enterprise, but also the pollutive effects the aquaculture operation may have on the local environment. For inland aquaculture, consideration needs to be given to environmental impact mainly in terms of demand for resources (such as land use, water use and seed requirements), waste outputs (such as uneaten food, faecal and soluble excretory products, chemicals and drugs) and saline water the salinity of which has increased from evaporative losses and, for coastal and offshore aquaculture, in terms of effects on wetlands, increasing nutrient loads, increasing toxicity and antibiotic resistance, diminishing environmental biodiversity and any adverse socio-economic and health implications.

With a few exceptions, it will usually be difficult to identify and evaluate potential threats to Indigenous aquaculture from parasites and predators before production begins. The threat posed by most potential parasites will often only becomes apparent after the farm is established. Fish kills and previous pathological studies carried out on local wild fish can be used to indicate potential pathogens. Predators include fish and other aquatic species that may be introduced to the production system through its water intake, as well as predatory birds, reptiles and mammals. The occurrence and abundance of potential predators in the vicinity of a site needs to be estimated and methods for their control determined.

Most Indigenous aquaculture sites are likely to be remote, in undeveloped areas where the threat of pollution and contamination is low. In more developed areas, it will be important to identify the presence and proximity of any pollution sources and gather available information about future development plans and past biological or industrial events, such as fish kills or oil spills. Details about the previous usage and history of the site should be sought, particularly in relation to any previous use of pesticides and herbicides, which are extremely toxic to aquatic life in very small concentrations.

[16] The growing season is defined by the period during the year that allows the production of a market-sized fish within reasonable time. As such, a growing season for a particular species may extend over more than one year.

[17] In this text, the terms *fresh, brackish, sea* (or *marine*) and *hypersaline* are used to refer to waters with salinities of <2, 2-32, 32-38 and >38g/L respectively. The salinites of inland waters in areas with high rainfall are usually low; those of waters in arid areas often higher, particularly in areas of the country affected by increasing salinisation of agricultural land. The salinity of sea water is usually between 33-36g/L, with an average of 36g/L, while that of salt lakes can exceed 300g/L.

Economic Factors

The economic factors relevant to aquaculture site selection are:

- infrastructure and services (the installations, equipment and services required for production and related activities);
- labour (staff with the requisite technical and management skills);
- sources of feed, equipment and raw materials (mainly pelletised feeds);
- diagnostic services (pathological and analytical services);
- processing, packaging and transportation.

Infrastructure costs usually constitute a significant component of the capital costs of an aquaculture operation. This is a significant factor in remote areas where much of Australia's Indigenous aquaculture development will take place. Any relevant, existing infrastructure such as buildings, roads and power supplies may add to the value and potential of a proposed aquaculture site. The availability of services such as portable water, telephone lines, sewerage and security are also important determinants of site suitability. Consideration also needs to be given to the availability and cost of trades' persons, such as electricians, plumbers and builders, who will be needed during the construction and operational stages.

Some aquaculture operations need only semi-skilled and unskilled labour, while others need highly-skilled and experienced staff. The availability of the requisite skilled, semi-skilled and unskilled labour is a critical issue for Indigenous aquaculture development. This issue is linked with education, training and extension and dealt with in some detail in this study.

Feeds acquired from external sources can comprise a significant portion of total operating costs, particularly for intensive operations. Indigenous aquaculture projects will include extensive systems, in which little or no supplementary feeding is provided, to semi-intensive and intensive projects, where significant quantities are provided from external sources. For more intensive operations, the availability and quality of feeds and other essential raw materials will be important, particularly in some of the more remote regions of Australia, for which the proximity of reliable feed suppliers assumes increasing importance. Hatchery feeds are usually significantly more expensive per unit weight than growout feeds, but smaller quantities are required. For hatchery feeds, the proximity of the supplier is therefore less critical.

Any efficient aquaculture operation requires an array of diagnostic services ranging from water quality analyses to pathology. Indigenous aquaculture projects will need to have equipment dedicated for analyses of water quality required for day-to-day farm management activities. Detailed analyses of water quality and soils required as part of site selection processes would be undertaken by specialised laboratories located in capital cities and many large regional centres. The proximity of a competent fish health laboratory to aquaculture operations is considered a distinct advantage: chronic and acute mortalities due to disease and other factors can often pose serious threats to aquaculture and effective diagnoses and treatments can make the difference between the success and failure of commercial aquaculture. Most state governments provide fish health services.

Marketing research carried out to identify the preferred products will determine the type of processing and packaging needed. According to the degree of vertical integration in an aquaculture operation, some or all

processing and packaging may take place on site; alternatively, separate specialist facilities can be employed to undertake these functions.[18] A decision to use external companies or contractors for processing and packaging would be influenced by the availability, proximity and quality of relevant facilities. The means and associated costs of transporting the product to market need consideration, particularly for sites remote from the target markets. In some cases, the selection of species for Indigenous aquaculture will be influenced by transportation factors: the production of high-value species or products can offset high transportation costs.

Social and Legal Factors

The social and legal factors relevant to aquaculture site selection are:

- cultural factors;
- urban proximity;
- competitive resource use; and
- legal issues and land tenure.

Cultural factors assume significance for many Indigenous communities, in respect to the site that may be used for aquaculture as well as the species that are candidates for culture. The use of some areas for anything other than their traditional uses may be unacceptable, just as the culture of certain totem species would not be allowed for different people and communities. The management requirements of selected species will also need to be considered for periods when daily work is not possible; for example during the Law, which takes precedence over all other activities.

Urban proximity is unlikely to be a significant issue for Indigenous aquaculture development, since the communities next to which farms would be located would already provide for the social and other requirements of the people employed in the project.

Competing resource use is becoming increasingly important to aquaculture development, particularly in coastal areas near major urban centres. Competition for resources, particularly where they are scarce or limited, may arise internally, within Indigenous communities, or externally, between communities and other interest groups.

An important component of any proposal to develop Indigenous aquaculture will be consideration of the licensing and legislative requirements of the relevant local, state and federal government authorities. A site plan for each project will be required, together with information about the species to be cultured, water source and quantities, discharge point and waste-water treatment. There may be a requirement for some form of environmental impact study to be carried out in environmentally-sensitive areas. Other relevant issues include land ownership, legislative and other requirements for land acquisition or leasing and rights of access.

Species for Indigenous Aquaculture

The following discussion provides a rationale for the selection of species best suited for Indigenous aquaculture projects. It considers the characteristics of species in relation to their compatibility with the sites and production systems.

For Indigenous aquaculture to be successful, it will be essential that the species targeted for production satisfy certain conditions in respect of marketing, culture technology, production efficiency and commercial viability. The species selection criteria that collectively comprise each of these categories are discussed below.

[18] Frequently, the equipment and methods that are used for processing and packaging can be both specialised and expensive and it is usually only large-volume, vertically integrated aquaculture operations that undertake these activities in-house. Smaller operations often depend, at least to some extent, on external processors and packagers.

Marketing

For an aquaculture project to succeed, it is essential that it grows a product that the market wants. One of the main reasons aquaculture projects fail is they continue to disregard this concept, despite its simplicity. Any proposed Indigenous aquaculture project must be market driven; that is, it needs to grow a product in demand in the market place at an acceptable price. When selecting a species for aquaculture, consideration needs to be given to the features of the product as well as the economics and features of the market place.

Product features refer to its physical characteristics, form and quality. Market economics refer mainly to volume and price demands of the market place and consequently have a significant influence on the choice of a species for aquaculture. A clear assessment needs to be made of the likely returns for the species under consideration for aquaculture and the volumes likely to be able to be placed in the market to ensure that an adequate return can be received. Market place features include market structure, competition and segmentation.

Indigenous aquaculture operations growing high-value products for distant markets will need to command a premium price in the market place to offset the disadvantage of distance and will have to select the species that can command the requisite prices.

Culture Technology

For Indigenous aquaculture to proceed, it will be necessary to select species with reasonably well known culture technologies. Culture technology describes the technical procedures used to culture a species through the various stages of its life history. It includes technical procedures for broodstock husbandry and spawning, larval rearing, juvenile production and growout.

For many species, technology for the control of broodstock maturation and spawning in captivity is necessary to ensure the supply of seed stock and avoid reliance on the repetitive collection of wild seed or wild broodstock in or near spawning condition. For others, such as some marine prawn and mollusc species, wild females in reproductive condition are captured and spawned in a hatchery or devices are placed in the ocean to collect wild spat that are then on grown.

Favourable attributes for species being considered for Indigenous aquaculture include the reproductive characteristics of the species in captivity, its fecundity, the size of the eggs that are produced and their quality. Higher fecundities are usually preferred for aquaculture candidate species, since fewer broodstock and smaller facilities are then required for production purposes. Similarly, the early development and behaviour of larvae and juveniles influence the potential of a species for aquaculture. Relevant factors include the size of the newly-hatched larvae, their ease of culture through the successive stages of their life histories, their behaviour and the duration of the larval period.[19]

The supply of adequate quantities of good-quality seed for growout is often a significant constraint to aquaculture development, so the status of the hatchery technology available for a species is an important species-selection criterion. The hatchery stage of the culture cycle is usually the most demanding in terms of culture technology. This is not considered a disadvantage for the development of Indigenous aquaculture, since a common hatchery could be established that provides the requisite seed stock to numerous and widely-distributed growout farms.

Culture technologies for growout are frequently less demanding than for hatchery production and are concerned mainly with providing a suitable growing environment and diet for the species under culture.

[19] The duration of the larval period is important, since species with shorter larval periods are usually easier to rear to the juvenile stage and therefore considered better aquaculture candidates.

Production Efficiency

The efficiency with which a species can be produced is determined mainly by its growth rate, food conversion efficiency, diet, environmental tolerances, hardiness and behaviour.

The growth rate of a species is one of the most important characteristics that govern its suitability for aquaculture. Rapid growth rates allow a marketable size to be achieved in shorter periods and permit more frequent harvests. Some slower-growing species with high market values may be considered good aquaculture candidates, but it can be difficult to culture them economically; additionally, a long growout increases the risk to the farm. The main factors that influence growth rate under culture conditions are temperature, dissolved oxygen concentration, ammonia concentration, salinity, competition, food availability and composition, age and maturity. Consideration and evaluation of these factors and their interaction with each other and the production system constitutes an important aspect of the species selection process.

The food conversion ratio ("FCR") is an expression of the efficiency with which the culture species converts feed into flesh. Usually expressed as the ratio of the dry weight of the feed to the wet weight of the animal, FCR varies significantly according to species, size, diet and culture conditions. Because the cost of feed usually comprises a major component of total operating costs, the efficiency with which it is converted is an important species-selection criterion: species with more efficient FCRs are likely to be better aquaculture candidates.

The selection of a species for aquaculture should include consideration of the feeds that may be commercially available, together with the feeding habits of the species being considered. Most feeds in contemporary aquaculture are dry pellets that are either compressed or extruded and manufactured to be floating or sinking, according to the feeding preferences of the species. The palatability, size, shape and texture of pelletised diets are all important factors that influence acceptability and hence feeding rates and growth.

The environmental tolerances a species has to water quality parameters and other environmental variables characteristic of a site being considered for its aquaculture constitute a critical species-selection criterion. A species is best suited to culture in an environment characterised by variables that are within its optimum or ideal range.

Some culture species are hardier than others: their ability to withstand stress, crowding, handling and poor water quality is greater and consequently they are less prone to disease. Similarly, the habit of a species may determine its suitability to a particular culture system.

Commercial Viability

Whether undertaken to generate either commercial or social benefits to the communities, the viability of Indigenous aquaculture will be determined by its profitability. For commercial projects, the selling price of the product needs to more than compensate for its production costs, while the demand volume must be able to take up the output without excessive price erosion. For socially-oriented projects, profitability will be determined principally by the social benefits that are realised but also the economic reality of ensuring production costs remain competitive.

The profitability of an aquaculture operation is significantly influenced by the species being produced. One method of determining the potential profitability of a candidate species is to analyse the costs and returns that can realistically be expected for it, then carry out an analysis of investment feasibility.

Within the context of species selection, the commercial viability of a species can also depend on the infrastructure that may be necessary for its culture, its competitiveness, potential for integration with other systems or species and the amount of regulation and support that exists for its development.

Some species require significant infrastructure for their successful culture; others, such as bivalve mussels and oysters cultured in intertidal or subtidal areas require comparatively little. Competitiveness is important: the merits of a species need to be evaluated against those of other candidate species and with a view to competition from other producers.

Production Systems

An aquaculture production system can be defined as the integrated assemblage of natural resources, plant, equipment and management practices that has as its goal the culture of a selected species at a given site for defined economic or social reasons. A wide variety of production systems are available to modern aquaculturists and, to determine which is best suited to a particular species and site, and which would be the most practicable and profitable under given circumstances, it is important to know and be able to compare and evaluate the advantages and disadvantages associated with each.

To properly compare and evaluate different production systems, it is necessary to identify and define their components according to some common standard. Agencies in different states have developed various standards according to their requirements and according to the systems most commonly used. This study integrates these and other relevant descriptions of production systems and provides a standard that can be applied nationally.

Commercial aquaculture is characterised by a wide and increasing variety of production systems, each of which can be described and defined by six principal elements. These are:

i. location and water type;

ii. culture units;

iii. water flow;

iv. intensity;

v. production capability; and

vi. scale and integration.

Location and Water Type

Aquaculture production systems can be located either onshore (land-based) or offshore (water-based). Onshore locations may be classified as coastal or inland and offshore locations as nearshore or open ocean. For aquaculture purposes, the distinction between nearshore and open ocean locations is the influence of coastal processes: nearshore locations are influenced by coastal processes, while open ocean locations are not.

Today, it is technically feasible to locate onshore and offshore aquaculture production systems at almost any location; however, financial factors usually govern the practicability of a particular system for any given site.

The type of water used in aquaculture production ranges from fresh to brackish, marine and hypersaline, according to the salinity. Onshore coastal production systems usually use marine or brackish water and inland

systems fresh water; however, in Australia, large inland areas of Western Australia, New South Wales and Victoria are characterised by brackish surface and ground water, the salinity of which varies from nearly fresh to greater than 35‰. Offshore systems are usually marine, but can be fresh in the case of large, fresh-water lakes.

Culture Units

The numerous culture units that exist can generally be classified as tanks, raceways, ponds, cages, longlines, racks, ranching and fisheries enhancement.

Tanks and Raceways

Tanks and raceways are usually used in intensive, onshore production systems. They usually have high water-exchange rates, high stocking densities and share many common features in appearance and construction.

The main distinction between tanks and raceways, which has implications for their management, husbandry practices and the species for which they may be best suited, is their hydrodynamics. Tanks are characterised by a mixed flow, in which incoming water is mixed with original water and the quality of the water being discharged is about the same as that in the tank. Water in raceways water passes linearly along the raceway. There is little mixing within the raceway and the quality of the water discharged is usually considerably different from that near the inlet point.

Ponds

Ponds are widely used for the semi-intensive production of marine prawns and various fresh-water species. They are usually earthen and can be classified according to their type and whether they provide a static or dynamic environment.

Watershed ponds are those formed by building a dam across a stream or other water course; they are usually not profitable for the more traditional forms of aquaculture and so are uncommon. Levee ponds, the main type used for aquaculture, are supplied with pumped water and constructed either by excavating holes and building levees around them, or by constructing above-ground levees to hold water.

Ponds are also characterised by either a static or a dynamic water system. Static systems have no regular water input; dynamic pond systems have continuously or intermittently-flowing water that allows some of the volume to be exchanged daily. Dynamic pond systems are more expensive to build and operate; however, their yield is invariably higher.

Cages

Cages are offshore culture units enclosed on the bottom and sides by nets or mesh screens.[20] A wide variety of cages is available and has been used for aquaculture, from simple designs for sheltered, coastal waters to large, open-ocean cages designed to withstand cyclonic conditions. Cage systems are used predominantly for offshore marine finfish growout; however, the growout in cages of shellfish species such as abalone is becoming more common.

Longlines and Racks

Longlines and racks are commonly used to culture bivalves and other shellfish.[21] Longlines are lines suspended at the water surface or in the water column between anchors and floats. They support several secondary lines, to which can be attached an array of structures such as spat collectors and pearl, lantern and pocket nets in which

[20] Cages are often confused with and incorrectly called pens or enclosures, terms with which, in aquaculture, they are not synonymous. In aquaculture, an enclosure is usually a natural bay closed off by a net or some other barrier. A pen is transitional between an enclosure and a cage, in which all the sides are enclosed by a net or other material and the bottom is formed by the natural sea or lake bed.

[21] Many systems other than longlines and racks are used to grow shellfish, such as floats, rafts, trays and posts. The fundamental principles behind these methods are similar to those of longlines and racks, which are considered to be the predominant systems used for shellfish aquaculture today. Longlines and racks are therefore the systems used in this study to represent and describe shellfish aquaculture in offshore production systems other than sea cages.

shellfish are contained; or ropes, to which shellfish are attached by various means. Rack systems are used in relatively shallow water to support bivalves above the sea bed. They are most common in intertidal areas where tidal fluctuations sequentially submerge and expose the racks and the shellfish they contain.

Ranching and Fisheries Enhancement

Ranching and fisheries enhancement involve the release into the wild of seed grown in onshore facilities. For it to succeed, there must be some guarantee that the fish released will be available for later harvesting. Ranching is most likely to be successful when the species being ranched is:

- high in value;
- characterised by migratory behaviour and returns naturally to its point of release (salmon provides a good example);
- relatively stationary and can be seeded or stocked on the sea bed and reefs, from which it may later be harvested (shellfish with limited mobility, such as scallops, abalone and trochus, are good examples); or
- stocked in a natural water body from which there is no escape.

Water Flow

According to the type of water flow, a production system may be open, flow-through or recirculating. True closed systems, which, by definition, have no water flow or exchange (other than the initial flow needed to fill the culture units), are rarely seen in commercial aquaculture.

Open production systems usually refer to aquaculture in natural water bodies such as oceans, bays and fresh-water lakes. Offshore marine finfish production systems are usually open and use cages as culture units.

Flow-through systems, also known as single-pass systems are the most common in onshore aquaculture and are characterised by a continuous water flow. The water usually passes once through the culture units and is made to enter and leave the culture unit simultaneously and at equal flow rates.

Recirculating systems are those in which most of the water circulated through the culture units is continuously treated and recycled. These systems are comparatively expensive to establish and use more complex technology than other systems, so they are usually employed to culture high-value species in areas where large volumes of high-quality water are not available or the temperatures unsuitable.

Intensity

The intensity of an aquaculture production system is defined mainly by the level of management, the stock density and the yield per unit volume or area. According to these parameters, production systems may be classified as intensive, semi-intensive or extensive. These three classifications are not necessarily exclusive of each other; different levels of production intensity can be used within a single aquaculture production system and differences between semi-intensive and intensive systems can become less distinct, as is the case for many marine prawn farms, which are becoming progressively more intensive as management and technical procedures improve.

Intensive systems typically have a high level of management, high stock densities and use artificial feeds for the nutritional requirements of the stock. They are frequently vertically integrated to some degree and all inputs such as feeding, water quality, water-flow rates and waste-water treatment are monitored and controlled. Most intensive systems are technically-oriented, require properly-engineered construction and operation and operate at stock densities that result in maximum sustainable yields and profitability.

Semi-intensive systems typically have an intermediate level of management, intermediate culture densities and, for nutritional requirements, depend on increased natural productivity, which is augmented by adding fertilisers, and on supplementary feeding. Some inputs, such as supplementary feeding, aeration and water exchange, are provided. Semi-intensive systems support higher stocking densities than extensive systems, resulting in improved yields and increased profitability. In order to maximise return on invested capital, the trend in semi-intensive aquaculture has been towards the production of higher-value species and increasing the level of intensity and yield as far as possible.

Extensive systems usually have a low level of management, low culture densities and, for the nutritional requirements of the species under culture, depend on natural productivity, which may be augmented by some fertilisation.

Production Capability

Production capability or yield is simply a measure of the quantity of fish produced within the system per unit volume or area per unit time. It is measured according to the species under culture and the production system.

Scale and Integration

Scale refers to the physical size of an aquaculture operation or the area it occupies, not its level of production or yield. Scale is usually governed by a minimum economic unit for the species under culture and is influenced by the intensity of the production system and the culture technology. Small, medium and large-scale production systems usually are defined somewhat arbitrarily as those that occupy areas of up to 20 ha, 20-200 ha and greater than 200 ha respectively.

The more intensive production systems are usually small-scale and semi-intensive systems usually medium to large-scale. Both are usually distinguished by some degree of vertical integration.

Production systems are also defined and influenced by their degree of integration.

Vertically-integrated systems comprise some or all of the mutually-dependent elements that constitute the production cycle, such as the hatchery, growout farm, processing operations and associated activities such as feed production.

Horizontal integration involves the merging of aquaculture with agricultural or other industries to maximise the collective income that can be generated from a limited resource by utilising by-products or taking advantage of complementary, synergetic activities.

Polyculture is a form of integrated aquaculture that involves the simultaneous production of more than one species within a single production system, not necessarily within the same culture unit, where there is some degree of interdependence between the species.[22] In efficient polyculture, the output from a single production system can be improved, and the profitability increased, by growing different but complementary species that make optimum use of available resources.

[22] Poyculture assumes some interdependence between species. Where there is no interdependence, the production system is considered a multi-species one.

APPENDIX TWO: Candidate Species

The consultative process carried out during this project identified a large number of candidate species for Indigenous aquaculture development.[23] In order to focus limited financial and other resources on development, it is often necessary to determine which of the candidate species present the best opportunities for success. For many species these determinations are often subjective, since the empirical data required for objective decisions do not yet exist. Further, species selected for Indigenous aquaculture, at least initially, would have to be compatible with certain cultural factors.

Generally, the classification of species according to their perceived aquaculture potential should consider:

- marketing, production efficiency and commercial viability characteristics;
- the state-of-the-art of the culture technology for the species; and
- the compatibility of suitable production systems with the nature of the available sites.

Good candidate species should have:

- favourable marketing, production efficiency and commercial viability factors;
- either well-known or reasonably-well-known culture technologies; and
- production systems compatible with the nature of the available sites.

Poor candidates would usually be characterised by having:

- unfavourable marketing, production efficiency or commercial viability factors;
- poorly-known culture technologies; and/or
- production systems incompatible with the nature of the available sites.

Relevant comments are provided in respect of this classification system for each of the candidate species discussed in chapter three.

It should be noted that the Fisheries or Primary Industries departments of most state and territory governments can provide more detailed brochures, notes and other published information about the culture technology and aquaculture potential for most of the species currently being produced by, or contemplated for, aquaculture.

[23] It is emphasised that the lists of candidate species are inclusive, not exclusive. Literally, hundreds of species have been considered for aquaculture in Australia alone and it would be impracticable to provide information about all of these in a document of this nature. Accordingly, this study provides limited information about those species raised and discussed as candidates for Indigenous aquaculture during the consultative process. It is likely that many species that might be good candidates for aquaculture in the future, especially under the often-unique cultural and economic conditions prevailing for Indigenous aquaculture, have not been included in the lists of species. Fisheries departments in the various states and territories are well placed to provide initial information about these latter species if required.

Table 5. Candidate finfish species for Indigenous aquaculture.

Common name	Scientific name	Culture environment
Barramundi	*Lates calcarifer*	Tropical, marine, brackish and fresh water
Reef fishes Mainly	*Plectropomus spp. and Epinephelus spp.*	Tropical, marine
Eels	*Anguilla spp.*	Tropical and temperate, fresh water
Aquarium fishes	Various species	Mainly tropical, fresh water and marine
Southern bluefin tuna	*Thunnus maccoyyi*	Tropical and temperate, marine
Snapper	*Pagrus auratus*	Mainly temperate, marine
Black bream[1]	*Acanthopagrus butcheri*	Mainly temperate, brackish and fresh water
Mulloway[2]	*Argyrosomus hololepidotus*	Temperate, marine
Sleepy cod	*Oxyeleotris lineolatus*	Tropical, fresh water
Rainbow trout	*Oncorhynchus mykiss*	Temperate, marine, brackish and fresh water
Atlantic salmon	*Salmo salar*	Temperate, marine and fresh water
Silver perch	*Bidyanus bidyanus*	Tropical and temperate, fresh water
Murray cod	*Maccullochella peeli*	Temperate, fresh water
Australian bass	*Macquaria novemaculeata*	Temperate, fresh water

Notes
[1] Other species commonly known as black bream include Acanthopagrus berda, the tropical or pikey bream, which is abundant in tropical estuaries in northern Australia, and *Hephaestus spp.*, the sooty grunters, different species of which occur across northern Australia and that have been considered for aquaculture.
[2] Mulloway are commonly known as jewfish on the east coast of Australia.

Table 6. Candidate shellfish species for Indigenous aquaculture.

Common name	Scientific name	Culture environment
Trochus	*Trochus niloticus*	Tropical, marine
Pearl oysters	*Pinctada spp.*	Tropical, marine
Edible oysters	*Crassostrea sp., Saccostrea sp.*	Temperate and tropical, marine
Abalone	*Haliotis spp.*	Temperate and tropical, marine
Mussels	*Mytilus edulis*	Temperate, marine
Marine prawns	*Penaeus spp.*	Tropical, brackish water and marine
Giant clam	*Tridacna gigas*	Tropical, marine
Mangrove crab	*Scylla serrata*	Tropical, brackish water and marine
Scallops	Various species	Mainly temperate, marine
Beche-de-mer or trepang	*Holothuria spp.*	Tropical, marine
Tropical rock lobster	*Panulirus ornatis*	Tropical, marine
Redclaw crayfish	*Cherax quadricarinatus*	Tropical, fresh water
Fresh-water prawns	*Macrobrachium rosenbergii*	Tropical, fresh water
Yabbies	*Cherax albidus*	Temperate, fresh water
Marron	*Cherax tenuimanus*	Temperate, fresh water
Mud crabs	*Scylla spp.*	Tropical, brackish water and marine

Finfish

Barramundi

Barramundi (*Lates calcarifer*) are found naturally in northern Australia throughout the Wet Tropical Region, from the Ashburton River in Western Australia to south of Fraser Island in Queensland. Translocations for the purpose of aquaculture have occurred and the fish is now produced in cooler, temperate areas using recirculating systems or geothermal ground water. The fish enjoys a high market profile and is usually considered one of Australia's best-eating fish. Plate-size fish have generally predominated the domestic market, but there is considered to be

significant potential for larger fish weighing 2-3 kg for the fillet market. The national cultured barramundi production for 1998-99 is about 800 tonnes. The production of larger fish will enable growers to supply the large domestic market for barramundi fillets and enter the export market, which would almost certainly be based on larger fish. Increasing volumes anticipated in the domestic and export market places may depress prices in the future.

The culture technology for barramundi is very well known and a large amount of published information about all aspects of barramundi aquaculture is currently available. Larvae can be reared using clear water or green water in intensive tanks or in extensive pond systems. In a good production system, the species has a good production efficiency and production costs can be kept reasonably low. Barramundi can be grown in a variety of production systems, using intensive and semi-intensive tanks, ponds and cages. The commercial viability of barramundi farming will be determined in the future by the efficiency of individual operations and maintaining a low cost of production to allow competitive sale pricing.

Reef Fishes

Included in this category are mainly serranid species, including coral trout (*Plectropomus leopardus*), estuary cod (*Epinephelus coioides*), barramundi cod (*Cromileptes altivelis*) and other fish generally known as groupers in the high-value South-east Asian market. It also includes sea perches or lutjanids such as mangrove jack (*Lutjanus argentimaculatus*) and red emperor (*Lutjanus sebae*). These reef fishes are usually found in demersal habitats on coral reefs, in coastal bays and estuaries and are generally distributed throughout tropical Australia. The groupers are characterised by a high market demand and value, particularly in live form in export markets.

Culture technologies for reef fishes such as coral trout and barramundi cod are in the process of being developed in countries such as Australia, Indonesia, Taiwan and Japan. Estuary cod are currently grown in Taiwan and the requisite culture technology is being developed in Western Australia and Queensland. Mangrove jack are being produced in Queensland with some success at a research level, but commercial-scale production has not yet been achieved. Given the high value of reef fishes, the technologies needed for their commercial culture will probably be available in the near future. Based on the culture of similar species elsewhere and the high value of these species, the production efficiency and commercial viability of some reef fishes will be suitable for commercial aquaculture.

Eels

The main species of interest for aquaculture are the short-finned eel (*Anguilla australis*) and long-finned eel (*Anguilla reinhardtii*). Short-finned eels are restricted to the South-Eastern Region where their natural range includes the Tasmanian, South-East Coast and southern parts of the North-East Coast drainage divisions. The natural range of long-finned eels includes parts of the Wet Tropical and Eastern Temperate regions and extends from Cape York to Melbourne and Tasmania. Eels are highly regarded in export markets. Most of the product grown in semi-intensive systems is usually sold to European markets in smoked form, while smaller quantities are sold live into markets in Hong Kong, Taiwan and Korea. Eels produced in intensive, recirculating systems are usually sold in smoked form to domestic markets and live to domestic and export markets such as Japan.

Eel seed stocks are harvested wild; at present, hatchery technology to produce juveniles for growout does not exist. This is the biggest factor affecting production. The growout technology is well known, with eels being produced in semi-intensive ponds and more intensive flow-through and recirculating systems. The commercial viability of the industry sector is good, due to the usually-high market price for the product.

Aquarium Fishes

Aquarium or ornamental fishes produced by aquaculture mainly include goldfish and numerous species of tropical, fresh-water fishes. About 60 species are grown in Australia and sold principally to the domestic market, although there is considered to be significant potential for native species in export markets. Among the fresh-water species grown are angel fish (*Pterophyllum scalare*), goldfish and black moor (*Cyprinidae family*), saratoga (*Scleropages leichardti* and *S. jardini*) and some natives such as rainbow fishes (*Melanotaenia spp.*).

Among the marine species, the culture of leafy seadragons (*Phycodorus equus*) is either prohibited or allowed under strictly-controlled conditions according to the state. Seahorses are current cultured in a farm in Tasmania. Marine aquarium fishes with potential for aquaculture mainly include tropical species that inhabit coral reefs. These species have a reasonably high market value, particularly in terms of value per unit weight. At present, however, most marine aquarium fish supplied to domestic and export markets are captured in the wild and the technology required for their mass production is, generally, poorly known.

The culture technologies are well known for the more common fresh-water species. More recent interest has focused on the production of marine fish for the aquarium trade, but culture technologies are in the research stages for many of these species. Once suitable culture technology is available for marine aquarium fishes, the production efficiency and commercial viability for these species is likely to be quite good. The commercial viability of aquarium fish aquaculture would vary significantly according to the site, species and production system. The development of an aquarium fish industry sector, especially collection of wild fresh-water aquarium species in northern Australia to supply both domestic and overseas markets, may present significant opportunities for Indigenous aquaculture.

Snapper

The natural distribution of snapper (*Pagrus auratus*), also known as pink snapper, in Australia extends across the southern half of the continent including Tasmania, up to Coral Bay off the west coast and the Capricorn Group off the east. The fish inhabit coastal and deep offshore waters. The fish is highly regarded in domestic and export markets. Plate-size cultured fish might fetch reasonably high prices in domestic and export markets for fresh-chilled and possibly live product forms.

Culture technology suitable for commercial production has been recently developed for snapper in Australia, although the commercial viability of the species is still unknown. It is likely there will be competition in the market place from wild-caught product from the Australian and New Zealand wild-capture fisheries.

Black bream

Black bream (*Acanthopagrus butcheri*) are found in estuaries around the southern coast of Australia, from the Murchison River in Western Australia to southern New South Wales and including Tasmania. The species has some demand in the market place but is not usually considered high value, possible due to the variable supply from the wild-capture fishery. The more regular supply that could be achieved with cultured fish could possibly achieve premium prices in domestic markets. There may be some potential for live fish in some export markets in Asia.

The culture technology for the species has been developed and a hatchery manual produced. Generally, black bream are hardy fish well adapted for aquaculture. They have been grown with limited success in farm dams

containing fresh water, but may be better suited to more brackish water in warmer areas. Work to develop an efficient pelletised diet is planned. The commercial viability of black bream aquaculture is presently unknown, but the species is generally considered to have some potential if cultured under the right conditions.

Mulloway

Mulloway (*Argyrosomus hololepidotus*) occur naturally in coastal and estuarine waters across the southern half of Australia, excluding Tasmania, up to Exmouth Gulf on the west coast and southern Queensland in the east. The fish does not generally command a high market price. A domestic market might be developed for plate-size fish produced by aquaculture.

The culture technology has been developed for mulloway on a small, research scale but as yet is unproven on a commercial scale. There is no commercial production of juveniles for grow-out culture. The commercial viability for the species may be marginal, unless a reasonably good market can be developed.

Sleepy Cod

Sleepy cod (*Oxyeleotris lineolatus*) occur naturally in fresh water habitats in northern, tropical Australia, from the Kimberley region of Western Australia across the Northern Territory to the east coast of Queensland. The species is intensively marketed overseas, where Asian sleepy cod (*Oxyeleotris marmoratus*), which are closely related to the Australian sleepy cod, have a very high value. The production of sleepy cod in Asia is limited and there are opportunities for domestic and export markets to be developed for fish cultured in Australia.

Due to the close relationship between the different species, the culture technology that is well developed for the Asian sleepy cod is likely to be readily transferred to Australian sleepy cod. The culture technology for sleepy cod in Australia, although not well established at present, has been the subject of initial research and ongoing commercialisation and evaluation by the Queensland Department of Primary Industries. The production efficiency and commercial viability will probably be high: a recent economic analysis of the species indicated that it could be farmed profitably. The species is particularly hardy and can be readily transported under moist conditions, a feature that has significant cost-reduction implications for the live transportation of the fish to the premium Asian markets.

Rainbow Trout

Trout farming has been undertaken in Australia for some time. The main species produced by aquaculture is rainbow trout (*O. mykiss*). The smaller quantities of brown trout (*Salmo trutta*) produced are used mainly for restocking rivers for the recreational fishery. Trout are not native to Australia and all existing stocks have been introduced. Rainbow trout cultured in fresh water are sold mainly in domestic markets, where competition is strong. The species can also be grown out in brackish and marine water, although there are indications that full-strength sea water is not ideal for the growout of rainbow trout. The latter are known as sea trout and compete in the market with Atlantic salmon, which they resemble. Since they can be cultured in water of varying salinity, rainbow trout may also have some potential for aquaculture in inland areas affected by rising, saline ground water.

The culture technology for trout is very well known; in fact, as a result of its long farming history, rainbow trout represents one of the few species that can be considered truly domesticated. The fish have been grown using ponds, tanks, raceways and cages. Rainbow trout marketed as sea trout are grown out in marine water, usually in

cages. The competitive market for plate-size fish means that only the more efficient farms with low production costs and a relatively high degree of vertical integration may be considered commercially viable.

Atlantic Salmon

Atlantic salmon (*Salmo salar*) is not native to Australia and all existing stocks have been introduced. The species is presently cultured predominantly in Tasmania, which has a world-class salmon farming industry, and smaller quantities are grown in Victoria in fresh water. There is considered to be some potential off the Victorian and South Australian coasts for cage-based farms. Sea water temperatures off the southern coast of Western Australia are generally considered too warm for the species, except on a seasonal basis. There are domestic and export markets for Atlantic salmon; however, some aspects of marketing are in a state of uncertainty as a result of a World Trade Organisation decision to allow the importation of unprocessed salmon into Australia. Competition can be expected from major producing countries such as Canada, Norway, Chile and Scotland.

The culture technology for the species is very well known and high levels of production efficiency are being achieved. Presently, salmon farming is commercially viable when undertaken using world's-best-practice culture methods.

Silver Perch

The natural range of silver perch (*Bidyanus bidyanus*) includes most of the Murray-Darling drainage division, but, as a result of translocations for recreational fishing and aquaculture purposes, the fish are now more widely distributed, although relatively uncommon in the wild. The fish enjoys a reasonably-high profile and usually attracts a premium price in the domestic market, where it is usually sold in live form. A high level of interest in the aquaculture of the species has ensued from the relatively high price it achieves in domestic markets. The commercial outlook is generally positive, since demand is expected to increase and production costs decline as production technologies improve.

The culture technology and production efficiency of the species are well known and several hatcheries have been established in southern states for the species. Growers can now usually purchase juveniles for growout directly from a commercial hatchery. Silver perch can be grown out in a range of production systems, from earthen ponds using extensive methods to semi-intensive, purpose-built ponds. Intensive systems using tanks and raceways have also been used with some success. The species may be considered commercially viable if cultured efficiently and good aquaculture practices, improved feeds, continued technology development and effective marketing strategies are expected to increase future production and profitability. The limited salinity tolerance of the species may restrict its use in inland saline waters. In general, commercial farmers have not been able to match the results of research and pilot-scale trials consistently.

Murray Cod

Australia's largest native fresh-water fish, Murray cod (*Maccullochella peeli*) are found naturally throughout most of the Murray-darling division in the Eastern Temperate Region. Wild stocks are declining, so there are opportunities for aquaculture production. The species has a high market profile and is in demand.

The culture technology for the species is reasonably well known and considered adequate for commercial production. Currently, one of the biggest constraints in the commercialisation of the species is the production of adequate supply of fingerlings for grow-out culture. Murray cod are considered well suited to growout in flow-through ponds, but are proving to be amenable to intensive, tank-based closed recirculating production systems.

Production efficiencies are not well known. Given the usually-high value of the flesh, the commercial viability of Murray cod aquaculture is likely to be good.

Australian Bass

Australian bass (*Macquaria novemaculeat*a) occur naturally in the fresh-water streams in the Eastern Temperate and southern parts of the Wet Tropical regions. The fish have a reasonably-high market profile but are not yet cultured in any significant quantities.

Culture technologies are not well known but in the process of further development. The production efficiency of the species is not well known. Its viability for commercial aquaculture is unknown, but likely to be reasonable.

Shellfish

Pearl Oysters

Pearl oysters include the silver-lip oyster (*Pinctada maxima*), which produces the highly-valued South Sea pearl, and the so-called non-P. maxima species, predominant among which is the black-lip oyster (*Pinctada margaritifera*). Black-lip oysters, which produce black pearls, are generally considered the most commercially-viable non-P. maxima species. The silver-lip oyster is the basis of Australia's valuable South Sea Pearl aquaculture industry.

Although the South Sea Pearl industry is based mainly on the use of wild P. maxima, the culture technology for oyster species generally is well known and increasingly, commercial hatcheries have regularly cultured mass quantities of spat suitable for commercial growout. The production efficiency and commercial viability of the pearl oyster species are generally well established.

Edible Oysters

Mainly cupped oysters are cultured in Australia, but there has been some interest in flat oysters. The main species are the Pacific oyster (*Crassostrea gigas*) and the Sydney rock oyster (*Saccostrea glomerata*). There is considerable potential in tropical areas for the culture of the tropical oyster. A species on the west coast considered to have some potential is similar to the Sydney rock oyster. Most oysters are sold live into domestic markets, often directly to restaurants.

The culture technology for edible oyster production is well known. The main requirement for their culture is high-quality estuarine or sea water with a suitable level of primary production. Most culture areas are in inter-tidal or sub-tidal areas using racks and longlines. The potential for the existing industry to expand is generally limited to the availability of suitable sites for growout. Oyster aquaculture has been shown to be commercially viable if efficient production techniques are used at suitable sites.

Abalone

Several abalone species are currently either being produced by aquaculture in Australia or being developed for future production. The predominant temperate species are greenlip abalone (*Haliotis laevigata*), brownlip abalone (*Haliotis conicopora*), and black-lip abalone (*Haliotis rubra*). Research and development is currently being carried out to develop culture technology for other species including Roe's abalone (*Haliotis roei*), staircase abalone (*Haliotis*

scalaris) and the tropical or asses-ear abalone (*Haliotis asinina*). Some work has also been done on hybrids. The natural distribution of these abalone clearly varies according to species. Most are temperate and found throughout the South-Eastern and Western Temperate regions, while the tropical abalone is found mainly in the warm waters of the Wet Tropical and Dry Tropical regions. The market demand for abalone is increasing. Since the wild fishery is stable or declining, there is significant potential mainly in export markets for cultured abalone.

The culture technologies for the predominant temperate species are well known and commercial abalone farms targeting these species are in production or being developed in all southern Australian states. The commercial viability of abalone farming is reasonably good and the outlook optimistic, mainly due to the high market value of the product. Most abalone farms are onshore and use intensive, flow-through production systems characterised by an initially-high capital outlay.

Tropical abalone is the fastest growing abalone species. Under culture conditions, it is marketable within 18 months or less. It has the added advantage of having a very small thin shell and a large foot muscle producing a very high meat to shell ratio. The culture technology for the tropical abalone species is being developed but believed to be very similar to its temperate cousins. A large amount of research and development work has been carried out on tropical abalone overseas, particularly in the Philippines and Thailand, and more recently in Australia. The production efficiency and commercial viability are also unknown but, given the fast growth rate, good market prospects and probable high value, likely to be positive.

Mussels

Blue mussels (*Mytilus edulis*) are distributed naturally throughout southern Australia and cultured in all Australian states except Queensland. Growers usually sell product into local and domestic markets.

Mussel farms depend on wild spatfall for seed stock. Production is invariably offshore and uses open, extensive systems growing mussels on longlines. Prices are comparatively low and industry expansion will be governed by the availability of offshore sites characterised by adequate levels of primary productivity and water quality.

Trochus

Trochus (*Trochus niloticus*) have been harvested for many years off the Dampier Peninsula of Western Australia, where a major project is under way to re-seed the reefs on which wild populations have been depleted. There is a growing market for trochus products, which principally include the shell and meat. The shell is traditionally used for making button blanks, but markets are increasing for polished shells and other products, while the market for trochus meat is considered under-developed.

The culture technology for the species is well established and procedures for mass seed production are well developed. In open culture systems, based on reseeding and stock enhancement of suitable reefs, the production efficiency is likely to be high, since no inputs beyond the hatchery-rearing stage would be required until harvest. The commercial viability of trochus aquaculture, using what is effectively a ranching production system, is presently unknown but likely to be good. Research into the stock enhancement of trochus is currently being carried out in Australia, Vanuatu and Indonesia under an ACIAR funded research project.

Marine Prawns

The most widely-cultured marine prawn in Australia and the world is the black tiger prawn (*Penaeus monodon*). Other candidate species for Australian aquaculture include the kuruma prawn (Penaeus japonicus) and, more recently, the banana prawn (*Penaeus merguiensis*) and the brown tiger prawn (*Penaeus esculentus*). These species are generally distributed throughout tropical waters of Australia and South-east Asia; however, their occurrence in the wild is becoming increasingly rare in some countries, leading to shortages in the availability of spawning stocks. Cultured marine prawns, which are known as shrimp throughout the rest of the world, are characterised by high values in domestic and many export markets and the worldwide demand continues to increase. Of those presently cultured in Australia, black tiger prawns are usually sold chilled into domestic markets, mainly in Sydney, Melbourne and Brisbane, while kuruma prawns are grown exclusively for export into the Japanese markets in live form.

The culture technologies for marine prawns, particularly that for black tiger prawn, are well known and hatchery and growout procedures well established. The maturation of captive broodstock is difficult and the industry currently relies on the supply of wild-caught spawning stock for its egg supply. The rapid growth rate of the species and their comparatively low requirements for protein make them attractive candidates for aquaculture. The good management of coastal environments in Australia and the uptake and development of modern culture technologies will lead to the continued development in this country of an internationally-competitive industry. Marine prawn aquaculture is almost invariably practised in earthen ponds established close to sources of high-quality tidal estuarine or sea water. Recirculation systems presently being developed in some countries are unlikely to be commercially competitive here. The aquaculture of black tiger prawns in Australia is considered commercially viable and there is significant potential for the industry to expand.

Giant Clam

Giant clams (*Tridacna gigas*) are distributed on reefs in oceanic-quality water throughout much of northern Australia. The meat from the species is considered a delicacy and it may have moderate prospects in Southeast Asian markets. There may also be a limited market for small specimens suitable for the aquarium trade.

The culture technology needed for the production of the species has been developed and is available; giant clam aquaculture is currently in the early stages of commercial development in several island nations in the Pacific Ocean. The production efficiency would be expected to be high in suitable locations. The commercial viability is presently poorly known, but likely to be profitable under appropriate conditions. Some coastal Indigenous communities are keen to support stock enhancement of giant clams in their depleted reefs.

Mangrove Crab

Mangrove crabs (*Scylla spp.*), also known as mud crabs, are found in mangrove areas in estuaries and bays throughout northern Australia. The species has moderate to high values and is very popular in South-east Asian markets such as Malaysia, Singapore, Hong Kong, China and Taiwan. Better prices are usually achieved for live product. The supply of mud crabs from traditional sources is decreasing due to over-exploitation and importers are now constantly seeking new sources of supply.

The culture technology for the species is still being developed; most Asian producers depend on the supply of wild-caught seed stock for growout. The production efficiency and commercial viability of mud crab aquaculture

under Australian conditions is poorly known. An ACIAR research programme is currently focusing on five species of mud crab and the requisite technology for their culture might be available in the near future.

Scallop

Various species of scallop have at various times been considered for aquaculture in Australia and some research has been carried out to develop the required technology. Scallops are usually highly regarded and command high prices in domestic and export markets.

Culture technology has been developed for various species in Australia and overseas; however, the commercial viability of scallop farming has yet to be demonstrated in Australia.

Beche-de-Mer

Beche-de-mer (*Holothuria spp.*), also known as trepang or sea cucumbers, occurs naturally in most tropical coastal waters across northern Australia. In dried form, they have a high value in Southeast Asian markets.

The culture technology for various species is currently being developed and the production efficiency and commercial viability are presently unknown. Subject to the development of the requisite technologies, some species may be good candidates for Indigenous aquaculture in the future. Research into the aquaculture of trepang is currently being carried out in the Solomon Islands by ICLARM and ACIAR.

Tropical Rock Lobster

Tropical rock lobsters occur naturally in tropical waters across northern Australia. As are all rock lobsters, the species is highly regarded and commands high prices in domestic and export markets. Traditionally, frozen tails have been sent to export markets, but more recently tropical rock lobsters taken using a hookah are sent in live form.

Of all the rock lobsters that occur in Australian waters, the tropical rock lobster (*Panulirus ornatis*) is probably the one most suited to closed-cycle aquaculture due to its comparatively short larval phase. The hatchery technology for rearing juvenile rock lobster has not yet been developed; however, research in this area is currently being undertaken. There may be some potential, particularly among Indigenous communities, for fattening and growing out wild-caught animals. Research is also under way to assess the viability and merit of growing out wild-caught juvenile rock lobsters in the puerulus development stage. The commercial viabilities of these activities have yet to be determined.

Redclaw Crayfish

Various strains of redclaw crayfish (*Cherax quadricarinatus*) occur naturally in permanent fresh-water systems in the Northern Territory and Queensland and the species has been introduced in small numbers to Western Australia. There is a reasonable domestic market for redclaw and the species is considered to have good potential in a developing export market. Redclaw farms are located predominantly in Queensland, where much of the current production takes place, and there are a few licensed operators in the Northern Territory.

The culture technology for the species is well known and the industry in Queensland is undergoing rapid growth. Production is generally limited by the amount of fresh water available, so sites suitable for redclaw culture are likely to be limited to those with adequate quantities of fresh water supplies.

Fresh-Water Prawn

Fresh-water prawns (*Macrobrachium rosenbergii*), also known as giant fresh-water prawns or cherabin, are distributed in fresh-water habitats across northern Australia. Market opportunities for the species include local and domestic niche outlets but could include export markets if adequate quantities can be cultured. In south-east Asia, live cherabin are sold at a premium price and fetched over 50% higher than the marine prawns.

The species is widely cultured in areas of South-east Asia and Hawaii, and recently in South America and Africa. The culture technology is reasonably well known; however, early attempts in the 1980's to grow the species in Australia have failed, possibly due to lack of expertise and a good understanding of the culture requirements of local stocks. More recently, there has been renewed interest in the culture of fresh-water prawns in many parts of the world and the potential of the species for aquaculture, using technologies developed for the monodon industry, is being re-evaluated. Production efficiency under Australian conditions is unknown; however, in some areas of northern Australia huge numbers of wild juveniles, which can be used for growout trials, are available. This species is best suited to genuinely-tropical sites and like the marine prawns can be harvested after a short culture period of 5-6 months.

Yabbies

Several species and strains of yabby exist in Australia; the main types farmed in the southern states of the country are *C. albidus* and *C. destructor*. Native to south-eastern Australia, yabbies are now widespread mainly as a result of introductions to stock farm dams. In Western Australia, the species occurs and is farmed throughout much of the Wheatbelt where it now forms the basis of a valuable and thriving aquaculture industry. Yabbies are also cultured in South Australia and Victoria, where production is rapidly increasing with the establishment of new farms, some of which have been purpose-built. Live and processed yabbies are currently exported to high-value markets in Europe and Asia, where demand is expected to continue to increase.

The culture technology for yabby farming is well known. The species is usually grown in extensive or semi-intensive systems in farm dams or purpose-built ponds. An advantage of farming yabbies is the relatively low capital investment required to enter the industry and the relatively low levels of technical expertise and management required. Research is being carried out to continue to increase production efficiencies by improving technical and management practices.

Marron

Marron (*Cherax tenuimanus*) is native to the high-rainfall areas in the south west of Western Australia. As a result of translocations, the distribution of the species in Australia now extends between Esperance and Geraldton in Western Australia and into other southern Australian states. The most successful marron farms are located in Western Australia and South Australia. Live marron is highly regarded as a luxury product in the market place and the product usually attracts higher prices than other fresh water crayfish.

The culture technology for the species and its requirements are now well understood and a detailed culture manual is currently being upgraded. Juvenile seed stocks are usually readily available from hatcheries; however, commercial production tends to be variable. The commercial culture of marron has yet to be proven on a scale large enough to provide sufficient quantities to establish a presence in export markets. This is another species for which commercial results have often not matched research and pilot-scale results; however, some farmers are now achieving very good results. Research is ongoing to reduce the variability in individual growth rates.

Appendix Two

APPENDIX THREE: Contact Addresses for Funding Agencies

Contact addresses are usually provided only for capital cities or central agencies or offices as a first point of contact. In many cases, the funding or service organisation is represented by regional offices, the addresses of which can be obtained from the contact provided.

Commonwealth Agencies

Fund or service	Organisation	Contact
Commercial Development Corporation	ATSIC	Commercial Development Corporation Level 5, Bonner House Neptune Street Woden ACT 2606 Phone: 02 6285 3031 Facsimile: 02 6285 2348
Fisheries Research and Development Corporation	Fisheries Research and Development Corporation	25 Geils Court Deakin ACT 2600 PO Box 22 Deakin West ACT 2600 Phone: 02 6285 0400 Facsimile: 02 6285 4421 E-mail: frdc@frdc.com.au Website: http://www.frdc.com.au
Various	Indigenous Land Corporation	GPO Box 652 ADELAIDE SA 5001 Phone: 08 8407 5900 Fax: 08 8212 7264 E-mail: ilcinfo@ilc.gov.au Website: http://ilc.gov.au
Invest Australia: Feasibility Study Fund	Commonwealth, state and territory governments	General Manager Invest Australia 20 Allara Street Canberra City ACT 2600 Phone: 02 6213 7560 Fax: 02 6213 7843
AQUAPLAN	Aquatic Animal Health Unit, ACT	National Office of Animal and Plant Health GPO Box 858 Canberra ACT 2601 Phone: 02 6272 4328 Fax: 02 6272 5237

Australian Centre for International Agricultural Research (ACIAR)	Australian Centre for International Agricultural Research (ACIAR),	Commonwealth Director ACIAR ACIAR House, Traeger Court Fern Hill Park Bruce, ACT 2617 Phone 02 6217 0500 Fax 02 6217 0501
Rural Industries Research & Development Corporation (RIRDC)	Rural Industries Research & Development Corporation, Commonwealth	Research Manager Rural Industries Research & Development Corporation Level 1, AMA House, 42 Macquarie Street Barton ACT 2600 Phone 02 6272 4539 Fax 02 6272 5877
Strategic Partnerships with Industry - Research and Training (SPIRT) Scheme	Australian Research Council, Commonwealth	Assistant Director Program Management Group Australian Research Council GPO Box 9880 Canberra ACT 2601 Phone 02 6284 6644 Fax 02 6123 6900
Aboriginal Affairs	The Minister for Aboriginal and Torres Strait islander Affairs	Office of Senator John Herron Parliament House Canberra ACT 2600 Phone 02 6277 7620 Fax 02 6273 4142 Email atsia@atsia.gov.au Internet http://www.atsia.gov.au
Export Market Development Grant	AUSTRADE, Commonwealth	Tollfree 13 28 78

State and Territory Government Agencies

Fund or service	Organisation	Contact
Business inquiries and assistance	Canberra Business Promotion Centre, Canberra ACT	Phone 02 6241 7757 Fax 02 6207 7395 Email actbg@act.gov.au

Various	Office of Aboriginal Economic Development, Department of Commerce and Trade, Western Australia	168-170 St George's Tce PERTH WA 6000 PO Box 7234 Cloisters Square PERTH WA 6000 Phone 08 9327 5666 Tollfree 1800 628 767 (country callers only) Fax 08 9327 5481
Aboriginal Affairs	Aboriginal Affairs Department, WA	Level 1 197 St George's Terrace Perth WA 6000 PO Box 7770 Cloister's Square Perth WA 6850 Phone 08 9235 8000 Fax 08 9235 8088 Email info@aad.wa.gov.au Internet http://www.aad.wa.gov.au
Aboriginal Affairs	Department of Premier and Cabinet Office of Aboriginal Affairs	3rd Floor, Public Buildings Franklin Square Macquarie Street GPO Box 1156 Hobart TAS 7001 Phone 03 6233 3671 Fax 03 6233 4506 Email oaa@dpac.tas.gov.au Internet: http://www.dpac.tas.gov.au
Pre-Feasibility Study Program	Department of Commerce and Trade, Western Australia	168-170 St George's Tce PERTH WA 6000 PO Box 7234 Cloisters Square PERTH WA 6000 Phone 08 9327 5666 Tollfree 1800 628 767 (country callers only) Fax 08 9327 5481
Business inquiries and assistance	Small Business Development Centre, WA	553 Hay Street Perth WA 6000 GPO Box C111 Perth WA 6001 Phone 08 9220 0222 Fax 08 9325 3981 Email info@sbdc.com.au Internet http://www.sbdc.com.au

Business inquiries and assistance	South Australian Department of Industry and Trade	The Business Centre 145 South Terrace Adelaide SA 5000 Phone 08 8463 3800 Internet: http://www.businesschannel.sa.gov.au
Aboriginal Affairs	Department of State Aboriginal Affairs (DOSAA)	Level 1, Centrepoint Building 22 Pulteney Street Adelaide SA 5000 Phone 08 8226 8900 Fax 08 8226 8999 Internet: http://www.dosaa.sa.gov.au
Business Tasmania: Small Business Program	Business Tasmania, Tasmania	Small Business Program Manager Client Services Officer Business Tasmania 5th Floor ANZ Centre, 22 Elizabeth Street, Hobart TAS 7000 Ph: 03 6233 5577 Fax: 03 6233 5800
Women in Business Mentor Program	NSW Department of State and Regional Development, New South Wales	Manager, Women in Business Program L43, Grosvenor Place, 225 George Street Sydney NSW 2000 Email: lynnette.dorn@business.nsw.gov.au Internet: http://www.smallbiz.nsw.gov.au Tollfree 02 9338 6704, 02 9338 6699 Fax 02 9338 6755
Business inquiries and assistance	Department of State Development Business Tasmania	22 Elizabeth Street, Hobart TAS 7000 GPO Box 646, Hobart, TAS 7001 Ph: 03 6233 5577 Fax: 03 6233 5800 Internet: http://www.bt.tas.gov.au
Aquaculture Business Approval Package	Department of State Development Business Tasmania	22 Elizabeth Street, Hobart TAS 7000 GPO Box 646, Hobart, TAS 7001 Ph: 03 6233 5577 Fax: 03 6233 5800 Internet: http://www.bt.tas.gov.au
Co-operatives Formation Assistance	NSW Department of Fair Trading, New South Wales	154 Russell Street Bathurst NSW 2795 Tollfree 02 6333 1400 Fax 02 6333 1402

Aboriginal Affairs	NSW Department of Aboriginal Affairs	Level 5 83 Clarence Street Sydney NSW 2000 Phone 02 9290 8700 Fax 02 9262 2690 Internet: http://www.daa.nsw.gov.au
Business inquiries and assistance	NSW Department of State and Regional Development	General Inquiries Level 35, Governor Macquarie Tower 1 Farrier Place PO Box N818 Sydney NSW 1220 Level 44, Grosvenor Place 225 George Street PO Box N818 Sydney NSW 1220 Phone 02 9228 3111 Fax 02 9228 3626 Internet: http://www.business.nsw.gov.au
Environmental Guidelines	Queensland Department of Primary Industries, Queensland	The Director Environmental Operations Floor 10, 160 Ann Street BRISBANE Q 4000 Phone 07 3227 7651 Fax 07 3227 7237
Seafood Services Australia	Queensland Department of Primary Industries, Queensland	Principal Scientist Department of Primary Industries (Qld) DPI 19 Hercules Street Hamilton QLD 4007 Phone 07 3406 8597 Fax 07 3406 8677
Product Assessment, Development and Management Services	Victorian Innovation Centre, Victoria	Operations Manager Hawthorn Technology Centre 192 Burwood Rd Hawthorn VIC 3122 Phone: 03 9819 6588 Fax: 03 9819 6389

Aboriginal Affairs	Queensland Government Department of Aboriginal and Torres Strait Islander Policy and Development	Central Office Enterprise House 46 Charlotte Street Brisbane PO Box 397 Brisbane Albert Street QLD 4002 Phone 07 3224 2011 Fax 07 3404 3572 Internet: http://www.indigenous.qld.gov.au
Business inquiries and assistance	Queensland Government State Development Centre	Brisbane State Development Centre Floor 21 111 George Street Brisbane QLD 4000 GPO Box 168 Brisbane Albert Street Phone 07 3225 1915 Fax 07 3224 8661 Internet: http://www.statedevelopment.qld.gov.au
Business inquiries and assistance	Small Business Victoria	Level 5, 55 Collins Street Melbourne VIC 3000 Phone 13 22 15 Fax 03 9651 9725 Email sbv@sbv.vic.gov.au Internet: http://www.sbv.vic,gov.au
Aboriginal Affairs	Aboriginal Affairs Victoria	Level 7, 589 Collins Street Melbourne VIC 3000 PO Box 4057 Phone 03 9637 8000 Fax 03 9616 2954 Internet: http://www.nre.vic.gov.au
Aboriginal Affairs	The Northern Territory Office of Aboriginal Development	Level 1, Darwin Central Office Suites 21 Knuckey Street Darwin NT 0800 GPO Box 4450 Darwin NT 0801 Phone 08 8924 4225 Fax 08 8924 4222 Internet: http://www.nt.gov.au

Business inquiries and assistance	The Northern Territory Department of Industries and Business	Territory Business Centre Ground Floor, Development House 76 The Esplanade Phone 08 8924 4280 Fax 08 8924 4290 Toll free 1800 193 111 Email territory.businesscentre@nt.gov.au Internet: http://www.tbc.nt.gov.au