NAURU

AQUACULTURE

DEVELOPMENT PLAN

2005—2010

Nauru Fisheries & Marine Resources Authority

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Foreword

The economy of Nauru was for many years dominated by the phosphate mining industry. The fisheries sector, in particular the aquaculture sector, was largely neglected because other sectors had priority.

Today, however, the fisheries sector is receiving greater attention, particularly in attempts to alleviate the food security situation, and aquaculture has a role to play. Milkfish is the national fish of Nauru, and fish farming of milkfish was an important traditional activity. The introduction of Mozambique tilapia, however, had a detrimental effect on milkfish farming. Fortunately there are now improved species of tilapia that are gaining popularity worldwide, and these may co-exist with milkfish aquaculture and also provide a more acceptable short-term solution as a food source.

The Nauru Aquaculture Development Plan is a five-year strategic plan that takes a significant step forward in outlining the aquaculture requirements of Nauru. It takes in capacity-building, research and development, and awareness-raising programmes. The plan maintains a focus on the subsistence needs of the people of Nauru. A research facility is proposed to help farmers with technical requirements such as conducting experimental trials, maintaining fish broodstock, producing fish fingerlings and providing training.

The Government of Nauru hopes that, with a dedicated and sustainable aquaculture programme, the country will be become more self-sufficient in its fish food needs.

Honourable Marcus Stephen, MP
Chairman,
Nauru Fisheries & Marine Resources Authority

NAURU AQUACULTURE DEVELOPMENT PLAN 2005-2010

1) Physical Background

Nauru is an ancient submerged volcano with a karstified limestone cap of coral origin about 550 metres thick (Hill & Jacobson 1989). It is described as a raised coral atoll. It has a land area measuring 21 km² (roughly 6 km long by 4 km wide) which consists of a coastal low-lying plain 150–300 metres wide rising to a plateau which is about 50 metres above sea level, with the highest point reaching 70 metres (Figure 1). The plateau comprises 80 per cent of the land area. There are four depressions on the plateau, the most significant one forming Buada Lagoon (Figure 2), which is ±30,000 m². The other water bodies, known as ponds, are on the fringing coast or just a few metres from the basement of the escarpment. They range from about 40 m² to about 10,000 m², either manufactured or naturally occurring, and the Anabar pond, at ±10,000 m², is the most significant (see Figure 3).

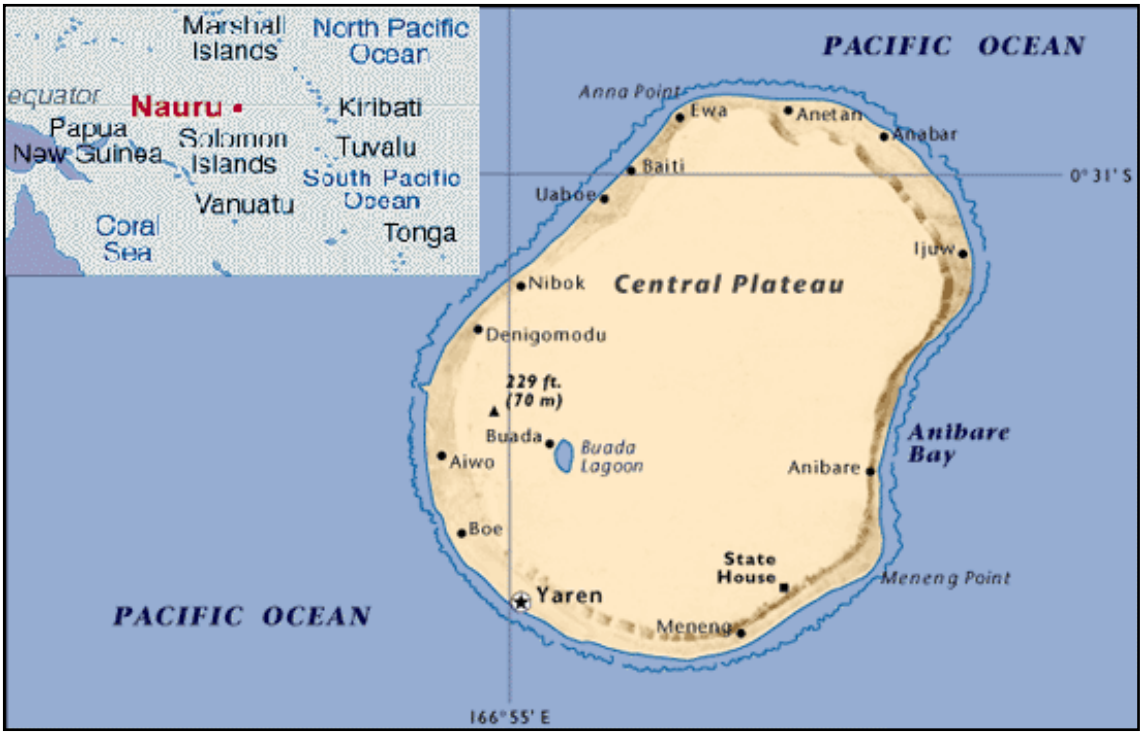


Figure 1: Locality map of Nauru and the 14 districts

Figure 2: Buada Lagoon

Figure 3: Anabar Pond

2) Aquaculture Background

Nauru has a unique history of fish aquaculture in the Pacific dating back hundreds of years. Milkfish (*Chanos chanos*) was the most prized species, and was usually harvested on special occasions. Petit-Skinner (1981) mentioned that milkfish was also used for ornamental purposes and women would adorn themselves with fish scales and other body parts, especially for dancing (see Figure 4).

Figure 4: Woman with milkfish attached to her body ready to perform a traditional fish dance

The juvenile milkfish were collected on the intertidal reef and reared in brackish ponds. The most important areas for farming were Buada Lagoon and, to a lesser extent, the Anabar pond. Farming was divided among families, with walls and fences, and the people had an intricate social fabric intertwined with milkfish culture. Farming conditions were maintained by adults who would regularly wade through the lagoon to oxygenate the waters and reconstitute the nutrients. Children were forbidden to clap when they bathed, or to make any other disturbance that might cause the milkfish to flee from the shallow areas assigned to families (pers. comm. Tamakin 2004).

The Mozambique tilapia (*Oreochromis mossambicus*) was introduced around 1961, with assistance from the South Pacific Commission (now the Secretariat of the Pacific Community), but it was not accepted as a food source mainly because of its small size and poor flavour. Tilapia eventually infested all the milkfish ponds and competed for food. The result was that milkfish harvested from infested ponds took longer to grow to an edible size of more than 20 cm, and this caused many farmers to abandon their traditional practice of raising milkfish.

In 1981, the Food and Agriculture Organisation (FAO) launched an eradication programme but it was unsuccessful, as were several other attempts (Ranoemihardjo 1981). In 1991, the FAO South Pacific Aquaculture Development Project (SPADP) demonstrated that it was possible to raise milkfish in coexistence with tilapia (Dela Cruz 1995). A Taiwanese project at the same time achieved faster growth using more intensive methods but the capital costs were considered prohibitive. In 1998, SPADP introduced Nile tilapia (*Oreochromis niloticus*) and taste analysis using imported, freshly chilled Nile tilapia from Fiji proved that it was favoured as a food fish (Alefaio et al. 1997).

Semi-intensive farming methods were introduced by Taiwan in early 2001, using imported formulated feeds, nets, water pumps and aerators to enhance the water quality and growth rates of milkfish in concrete tanks. Concrete tanks measuring 20 m x 10 m and 1.5 m deep were constructed. The object was to farm milkfish in tilapia-free environments using seawater, and to determine the mortality and growth rates of milkfish through various levels of population densities (see Figure 5).

Figure 5: Concrete tank at Taiwanese milkfish farm in Anabar (2002)

Fish from the farm were considered to be of very high quality, given that the fish had a high fat content, a trait that Nauruans regard very highly. It is also worth noting that Nauruans eat their milkfish raw as in some of the neighbouring island countries.

3) ECONOMIC CRISIS

In the 1970s and 80s, the wealth from mining rock phosphate made Nauru, on a per capita basis, the richest country in the Asia–Pacific region, but by the early 1990s, the exhaustion of phosphate and inept management of the country's wealth resulted in a financial crisis. According to the 2004 government budget statement, there has been a major reduction in the standard of living and a decline of cash income to levels approaching US$1 a day, the definition of poverty. The problem is made worse by the absence of a robust subsistence economy, common in other countries of the Pacific islands, that can act as a back-up in times of economic difficulties.

Under the current circumstances of potential food shortages, the focus is towards subsistence. Some households have even taken to harvesting the wild Mozambique tilapia, once considered a trash fish, from backyard ponds. There has also been a dramatic increase in reef gleaning to meet household food requirements. Development of fish farming could help alleviate some of the pressures on reef fishing activities, which are showing signs of overfishing.

Decades of phosphate mining have had a widespread ecological impact, and the landscape where extrusion occurred remains scarred (Figure 6). The prospect of rehabilitating these areas as ponds for inland aquaculture has been raised.

Figure 6: Damage caused by phosphate mining

Along the coast, there has been a steady build-up of infrastructure, sea traffic and human population. This may have contributed to the declining recruitment of milkfish stocks. Today's elders recall the abundance of milkfish fry in their youth, and how on a lucky day you might encounter a large mass of "balled up" fry which could be easily scooped, yielding hundreds of fishes. Currently only a handful of milkfish fry are caught each night. The catch of juveniles was so poor that during the phosphate boom live fry were imported from Kiribati, and this continues to this day.

4) The State of Aquaculture

During the period of affluence, people relied on food imports for food security on Nauru, and the traditions and techniques for aquaculture were largely unpractised until recently. Even so, despite an introduced diet of processed foods, raw milkfish has always been a highly sought-after delicacy.

Today, the rejuvenation of milkfish farming has interested many farmers in starting up again. In 2000, the Buada Lagoon Owners Association (BLOA) introduced 10,000 milkfish fry from Kiribati into Buada Lagoon, reaping 5,000 adult fish some months later. BLOA have added stock several times throughout the years with 2005 being a very active year; 6,550 milkfish fry have been released into Buada Lagoon so far (August), and further stocks will be added later in the year. Harvesting is expected to start towards the end of 2005.

Figure 7: Backyard pond

Other people with smaller backyard ponds have started their own farms by importing milkfish fry from Kiribati and are also expected to harvest their fish in the latter part of 2005. This renewed interest has been stirred up by the recent priority given to aquaculture development by the Nauru Fisheries and Marine Resources Authority (NFMRA) through the *National Fisheries Objectives and Strategies 2003–2010*. This has been done with assistance from regional organizations such as the Secretariat of the Pacific Community (SPC), and we will look at this in more detail later in this report.

Other coastal ponds, particularly the Anabar pond, have yet to be developed. Overgrown vegetation prevents access to many of these ponds, but this can be easily cleared.

The Anabar facility (former Taiwanese fish farm, see Figure 5) is the only government aquaculture project. It has not been used since the Taiwanese abandoned it in 2002, but the structure is still useable. The government supports an upgrade, and the facility could be used for quarantine, genetic selective breeding programmes and intermediate culture of fry.

The NFMRA is the agency responsible for aquaculture management and development on Nauru. Figure 8 illustrates the organizational structure of the NFMRA, showing where the aquaculture section is located. The NFMRA organizational structure is, however, now under review with the object of enhancing the output of the organization and reducing expenditure. In this respect, capacity building, particularly staff development, is a key focus, and an aquaculture expert will be brought in from overseas to stay on Nauru for three years to provide the necessary training and technology transfer.

Current fisheries legislation is inadequate to deal with all aspects of aquaculture, but this is expected to change with new legislation proposed to be in place by 2006.

NAURU FISHERIES & MARINE RESOURCES AUTHORITY

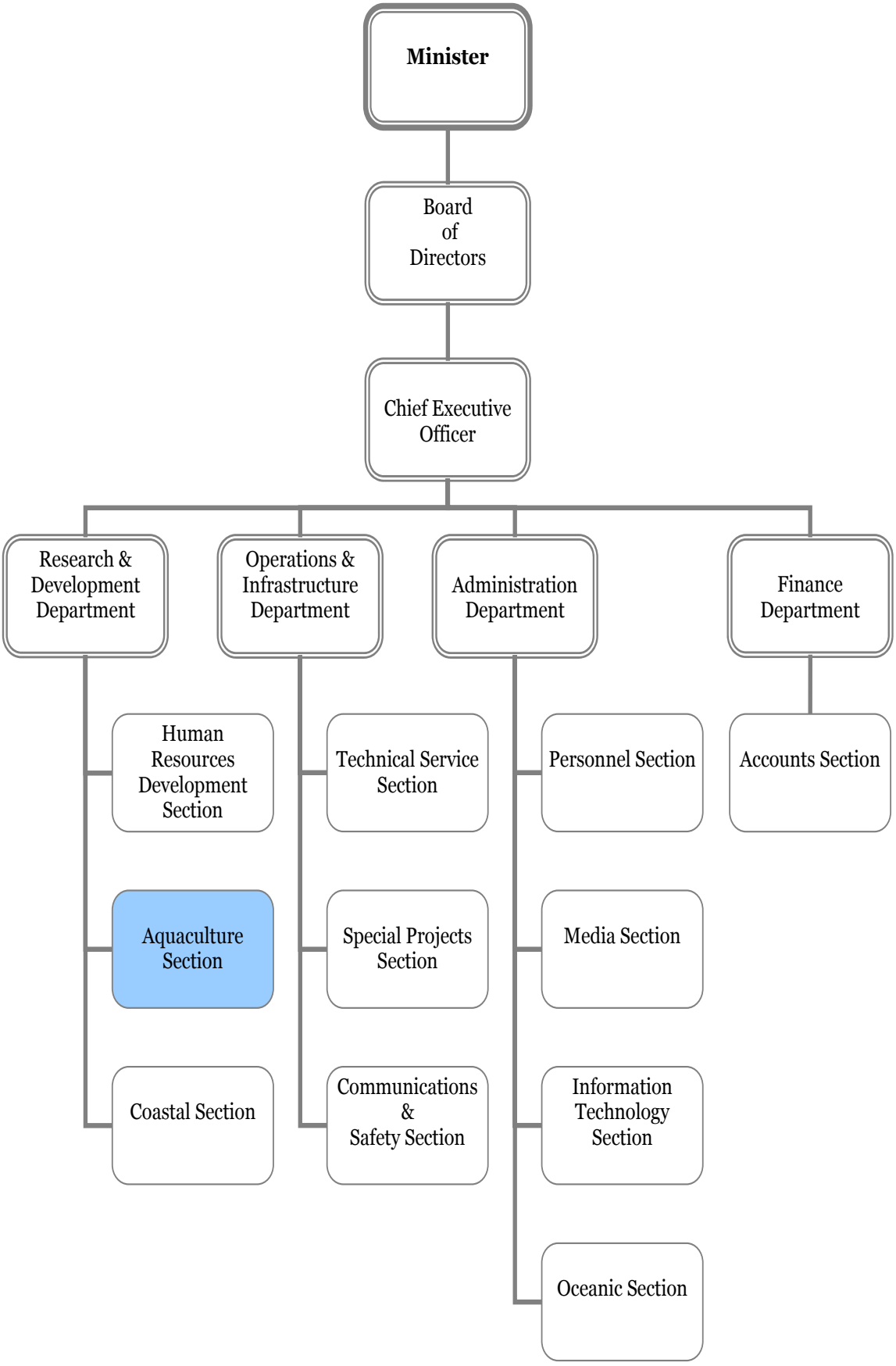


Figure 8: Organisational Structure of NFMRA

5) The Plan

Given the past significance of aquaculture on Nauru, fish farming and restocking programmes may have a constructive role to play in helping to solve the country's financial and food-shortage problems. In this regard, the NFMRA, with the assistance of the SPC, organized a workshop at the Meneng Hotel in November 2004 to devise a national plan of action to rejuvenate aquaculture.

Those involved in the consultations included government agencies, small business interests, BLOA representatives, major landowners, and people from the private sector with knowledge of or an interest in aquaculture. There was a two-step approach to developing a national action plan. Firstly, key "commodities"[1] considered to have the greatest potential for development were selected from a list of potential species. Then, different ways of making the best use of these were discussed.

5.1 Objective

The objective is to put in place a five-year plan to guide the Government of Nauru and provide information for all national stakeholders, international donors and development agencies. NFMRA's intention is to ensure that this inaugural plan is regularly updated as required by the needs of Nauru. The plan will be reviewed every two years to assess the priority of the chosen commodities and update strategies.

5.2 Prioritising Commodities

Fifteen commodities considered applicable to Nauru were reviewed by participants at the planning workshop (Figure 9). Each commodity was scored in terms of its:

- *impact potential* — that is, its benefit to the community, and technical and cultural suitability
- *feasibility* — that is, availability of support from agencies, and the local capacity to use it.

Depending on their scores, the commodities were ranked as *High, Medium* or *Low* priority (Table 1).

1. For the meaning of "commodities", see Figure 9.

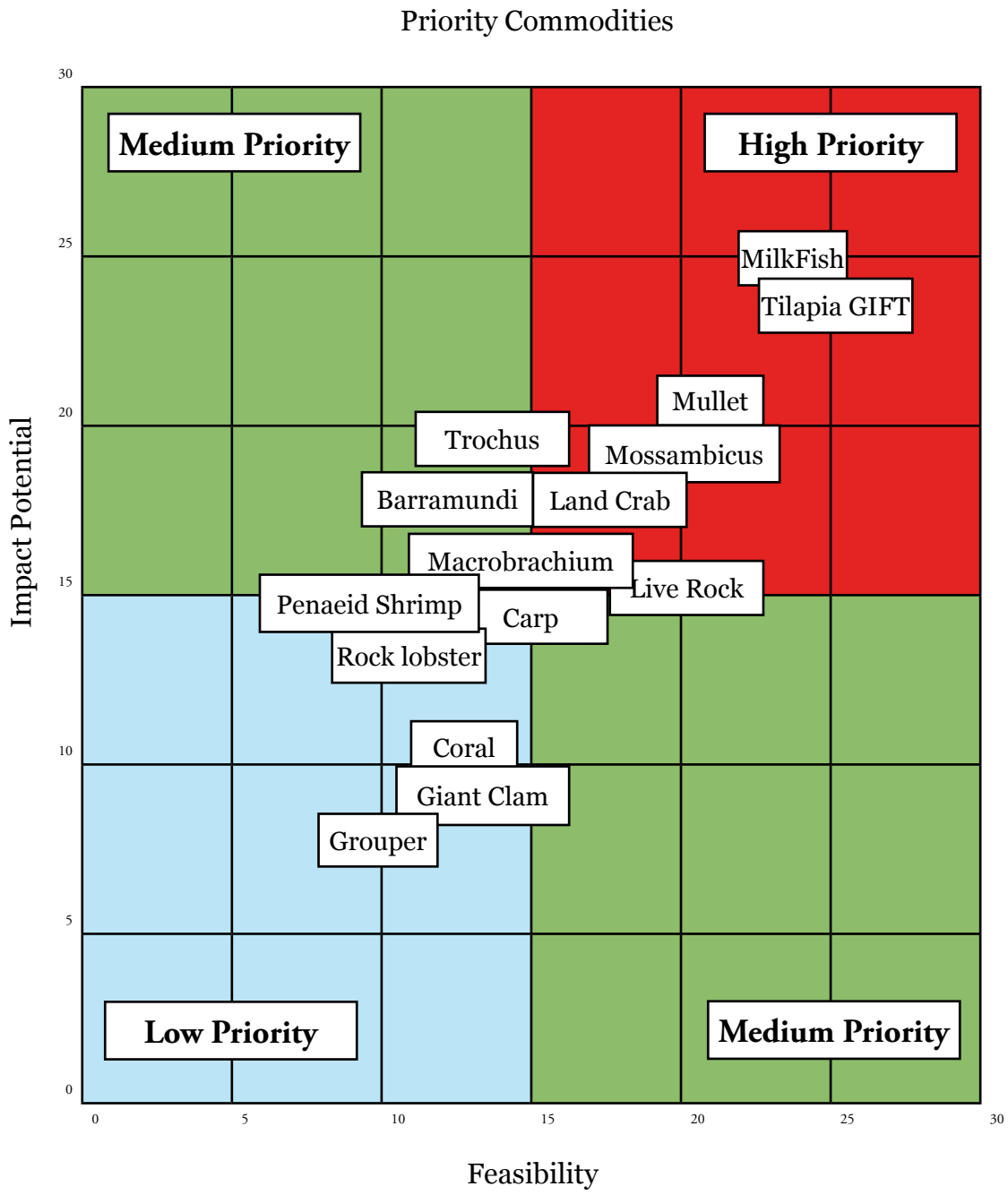


Figure 9: The results of scoring aquaculture commodities according to their impact potential and feasibility

Table 1: Priority assessment of aquaculture commodities for Nauru

Commodity	*Rank*
Milkfish	High
Tilapia GIFT	High
Mullet	High
Tilapia Mossambicus	High
Land Crab	High
Trochus	High
Barramundi	Medium
Live Rock	Medium
Macrobrachium	Medium
Carp	Medium
Penaeid Shrimp	Low
Rock Lobster	Low
Giant Clam	Low
Coral	Low
Grouper	Low

The most important finding from the commodity assessment was to give priority to commodities that can deliver food security under low input systems that can be easily operated in the current financial climate.

Milkfish had the highest priority and rejuvenating its culture would not only contribute to food security but rehabilitate some of the unique traditions and culture of Nauruan society, which are being lost.

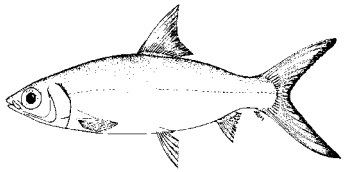
There was much interest in GIFT (genetically improved tilapia fish) tilapia, a superior aquaculture species compared with the wild Mozambique tilapia. As Mozambique tilapia was already present in most ponds, however, some delegates recognized that this resource could be better integrated into livestock production, perhaps as a source of feedstock, rather than trying to eradicate it.

Given the past experimentation with mullet culture, delegates wanted to investigate this species in a more structured manner.
Land crab is naturally abundant on Nauru and investigations to find out whether farming would improve the flavour of its flesh would be useful.

Trochus is not present on Nauru, but as it has been successfully introduced elsewhere in the Pacific to degraded reefs similar to those of Nauru, this should also be investigated further.

5.3 Key Commodity Profiles

Milkfish (*Chanos chanos*)



Milkfish is a warm-water species and prefers water temperatures of 20–33°C. Unlike many other large saltwater fish it is herbivorous, feeding on different types of algae. Brood stock can be raised and spawned in captivity to produce larvae in the hatchery. In nature, the larvae seek out clear coastal and estuarine waters. Milkfish attains sexual maturity in five years, both in the wild and under culture conditions.

Culture of this species is well developed in Asian countries, especially the Philippines, Indonesia and Thailand. Since milkfish is herbivorous, culture is by the extensive method where bodies of pond waters are fertilized with organic and/or inorganic fertilizers to enhance primary production. Fry are caught from the shallow tidal pools and lagoons and stocked in pre-fertilized culture ponds. Supplemental feeding is often done.

Most milkfish is produced for human consumption and marketed fresh, smoked, canned and frozen. A new market for the tuna bait industry is gaining popularity because cultured juvenile milkfish have been found to be excellent bait fish for the tuna longline industry.

GIFT Tilapia

GIFT tilapia is an improved strain of Nile tilapia that was selectively bred from wild tilapia originally collected from the Middle East, Africa and the Philippines. In 1998, after six generations of breeding, the GIFT strain was produced, showing an 85% improvement in growth rate. It was given to a non-profit organization for distribution worldwide. The Fiji Islands were among the first countries to receive GIFT tilapia, and there it has become a highly popular fish for eating. It was also found to be much better to farm than Mozambique tilapia.

GIFT tilapia is hardy and can tolerate a wide range of environmental conditions including those that occur on Nauru. They can be raised in simple earthen ponds and are able to survive in poor quality water. The fish eat a wide range of food types, and at low densities can survive on fertilized water alone, although supplementary feeding with 20–30% crude protein achieves the best growth. Fingerlings can be produced using simple breeding methods. Harvesting begins about 3–4 months after stocking the fingerlings, by which time they are around 200–300 g and big enough to eat.

Mozambique tilapia

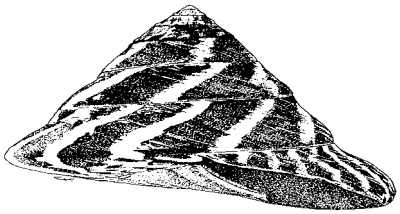
As its name suggests, the Mozambique tilapia is a native of Africa. This species was widely distributed throughout the Pacific in the 1950s and 60s by development agencies for aquaculture and/or reducing mosquito larvae. Unfortunately, the Mozambique tilapia did not achieve either of these targets. Instead it became widespread and was largely considered a pest. In some countries, however, particularly for the people of Fiji, and the Sepik river in Papua New Guinea, it did provide subsistence protein.

Mozambique tilapia has several characteristics that make it unsuitable for aquaculture, for example, it matures quickly and is highly fecund. Uncontrolled breeding leads to overcrowding and stunted growth in ponds. The fish will prey on other fish species and so any introduction to areas where it is not already present should be carefully considered. Once Mozambique tilapia are established, they are difficult to get rid of except by poisoning or by draining the place and leaving it to dry until the bottom has baked hard in the sun.

In Nauru, Mozambique tilapia has been eradicated from some ponds, using rotenone, a biodegradable pesticide, but chemical controls would be very difficult to apply in rock ponds because of the irregular surface caused by rock crevices. Another option is to introduce a predatory fish for biological control. Finally, it may be possible to outbreed the Mozambique tilapia through introducing an aquaculture programme for farming another species of tilapia such as Nile tilapia.

Rather than eradicate the Mozambique tilapia, an alternative is to take advantage of their hardiness and integrate them into livestock or crop farming. Elsewhere, nutrient waste from poultry or piggeries is used to fertilize the pond water, producing phytoplankton feed for the tilapia. These fish can be eaten by humans, but in the Pacific a more culturally acceptable practice may be to cook it as a high-protein feedstock

Trochus (*Trochus niloticus*)



Previous releases of adult trochus brood stock have successfully produced viable fisheries in the Pacific. Juveniles for stock enhancement can also be produced in the hatchery. The hatchery technology is relatively simple and inexpensive. Heat treatment (2–3°C increase in water temperature, and change of water) is used to induce spawning of eggs and sperm in adults. Settlement plates/substrates with benthic diatoms such as *Navicula* and *Nitzschia* spp. are placed in the tanks before larval settlement about five days after fertilization. Juveniles reach 1–2 mm diameter 4–8 weeks after settlement. Seeding for stock enhancement is a low-cost technology operation that could be conducted on a small scale or commercially. Seeding activities are suitable for women and artisanal fishers. Where translocation to a new country is considered, potential environmental and species diversity issues need to be considered. However, after 50 years of trochus translocation there have been few, perhaps no, recorded instances of adverse impacts in the Pacific.

The market for trochus shell is well established, although the price fluctuates. Shells are easily transported and non-perishable. The trochus meat tastes similar to the local *Turbo* spp. gastropods on Nauru, which are commonly gleaned as a highly desired food source.

5.4 Budget

As a guideline, Table 2 depicts the amount of funding required in order to achieve the objectives of this plan. It should be noted however that these figures are provisional and may change as conditions changes over time.

Table 2: Provisional Budget

	BUDGET	
	Activity	***AU$***
1	Policy & planning	7,000
2	Environment	3,000
3	Research & development	88,000
4	Community development	2,000
5	Fry & feed	15,000
6	Training	20,000
7	Infrastructure	219,000
	Total	***354,000***

THE PLAN

Aquaculture Strategic Plan 2005-2010

Objectives	*Strategy*	*Performance Indicators*	*Extra Budgetary Funding*
Policy and Planning			
Develop national policy on aquaculture	Consult with stakeholders	Consultation and public meetings to start by 2005	$2,000
	Generate public awareness campaign about aquaculture	National policy to be in place by 2005	
Micro-financing to be available for prospective farmers	Government to encourage donor agencies/banks for loan or revolving fund facilities	Financing available to all farmers before end of 2005	
Develop land policies to assist aquaculture	Consult with land and lagoon owners about policies	Consultation to begin by 2005	
	Review traditional and formal land tenure systems in place and/or adopted for aquaculture purposes , for example, milkfish farming in Buada lagoon	Review of land tenure systems to be completed by 2006	$5,000
Environment			
Control measures and regulations for waste disposal and pollution in Buada lagoon put in place	Coordinated response undertaken by Departments of Health, Environment (IDI) and Fisheries (NFMRA)	Information sharing to begin immediately	

	Public consultations and awareness-raising of impacts of waste and pollution undertaken	Campaigning through newspaper, public notice boards, radio, national TV, brochures, and posters to be ongoing	$3,000
	Community activities supporting best environmental and aquaculture practices supported	Aquaculture themes promoted through annual World Clean-up Day, Health promotion programmes, etc	
Research and Development			
Mullet farming techniques developed	Research on mullet collection from the wild and farming techniques undertaken	Mullet farming manual for Nauru developed by end of 2006	$10,000
	Demonstration mullet farm established to promote technology exchange	Mullet pilot farming trial to begin by mid-2006	$3,000
GIFT tilapia to be successfully introduced and trialled in Nauru	Pilot trials undertaken to introduce GIFT tilapia farming on Nauru	GIFT tilapia farming trials to begin by mid 2005	$10,000
Techniques for eradication of M. tilapia developed	Conduct a desktop literature review of various biological and chemical methods to eradicate M. tilapia	Desktop review of tilapia eradication techniques completed by early 2005	$5,000
	Conduct pilot trials on M. tilapia eradication	Eradication trials to begin by early 2006	$5,000
Develop various sources of milkfish fry for Nauru	Conduct research on methods to collect fry from the wild	Methods on fry collection to be published by end-2005	$3,000
	Investigate the importation of bulk (50,000 pieces) fry from Kiribati	Review of milkfish fry importation to be in place by late 2005	
	Develop hatchery techniques for artificial propagation of milkfish fry	First hatchery trials to begin by early 2006	$20,000

Land crab farming techniques developed	Undertake research on local land crab species to identify breeding habits, culture (stocking) practices and marketing techniques	Research results completed by late 2006	$5,000
Review feasibility of milkfish and tilapia polyculture	Compile all previous research results of milkfish and tilapia polyculture into a updated report	Polyculture report completed by late 2005	$5,000
Develop M. tilapia as a livestock feed	Trial integrated M. tilapia aquaculture with livestock farming (e.g. pig, chicken) as a source of fish meal feed	Integrated farming trials to begin by mid-2006	$5,000
Introduce Barramundi as a biological control fish	Research on possible disease introduction and pilot project to be undertaken on biological control	Trial work to begin by mid-2006	$5,000
Trochus introduction to be undertaken	Introduce seeds for stocking on the reef	Work to begin by early 2007	$20,000
Investigate potential of using pinnacle limestone for the live rock trade	Chemical analysis of rocks and evaluate international markets	Results to be completed by late 2006	$2,000
Community development			
Develop aquaculture milkfish farming awareness	Community landowners and stakeholders to be involved	Committee formed - to meetevery 6 months	
Reactivate Buada Lagoon Owners Association	Meetings and consultation with stakeholders to be carried out	Consultation to occur at least every three months	
Community education programme on aquaculture of milkfish and GIFT tilapia developed	National TV, newsletters and pamphlets promoting aquaculture in the community are produced	Awareness-raising to begin by late 2005	$2,000.00
Nauru Aquaculture Association established	Consult with association stakeholders and all pond owners on Nauru	Consultation to begin by end of 2005	
	Constitution drafted and election of office bearers	Constitution and office bearers in place by early 2005	

Fry and feed			
Community training programmes in methods of collecting milkfish fry from the wild	Fry collection methods developed and access to equipment, lights, oil provided	Regular training to be in place by early 2006	$5,000
NFMRA to be point of contact for fry from Tarawa	NFMRA to establish links with Kiribati fisheries, quarantine authorities and Air Nauru freight service	Access to Kiribati fry established before early 2005	
Source of milkfish broodstock established for future hatchery operations	Milkfish broodstock collected and maintained by NFMRA	Milkfish brood stock held at NFMRA facilities	$5,000
Local feeds for fish farming developed	Local ingredients raw and processed such as coconuts, grass, pawpaw are tested as feed	Feed research to begin by mid-2006	$5,000
Training			
Strengthen staff requirement for NFMRA in aquaculture	Assessment of NFMRA staff skills and requirements in manpower undertaken	Staff appraisal completed by mid-2005	
	Recruit and redirect staff into aquaculture as required	Recommendations for staff adjustments to be adopted based on the findings of the staff appraisal	
Training programmes for staff and farmers put in place	Farmers and staff consulted for priority training needs	Training needs assessment completed by mid-2005	
	Training materials for staff and farmers to be developed	Training materials to be developed beginning late 2005	
	Provide training to staff and farmers	Training of staffs and farmers to begin by late 2005	$20,000

Infrastructure			
Increase the number of fish ponds for farming	NFMRA to inspect and rehabilitate existing ponds	All ponds to be surveyed by 2005	
	Public demonstration fish ponds are established	At least three ponds ready for farming by mid-2005	$9,000
	NFMRA to investigate nursery containers for rearing milkfish fry	Nursery containers available for purchase before end of 2005	
Lack of fish farming equipment to be rectified	Excavator to be made available for pond construction purposes	NFMRA to secure services and rates for excavator by mid-2005	
	Sources for purchasing aquaculture equipment made available	Catalogues and salespersons' contacts to be made available to NFMRA by mid-2005	
Government to establish local aquaculture facilities for research and development	Anabar aquaculture facilities to be rehabilitated and upgraded	Anabar facilities upgrade to begin by 2005	$200,000
Establish quarantine facilities to assist with the importation of aquaculture species	Quarantine facilities to be incorporated at Anabar facilities	Quarantine facilities to be put in place by 2005	$10,000

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