Commonwealth of the Northern Mariana Islands

# Aquaculture Development Plan

# 2011–2015

SPC
Secretariat
of the Pacific
Community

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**Produced by**

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**Benigno R. Fitial**
***Governor***

**Eloy S. Inos**
***Lt. Governor***

Håfa adai, Tirow wáámi,

Fish and the fisheries have been a tradition in the Pacific for thousands of years. However, we are cognizant that this valuable resource is dwindling. Therefore, it is paramount that we develop a plan to protect the wild fish in the water, while still being able to feed our people sustainably.

We were very fortunate to have the Secretariat of the Pacific Community assist the people of the Commonwealth of the Northern Mariana Islands in formulating a 5-year plan for the development of Aquaculture and Fisheries Industries in our islands. On behalf of the people of our Commonwealth, we wish to express our deepest gratitude for the tremendous support the Secretariat has given us.

Herewith, we are pleased to make this report available to the people of CNMI.

Thank you, Si Yu'os ma'åse', and Olomwaay reemi.

**Benigno R. Fitial**

**Eloy S. Inos**

Economically, the CNMI Aquaculture Development Plan could not have been introduced at a better time. The Northern Mariana Islands are surrounded by vast water sources, complemented by a warm tropical climate, and strategically located in close proximity to major Asian markets. We have already seen how a lively aquaculture industry has helped the economies of many neighboring islands and countries in the Pacific region.

We are very confident in the success of aquaculture initiatives because of the Commonwealth's interest and commitment to a sustainable, environmentally sensitive, and profitable industry to serve as a pillar of its economic stability. It's already been demonstrated that a lively aquaculture industry here in the CNMI has the potential to invigorate our local economy by introducing new business opportunities that can stimulate the creation of much needed jobs for our people.

We are proud that our staff at the Northern Marianas College-Cooperative Research Extension and Education Services is placing every effort in implementing a long term plan that will ultimately help to develop various business projects here in the Commonwealth.

It is our hope that the CNMI Aquaculture Development Plan succeeds in laying the foundation needed to create a thriving aquaculture industry that will benefit our people and our economy.

**Lorraine T. Cabrera**
***Interim President***
***of the Northern Marianas College***

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The development of the CNMI Aquaculture Development Plan demonstrates the vision of the government and the people of CNMI the enormous potential and importance of the role of aquaculture to the country. It emphasized the government's role and responsibilities in planning ahead and setting direction in diversifying the country's resources. Developing aquaculture is an avenue to address issues such as food security, improve the economic wellbeing and address global challenges such as climate change that affect the way we live in the Pacific.

The CNMI Five Year Plan is the outcome of the consultation between key CNMI Government Agencies, local Industry Members, Communities and Overseas Partners and Agencies. The Plan will strengthen the development of commodities such as tilapia and shrimp aquaculture, which are already proving a success; it will also align resources to commodities that are feasible for CNMI.

This Plan is a fulfillment of the SPC Regional Aquaculture Plan 2007, which provides a roadmap to the SPC members in setting national strategies and directions to developing aquaculture. Given the challenges faced by the SPC region on how best aquaculture could be used as a vehicle to support food security, provide employment and build capacity, it is important that clear directions are set so that resources can be adequately allocated and utilized to realize the full potential of aquaculture. It is, therefore, SPC's view that the CNMI Aquaculture Development Plan paved the way to addressing these challenges at national levels.

SPC congratulates the CNMI for the enormous task in putting together this Five Year Plan and looks forward to the ongoing collaboration in its implementation.

**Robert Jimmy**
***SPC Aquaculture Adviser***

Photo: Jacques Patrois

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Photo: Jacques Patrois

# Acknowledgements

This plan was produced by the Northern Marianas College – Cooperative Research Extension and Education Service (NMC-CREES). Financial and technical assistance was provided by the Secretariat of the Pacific Community. Appreciation is extended to other government agencies, non-governmental agencies and private sector companies and individuals in the CNMI who contributed to the formulation of this document during national planning workshops and follow-up consultations.

Photo: Antoine Teitelbaum

# 1. Introduction

## 1.1 Overview of the Commonwealth of the Northern Mariana Islands

The Commonwealth of the Northern Mariana Islands (CNMI) is a 300-mile-long archipelago, consisting of 14 islands with a total land area of 184 square miles (Figure 1). The principal inhabited islands are Saipan, Rota and Tinian (Figure 2 and 3). The northern, largely uninhabited islands are Farallon de Medinilla, Anatahan, Sariguan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, Maug Islands, and Farallon de Pajaro. According to the 2005 census, the population was 69,927 people and the median age was 29 years. CNMI's per capita gross domestic product is USD 22,449.


*Figure 1. The Commonwealth of the Northern Mariana Islands*

In 1947, the Northern Mariana Islands became part of the post-World War II United Nations Trust Territory of the Pacific Islands. The United States (US) became the administering authority of the Trust Territory of the Pacific Islands under the terms of a trusteeship agreement. In 1976, the US Congress approved the mutually negotiated Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union with the US. The CNMI government adopted its own constitution in 1977, and the constitutional government took office in January1978. The Covenant was fully implemented on November 3, 1986, pursuant to Presidential Proclamation no. 5564, which conferred US citizenship on legally qualified CNMI residents. In recent years, CNMI has been forging closer links with the US. In 2008, a delegate seat was created for CNMI in the US Congress. In 2007, CNMI came under US federal minimum wage regulations and immigration law. In June 2009, the US Department of Homeland Security took over the CNMI's immigration and border controls.

## 1.2 The need for an aquaculture development plan

The completion of an aquaculture development plan for CNMI could not be more timely: CNMI has witnessed a recent and drastic economic downturn. CNMI has depended heavily on garment making and tourism as the core of its economy for many years, and both are in decline. Garment making has dropped from an export peak of USD 826 million in 2004 to just USD 25 million in 2008. Similarly, tourism has declined from a peak of 726,000 visitors in 1997 to 389,000 in 2007. Spurred by the need for economic diversification, the CNMI Department of Commerce sponsored an economic summit in 2009, which identified aquaculture as one of the four new pillars of the economy.

Public law 15–43, which became effective on January 14, 2007, mandated NMC-CREES to be the lead authority in aquaculture development for CNMI. Section 4, subsection 102 of the Act stipulates that the Northern Marianas College – Cooperative Research Extension and Education Service (NMC-CREES) shall establish a Commonwealth Aquaculture Development Plan and that the plan shall include building and operating an aquaculture facility in the Commonwealth. This directive has resulted in the following aquaculture plan, which was formulated from the results of over 100 consultations in CNMI.

The plan is based on input from a broad range of individuals, including current and potential farmers, state and college resource and extension personnel, lawmakers, and private-sector business people. Most of the information was gathered during three, one-day workshops, held in May 2010, on the islands of Saipan, Tinian and Rota. Individual consultations were also held with key personnel from the Northern Marianas College and the Department of Land and Natural Resources, and with private sector representatives.

## 1.3 Potential and opportunities for aquaculture

***High local demand for fresh fish by the resident population.*** The resident population of CNMI is made up of native Chamorro and Carolinians and guest workers primarily from the Philippines, China and Bangladesh. All of these ethnic groups are accustomed to eating a diet of fish. Countries that the guest workers originate from also have a long history of eating pond aquacultured commodities such as tilapia, milkfish, freshwater and marine shrimp.

***High demand for fresh fish from the tourist industry.*** CNMI has around 350,000 tourists per year, mainly from Asia and especially from Japan and Korea. These visitors have a diet high in seafood commodities. As visitors, they are also likely to pay a premium for high quality fish dishes.

***Limitless supply of clean seawater.*** The waters around CNMI are some of the cleanest in the world because they are many hundreds of kilometers from the nearest industrialized nation and there is no land-based pollution within CNMI.

***Access to technology.*** CNMI is a Commonwealth of the US and, therefore, has access to some of the most advanced agricultural technology in the world. There is also a number of resource agencies in the US that can provide technical and financial assistance to develop aquaculture in CNMI.

***Limited and declining inshore fish stocks.*** CNMI's reef areas are not extensive and only a limited number of fish can be caught sustainably from this area. There is increasing pressure on reef resources in CNMI and fish stocks are thought to be declining. While the situation is not good, it does represent an opportunity for developing aquaculture.

***Strong political will to diversify the economy.*** CNMI is under increasing pressure to diversify and expand its economy away from tourism and garment making. The political will to develop new technologies such as aquaculture has probably never been higher in the history of CNMI.

## 1.4 History of aquaculture production

Up until recently, aquaculture activities have been mainly limited to land-based, freshwater tilapia and brackish water penaeid shrimp culture. This is rapidly changing because NMC-CREES has begun researching marine fish and invertebrate culture in recent years.

Below is a brief timeline of aquaculture development in CNMI.

- 1995. NMC-CREES begins developing tilapia aquaponics research and extension activities. Small commercial farms are established.
- 1996. NMC-CREES begins tilapia farming research and extension activities. Small commercial farms are established.
- 1997–2004. Small-scale culture trials of Tridacnid (giant) clams take place in Saipan's lagoon.
- 2002. NMC-CREES begins grow-out trials with *Penaeus vannamei*.
- 2004. Saipan AquaCulture (a commercial shrimp producer) begins growing *Penaeus vannamei* commercially in land-based re-circulating systems.
- 2008–2009. NMC-CREES and the Tinian Municipal Government begin rearing trials with the ass's ear abalone (*Haliotis asinina*) using the macroalgae *Gracilaria bailinae* as an abalone feed.
- 2009–2010. Research trials initiated by NMC-CREES on grow-out of locally wild-caught juvenile rabbitfish (*Siganus* spp.) and mullets (*Mugil* spp.) in land-based re-circulating systems.
- 2009–2010. Research trials initiated by NMC-CREES on grow-out of hatchery-reared imported Asian sea bass (*Lates calcarifer*) in land-based re-circulating systems.
- 2010. Research trials initiated by NMC-CREES on tilapia *P. vannamei* polyculture in tanks.
- 2010. The Commonwealth Aquaculture Producers Association (CAPA) is formed.
- 2010. Saipan AquaCulture begins exporting specific pathogen free (SPF) shrimp broodstock to Asia.

## 1.5 Current status of commercial aquaculture in CNMI

While aquaculture remains primarily based on tilapia and shrimp culture, the industry is growing and there is increasing recognition of the potential and need for aquaculture development in CNMI. Saipan AquaCulture — the largest commercial producer of shrimp — uses 32 concrete tanks with re-circulating systems. The company produces shrimp for local consumption and export to Guam. In 2009–2010, Saipan AquaCulture also began exporting SPF shrimp broodstock to Asia. Saipan AquaCulture has its own hatchery and is also becoming a provider of post-larval shrimp to two of CNMI's smaller shrimp producers, a factor that is likely to lead to a general expansion in the industry. The two other shrimp producers in CNMI are based on Rota and Saipan, and use small-scale re-circulating systems for production. Another small shrimp farm is under construction on Saipan.

There are eight tilapia farmers in CNMI (five in Saipan, two in Rota and one in Tinian). Nearly all farmers use re-circulating production systems. Fry production is currently the responsibility of NMC-CREES, although one farmer has recently installed a small hatchery system for producing fry for sale. Three strains of tilapia are currently in production: the Chitralada variety from Thailand (*Oreocrhomis niloticus*), red Thai Variety (Red Hybrid), and Pearl White Variety. Production in 2009 was estimated at 10 mt with a value of USD 56,000. Fish are sold live or fresh, usually at a size of 200–250 g, for a price of USD 5–6 per kg.

Contact details for the above mentioned farmers can be found in Appendix I.

Photos: Simon Ellis

*Figure 2. Concrete grow-out tanks for shrimp at Saipan AquaCulture. (Left)*
*Figure 3. A typical small-scale tilapia grow-out system on Rota. (Right)*

## 1.6 Key government agencies involved in aquaculture development or regulation

### 1.6.1 CNMI agencies

***NMC-CREES***. Under Public Law 15–43, NMC-CREES is mandated to be the lead authority in aquaculture development for CNMI. It is currently the only public agency currently engaged in any aquaculture development activity in CNMI. NMC-CREES conducts research, extension and educational activities for aquaculture development.

***Department of Land and Natural Resources (DNLR), Division of Fish and Wildlife (DFW)***. This division was the government agency responsible for aquaculture development prior to the passing of Public Law 15–43. The primary role of DFW at present, with regard to aquaculture development, is issuing permits for 1) importing live aquatic species from outside the Commonwealth and 2) collecting juvenile or undersize species for aquaculture purposes. Permits for importing live animals from outside CNMI are issued on a case-by-case basis by the Director of DFW. A DFW permit is also required for exporting aquaculture products.

***Department of Land and Natural Resources (DNLR), Division of Agriculture (DOA).*** This division is responsible for ensuring that quarantine requirements are adhered to for imported species.

***Department of Coastal Resources Management (CRM)***. This agency issues siting permits for any proposed project that has the potential to directly and significantly impact coastal resources, including aquaculture or mariculture facilities. An environmental impact assessment (EIA) is generally required for large to medium size facilities.

***Division of Environmental Quality (DEQ).*** This division handles the permitting of activities relating to aquaculture development: CNMI Water Quality Standards Regulations; Earthmoving and Erosion Control Regulations; Wastewater Treatment and Disposal Rules and Regulations; Underground Storage Tank regulations; Well Drilling and Well Operations Regulations; CNMI Air Pollution Control Regulations.

***Marianas Public Lands Authority (MPLA)***. This agency deals with activities on submerged lands (i.e. those below the mean high water mark). Virtually all coastal or inshore aquaculture-related activities may require a permit, license, and/or conveyance of property interest from MPLA. Aquaculture activities are specifically supported by the Submerged Lands Act and are identified as the number one use activity.

Contact details for the above mentioned agencies can be found in Appendix I.

### 1.6.2 Overseas partners/agencies

US federal laws affecting aquaculture development. Two federal laws affecting aquaculture development in CNMI are the Clean Water Act (CWA) and the Endangered Species Act (ESA). The CWA regulates virtually all physical alterations and discharges into "waters of the US". Within CNMI, this term includes all territorial seas (i.e. three nautical miles seaward from the mean high water mark) and lagoons surrounding each island. The ESA only comes into effect if the project in any way impacts the living environment or life of a species on the US Endangered Species List. Agencies that work collaboratively to deal with these laws are the US Army Corps of Engineers (USACE), US Environmental Protection Agency (USEPA) and the US Fish and Wildlife Service (USFWS).

There are a number of US-based and other overseas agencies and organizations that collaborate with NMC-CREES in providing technical and financial assistance for aquaculture development. These include:

***Center for Tropical and Subtropical Aquaculture (CTSA).*** Based on Oahu, Hawaii, this grant-making organization has been instrumental in bringing technical assistance funding for the development of shrimp mariculture in CNMI.

***Oceanic Institute (OI).*** Using funding from the Center for Tropical and Subtropical Aquaculture, OI has worked with Saipan AquaCulture and NMC-CREES to improve shrimp culture techniques in CNMI.

***University of Arizona, College of Agriculture and Life Sciences.*** Scientists from this institution have provided technical assistance for tilapia producers in CNMI, and routinely liaise with NMC-CREES staff.

***University of Guam (UOG), College of Natural and Applied Sciences.*** Scientists from this institution have provided technical assistance for tilapia and shrimp farmers from CNMI, and routinely liaise with NMC-CREES staff.

***University of Hawaii College of Tropical Agriculture and Human Resources (CTAHR), Agriculture Development in the American Pacific (ADAP)***. The ADAP project has helped to bring together researchers in aquaculture from around the Pacific region to work on aquaculture issues.

***Secretariat of the Pacific Community (SPC).*** The aquaculture section at SPC has brought significant assistance to aquaculture development in CNMI in the form of overseas training opportunities, technical collaboration and co-funding to produce the aquaculture development plan for CNMI.

***Southeast Asian Fisheries Development Center (SEAFDEC).*** This organization, based in Ilo Ilo in the Philippines, has provided training to NMC-CREES and other CNMI residents in culture techniques for the ass's ear abalone (Haliotis asinina) and the macroalgae Gracilaria. SEAFDEC also provided the abalone and Gracilaria stocks for grow-out trials in Tinian in 2008.

***Asian Institute of Technology (AIT), Aquaculture and Aquatic Resources Management (AARM).*** This organization has provided technical assistance and training in marine fish culture to NMC-CREES.

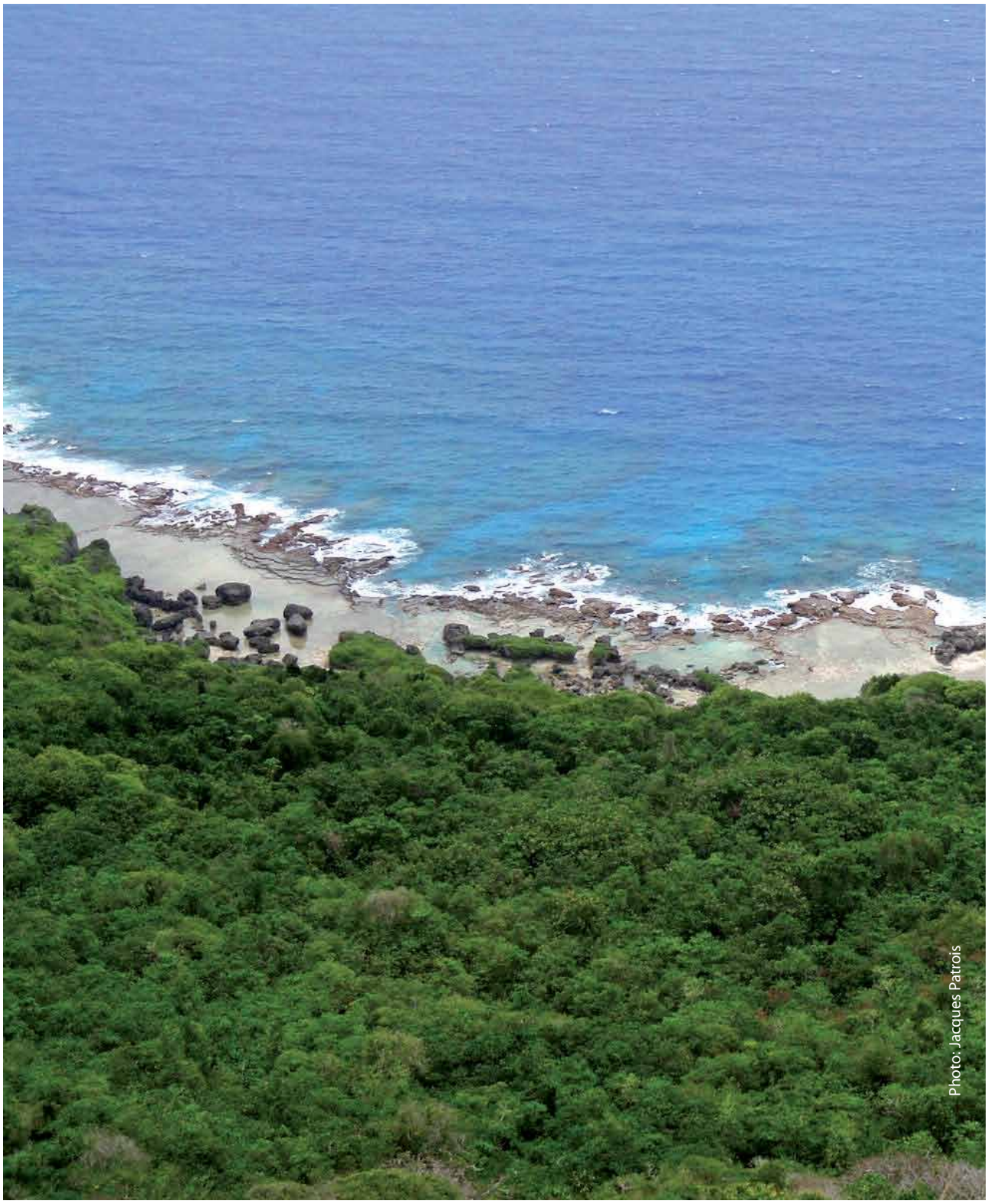

Photo: Jacques Patrois

# 2. Priority commodities

One of critical tasks of the CNMI aquaculture development plan was to select a list of priority commodities through consultations with CNMI aquaculture stakeholders and resource persons. In total, 12 commodities were chosen for presentation during consultations (Table 1) and these were scored by participants on two main criteria: feasibility and impact. Feasibility was defined by how appropriate the technology was for CNMI and how well the commodity might be grown and marketed. Impact was defined by how widespread the benefits would be, and how the commodity would impact local culture, society and the environment. Other commodities were also considered based on feedback from the consultations.

**Table 1. Potential Commodities for the CNMI presented during consultations (in alphabetical order)**

| | |
|---|---|
| Coconut crabs | Marine food fish |
| Corals | Marine ornamental fish |
| Freshwater ornamental fish | Marine shrimp |
| Freshwater crustaceans | Milkfish |
| Giant clams | Sea cucumber/sea urchins |
| Mangrove crabs | Tilapia |

Results of the commodity prioritizations for all of CNMI are presented in Table 2.

***High priority commodities.*** These culture technologies, which already exist in CNMI and include tilapia and marine shrimp, emerged as the highest priority commodities. This is most likely because they have wide recognition and an established track record for production within the Commonwealth, making their feasibility and impact high.

***Medium priority commodities.*** Marine finfish, freshwater crustaceans, giant clams and milkfish all fall into the medium prioritization category. There is increasing interest in marine fish culture, and a variety of species are being tested at NMC-CREES. The high value of these species combined with a strong demand for them makes their potential impact high. Freshwater crustaceans such as freshwater prawns (*Macrobrachium rosenbergii*), red swamp crayfish (*Procambarus clarkii*) and marron (*Cherax tenuimanus*) were also of medium priority due to their potential for culture in existing facilities, either in monoculture or polyculture. Giant clams (*Tridacna* spp. and *Hippopus* spp.) also stimulated considerable interest during consultations due to the past history of giant clam culture in the Commonwealth and the clams' natural occurrence in CNMI waters. The last of the medium priority commodities was milkfish (*Chanos chanos*), whose euryhaline nature, ease of culture, and popularity with the resident Filipino population in CNMI make it an attractive species for culture.

***Low priority commodities.*** The highest ranked on the low priority commodity list were sea cucumbers and sea urchins. Both of these echinoderms were of interest, but the lack of rearing areas and the newness of hatchery technology kept the rating of this commodity low. Hatchery and rearing technology for these species is likely to improve dramatically over the coming years, thereby increasing the attractiveness of these two commodities for the Commonwealth. Corals, freshwater ornamental fish, and marine ornamental fish all ranked low as commodities for CNMI. The primary reason was that all of these commodities need to be exported live and there are increasing restraints on air cargo from CNMI. Mangrove crabs (*Scylla serrata*) also ranked low as a marine commodity for CNMI due its near absence within the Commonwealth.

***Emerging commodities.*** During consultations, a number of emerging commodities were discussed. Emerging commodities are defined as species or groups of species that are of local interest but are not currently feasible to culture due to a lack of rearing technology, regulatory issues or physical constraints such

as land. The main emerging commodity for CNMI was the coconut crab (*Birgus latro*). During consultations, this species was rated for its potential impact, however rearing technology for this commodity is lacking. Bath sponges were also ruled out as a potential commodity for CNMI. It is not currently known whether any species of bath sponges are present in CNMI. In any case, current rearing technology for bath sponges requires large sheltered lagoons, which are lacking in CNMI. The final emerging commodity was the top shell (*Trochus* spp.) and the local turban shell (*Turbo* spp.). Rearing technology for both commodities exists, but at this time a strategy for stock enhancement has not been developed.

**Table 2. Marine commodity prioritization for CNMI.**

| High priority | Medium priority | Low priority | Emerging |
|---|---|---|---|
| Tilapia | Marine finfish | Sea cucumbers/sea urchins | Coconut crabs |
| Marine shrimp | Freshwater crustaceans | Corals | Trochus |
| | Giant clams | Marine ornamental fish | Sponges |
| | Milkfish | Freshwater ornamental Fish | Turban shells |
| | | Mangrove crabs | |

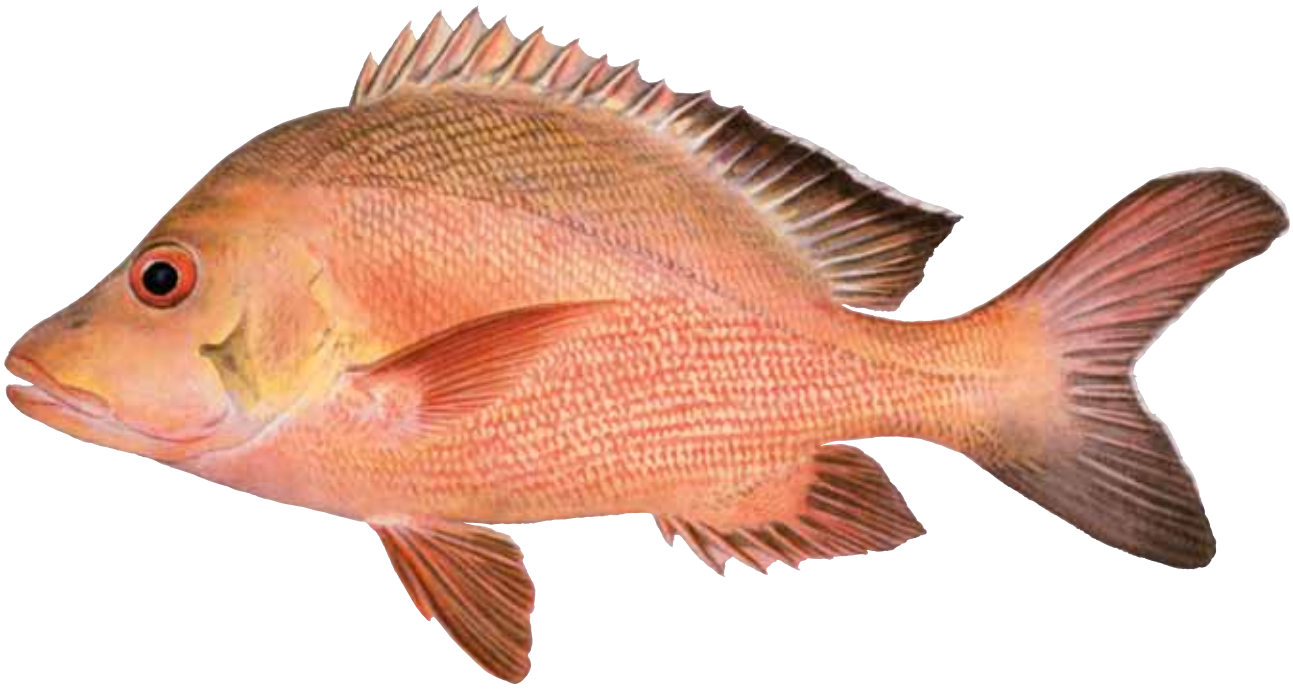

Illustration: Les Hata, © SPC

# 2.1 Tilapia

Tilapia was the highest ranked marine commodity for CNMI due to the fact that it is already well established as a farmed product on all three inhabited islands. This fish is exceptionally hardy and there is high demand for it from the guest worker and native population. Its acceptance on the market is growing, and it can be reared in a variety of ways, ranging from backyard extensive culture to intensive re-circulating systems. Feeds and seedstock are also readily available and marketing this hardy marine commodity is relatively simple through farmers and flea markets as a fresh or live product. Tilapia also grow well in polyculture systems, and trials are ongoing at NMC-CREES to combine shrimp and tilapia in re-circulating systems. Aquaponics – the growing of fish and hydroponic vegetables – has also been proven to be feasible in CNMI and presents another opportunity for development.

## Tilapia Commodity Development Plan

***Immediate actions***

- Work to produce feeds locally by identifying sources of available feed ingredients, expertise in this area, and the necessary equipment to make feeds.
- Reduce production costs by evaluating suitable alternative energy systems.
- Evaluate and identify possible funding sources for farm startups.
- Conduct trials to compare performance of present stocks to optimize grow-out.

***In two years***

- Locally produced feeds will be made on island.
- Farms will be run wholly or partially using alternative energy systems.
- Funding sources will be identified and made available to farmers.
- Tilapia stocks will be improved.

***In five years***

- Production costs will be lowered.
- Profitability will be increased.
- Production will be expanded.
- Dependency on fossil fuels will be decreased.
- Fish will be more marketable.
- Value-added products will be on the market.

Photo: Simon Ellis

*Figure 4. Pearly white tilapia, which is currently being grown in CNMI.*

# 2.2 Marine shrimp

Marine shrimp was the second highest ranked commodity due to it already being an established aquaculture commodity in CNMI. Shrimp are currently being raised in re-circulating systems on Saipan and Rota. There is enormous demand for food shrimp in CNMI, both from the resident population and tourists. Perhaps one of the biggest potentials for shrimp farming in the Commonwealth comes from the production of SPF broodstock for export to Asia. Disease-free broodstock shrimp sell for a high price and there is a constant demand for the product. At present, there are no shrimp diseases present in CNMI, making it an ideal place for establishing SPF facilities. In addition, CNMI is close to Asia and markets for SPF broodstock shrimp. Closing CNMI to the import of live, fresh or frozen shrimp from outside markets (for biosecurity reasons) would also boost local demand for food shrimp and would almost certainly create a thriving shrimp aquaculture industry in the Commonwealth. The presence of one medium size commercial shrimp producer with a hatchery on Saipan (Saipan AquaCulture) has helped to provide seedstock to local farmers, which has been a major obstacle to farm development in the past.

## Marine Shrimp Commodity Development Plan

***Immediate actions***

- Identify a financial adviser to help potential producers get access to available resources.
- Create an aquaculture technical review committee to assess the viability of projects and their conformity to existing regulations.
- Create a supply database and directory to help the aquaculture industry identify recognized local and off-island equipment suppliers.
- Create (or make available) a comprehensive list of existing opportunities in the Pacific for technical training.

***In two years***

- Diagnostic capacity for aquatic diseases will be established in CNMI.
- Domestic demand for fresh shrimps is being met by local production.
- A domestic breeding program will be established to avoid importing live shrimp from outside of CNMI.
- Quality control and labeling will be developed in order to create a CNMI shrimp brand.

***In five years***

- Importation of frozen shrimp will be banned for biosecurity reasons and to promote the local food industry.
- There will be local technical shrimp expertise for CNMI.
- CNMI will be established as an internationally recognized SPF shrimp broodstock producer.
- CNMI shrimp will be marketed as a high quality, exclusive product.

Photo: Antoine Teitelbaum

*Figure 5. White shrimp being raised for food at the Saipan AquaCulture facility.*

# 2.3 Marine finfish

Marine finfish was the third highest ranked commodity for CNMI due to the high demand for this product and the growing feasibility of this type of aquaculture in the region. Land based, inshore cage culture and open ocean cage culture are all possible options for CNMI. Hatchery technology now exists for many marine foodfish in the Pacific region, including rabbitfish (*Siganus* spp.), Pacific threadfin (*Polydactylus sexfilis*), groupers (*Epinephelus* spp. and *Plectropomus* spp.), mullets (*Mugil* spp.) and many other high value species. In addition, the development of offshore cage farming opens up new possibilities for farming sites in CNMI. Ongoing trials at NMC-CREES are also demonstrating the potential for grow-out of marine species in land-based re-circulating systems (similar to those being used for tilapia), thereby presenting an opportunity for existing farmers to grow higher value species in their systems.

## Marine Finfish Commodity Development Plan

***Immediate actions***

- Carry out a thorough site survey for cage aquaculture including the collection of depth and current data around CNMI.
- Undertake an economic study to corner the feasibility of marine fish aquaculture including open ocean cage culture.
- Ensure that control over three-mile offshore limit is ceded to CNMI from the US federal government.
- Work with DFW to approve: gear for collecting juveniles for culture, species for importation, and more concrete policies for aquaculture development.
- Review facility and logistical needs for seedstock production and/or import quarantine.
- Establish a coordinating committee for aquaculture in CNMI.
- Explore the possibility of an aquaculture industrial park to streamline the entry of farmers into the industry.

***In two years***

- Pilot grow-out trials for two to three chosen species are completed.
- Planning, fund raising and construction of hatchery and/or quarantine facility are completed.
- Private sector partnerships are developed.
- Review of regulations for aquaculture is completed.

***In five years***

- Private sector farms for marine finfish are operational.
- Export markets for marine finfish are developed.
- Seedstock supply to farms is stable either from hatchery production or from imports.


*Figure 6: Rabbitfish,* Siganus spp.*, are popular foodfish in CNMI. They have good aquaculture potential.*

# 2.4 Freshwater crustaceans

Freshwater crustaceans such as freshwater prawns (*Macrobrachium rosenbergii*), redclaw crawfish (*Procambarus clarkii*) and marron (*Cherax tenuimanus*) were the fourth highest priority commodity for CNMI. There is a high potential for culturing these species in existing facilities either in monoculture or polyculture. Many of these species also offer a more simple form of farming to marine shrimp while providing a similar product for the local and tourism market.

## Freshwater Crustacean Commodity Development Plan

***Immediate actions***

- Undertake a feasibility study to determine the size of the market for freshwater crustaceans.
- Carry out an import risk assessment to verify what ecological (invasive) and pathogenic (disease) risks there may be to introducing a new species.
- Carry out a study to determine opportunities for polyculture or integrated culture with other species.
- Carry out a study to determine opportunities for aquaponic polyculture.
- Determine feed requirements and availability.

***In two years***

- If a risk assessment finds that introducing a new crustacean species does not pose a risk, the species should be introduced.
- Establish a demonstration project to assess growth rates in different culture scenarios.

***In five years***

- If the demonstration project indicates that farming crustaceans is suitable for CNMI's environment then :
  - Produce training materials for freshwater crustacean farming.
  - Train farmers as required.
  - Establish a central hatchery or demonstration breeding facility.


*Figure 7. Freshwater prawns,* Macrobrachium rosenbergii.

# 2.5 Giant clams

There is a history of giant clam culture in CNMI. In the late 1990s and early 2000s, efforts were made to farm *Tridacna derasa* (which was imported from Palau) in Saipan's lagoon for sale to the tourist trade as food items. Efforts were abandoned due to poaching. Today, the main market for giant clams is the marine aquarium trade, where people keep smaller clams (4–8 cm) in home aquaria. Other local markets exist for giant clams such as food, shells for handicrafts, restocking for conservation, and ecotourism. Ecotourism in particular may have a viable niche in CNMI due to the country's tourism-based economy. Visitors may be willing to pay for a tour of a giant clam farm and buy handicrafts made from giant clam shells. Also, in other parts of the Pacific, dive and tour operators have established "adopt-a-clam" programs, where visitors pay to place clams back on the reef as a conservation measure. The highly colorful *T. crocea* and *T. maxima* occur naturally in CNMI waters, and so provide a resident broodstock for farming. Farms can also be land-based, and hatchery and grow-out methods are well understood and relatively simple.

## Giant Clam Commodity Development Plan

***Immediate actions***

- Develop a plan for giant clam seedstock production.
- Conduct an economic analysis to determine the feasibility of clam farming in CNMI.
- Work with DFW to determine which species of giant clam they will allow to be imported.
- Engage private sector farmers and chose farm sites.
- Promote giant clam conservation.

***In two years***

- Import giant clam broodstock or obtain broodstock locally.
- Produce and distribute seedstock.
- Establish farms and provide extension and training to farmers.

***In five years***

- Farms are established and producing giant clams.
- Marketing of giant clams to the aquarium industry is established.
- Multi-species giant clam culture is established.
- Explore less traditional markets for giant clams.

Photo: Simon Ellis

*Figure 8. Highly colorful* Tridacna maxima *for the marine ornamental trade.*

# 2.6 Milkfish

Milkfish (*Chanos chanos*) is one of the most cultured fish commodities in the tropics and has a long history of culture in the Pacific. It is a desirable commodity because it has a strong local market among guest workers in CNMI, especially the Filipino population. It is an easy species to grow because it feeds low on the food chain, grows fast, and can thrive in water of varying salinity (euryhaline). In addition, culture could easily be adapted to existing farms in CNMI. In many parts of the Pacific, milkfish fry can be captured locally in inshore areas. Otherwise, seedstock would have to be imported or grown locally in a hatchery.

## Milkfish Commodity Development Plan

***Immediate actions***

- Conduct feasibility study on producing milkfish for the local market.
- Identify constraints and biological parameters for producing milkfish in CNMI.

***In two years***

- If the feasibility study on producing milkfish for the local market is positive then:
  - Establish a demonstration project to assess growth rates in different culture scenarios.
  - Identify sources of seedstock.

***In five years***

- If the demonstration project indicates that farming of milkfish is suitable to CNMI's environment then:
  - Produce training materials for milkfish farming.
  - Train farmers are trained as required.
  - Establish a central hatchery or demonstration breeding facility.

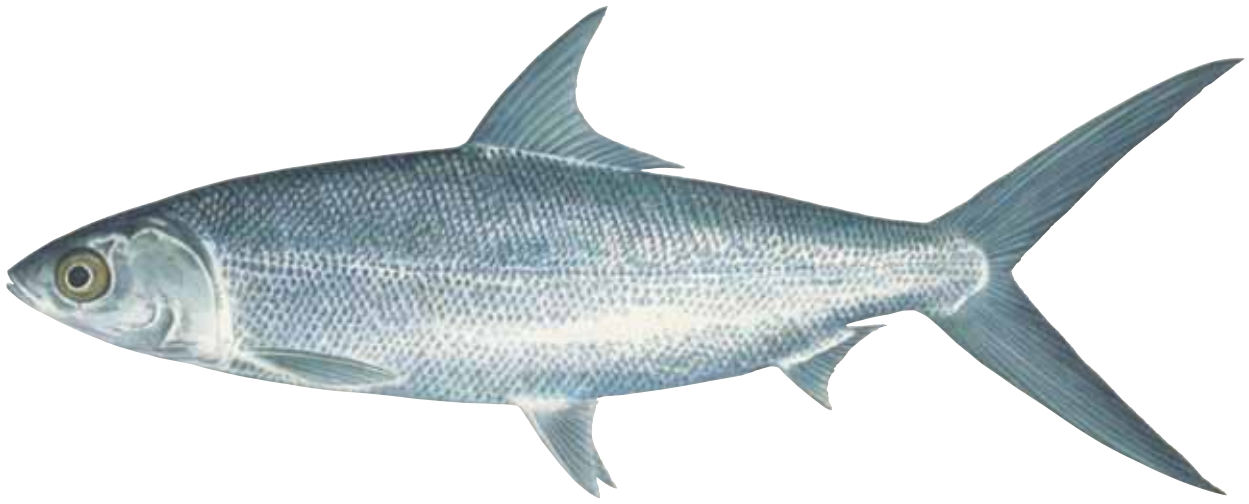

Illustration: Les Hata, © SPC

*Figure 9. Milkfish (*Chanos chanos)

# 3. Challenges to aquaculture in CNMI and strategies for success

During consultations regarding the CNMI Aquaculture Development Plan, participants were asked to list broad challenges they saw to the success of aquaculture in CNMI. The results of the consultations are shown in Figure 10.

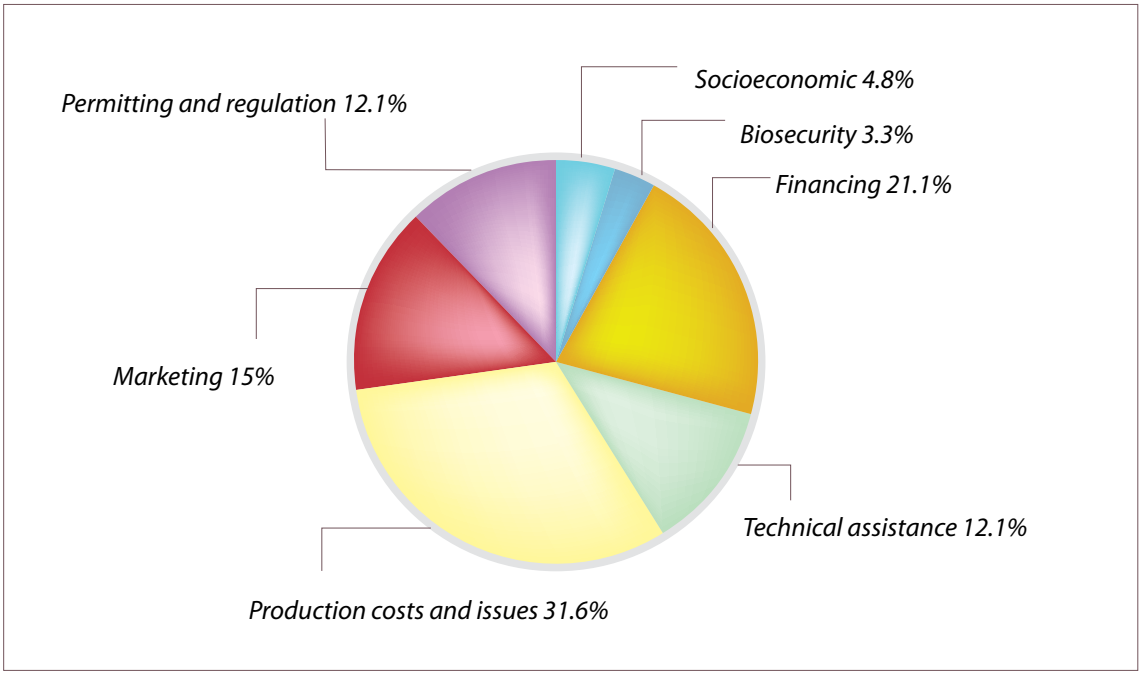


*Figure 10. Challenges to successful aquaculture in CNMI as prioritized by respondents during consultations (217 responses in total).*

## 3.1 Production costs and access to resources (31.6% of respondents)

Issues relating to production costs and access to physical resources proved to be the largest challenge to successful aquaculture in CNMI. Specific issues cited by respondents were:

- high water rates;
- high electricity costs;
- high feed costs;
- lack of available land;
- increasing local labor costs;
- low water pressure and lack of water;

- lack of competition among suppliers of equipment and materials;
- geographical remoteness of CNMI, leading to high transportations costs to major markets;
- lack of freshwater;
- poor access to seedstock and need for more hatcheries;
- reliance on imported aquaculture equipment and inputs; and
- high shipping costs for exporters and high costs of shipping compared with other countries.

**Table 3. Strategies to overcome production cost challenges**

| Objective | Action strategies | Measures |
|---|---|---|
| Reduce the cost of utilities for aquaculture | • Optimize the production system with efficient alternative low energy consumption systems and re-circulating systems.<br>• Identify and favor commodities that can be grown using less energy.<br>• Develop alternative energy systems for aquaculture.<br>• Seek government assistance measures for small aquaculture businesses. | Utility costs for farmers are reduced 30% in five years. |
| Reduce the cost of feeds for aquaculture | • Choose species that feed low in the food chain, such as milkfish or filter feeders.<br>• Choose species with low protein feed requirements, such as tilapia or milkfish.<br>• Work toward a reliance on locally available ingredients for "homemade" feeds.<br>• Study the feasibility of a local feed mill for producing aquaculture feeds. | Feed costs for farmers are reduced by 40% in five years. |
| Improve access to aquaculture sites and water resources | • Research the background for specific legislation that prioritizes aquaculture projects.<br>• Develop land leases for aquaculture from public lands.<br>• Develop specific zoning for aquaculture projects. | Aquaculture projects are easier to start with better access to sites and water resources. |

## 3.2 Financing (21.1% of respondents)

Financing for aquaculture projects was the second highest challenge among participants in consultations. Specific concerns cited by respondents included:

- limited access to financing opportunities;
- lack of or poorly developed business plans for farmers;
- poor availability of financing for producers in the short and long term;
- lack of micro-finance opportunities;
- start-up financing is only available to US citizens;
- access to grants is limited;
- need for the provision of low-interest loans from government or financial institutes;
- need for services to support farmers in finding funding; and
- high capital costs for some aquaculture ventures.

**Table 4. Strategies to overcome financial challenges**

| Objective | Action strategies | Measures |
|---|---|---|
| Improve the attitude of banks toward providing aquaculture loans | • Compile a model investment package to present to banks. | Model investment package for priority commodities is developed within two years. |
| Increase grant funding opportunities for farmers | • Train extension officers in how to fill out grant forms.<br>• Extension officers are readily available to assist in grant applications. | At least 80% of farmers who request assistance with grant applications have been assisted. |
| Increase finance and business skills of farmers | • Provide small and medium business and marketing training for farmers. | Small and medium training modules developed and regularly delivered (once per year). |
| Increase private sector and foreign investment interest | • Assemble an investment package of information about aquaculture opportunities in CNMI.<br>• Disseminate investment package to relevant authorities. | Investment package developed. Investment authorities are provided with investment information. |
| Consider forming a cooperative to share and mitigate financial costs | • Investigate revolving fund arrangements.<br>• Improve bargaining power cooperative bulk purchasing (e.g. equipment, feeds, seeds).<br>• Improve marketing arrangements to share supply costs. | Establish a farmer's cooperative within five years. |

# 3.3 Marketing (15% of respondents)

Specific comments from consultation participants on marketing challenges included:

- lack of markets for aquaculture products;
- undeveloped markets and no CNMI brand name;
- tilapia sales should be improved using taste testing;
- inconsistent access to markets;
- need support to establish a marketing cooperative;
- inconsistent quality and quantity of product;
- competition between local producers and importers; and
- limited airfreight capacity from CNMI.

**Table 5. Strategies to overcome marketing challenges**

| Objective | Action strategies | Measures |
|---|---|---|
| Make CNMI aquaculture products competitive with imported products | • Produce enough of a commodity to supply the local market.<br>• Produce a quality product that the local market is willing to pay more for.<br>• Conduct an advertizing campaign for a product that is: locally produced, of high quality, grown in the CNMI, free of pesticides, organic. | Commodities are high quality and produced in sufficient quantity to meet local demand. |
| Develop export markets for certain commodities | • Identify niche markets for CNMI commodities overseas to avoid competition with products coming from low production-cost countries.<br>• Identify local products of high interest for other countries.<br>• Develop value-added products rather than export raw products.<br>• Develop packaging that identifies the product as high quality and produced in CNMI.<br>• Use the Internet and other specialized marketing for promoting products. | Export markets for niche commodities are established within three years. |

## 3.4 Technical assistance (12.1% of respondents)

Specific comments from consultation participants on technical assistance challenges included:

- general lack of available technical assistance;
- lack of aquaculture knowledge within regulatory bodies;
- lack of available technical knowledge for some commodities;
- technical assistance for fish farming and shrimp culture is still needed;
- legislators need to have a basic understanding of aquaculture in order to provide assistance;
- education about aquaculture is needed for groups or individuals; and
- need to know where to go to seek technical assistance.

**Table 6. Strategies to overcome technical assistance challenges**

| Objective | Action strategies | Measures |
|---|---|---|
| Develop training programs for technical assistance | • Expand personnel levels at NMC-CREES, DLNR and other agencies involved in aquaculture.<br>• Seek professional development and training abroad.<br>• Encourage visits from overseas experts.<br>• Seek funding for grants.<br>• Increase the number of trainings. | Increased numbers of training opportunities and faster adoption of new technologies. |

Photo: Karine Briand

## 3.5 Permitting and regulation (12.1% of respondents)

Specific comments from consultation participants on permitting and regulation challenges included:

- issuing of permits and coordination of permits applicable to Public Law 15-43;
- need to update, amend and introduce new laws;
- permitting regulations are unclear;
- permitting regulations regarding ocean cages need to be clarified;
- understanding permitting steps to planning an aquaculture venture;
- clarification as to whether hobbies related to aquaculture need permits;
- lack of biosecurity legislation;
- impact of US federal legislation on immigrant labor;
- environmental regulations to deal with waste management, diseases and invasive species are unclear;
- need to simplify the processing, permitting and regulations for those who want to enter into aquaculture;
- unclear and sometimes over-regulation of aquaculture;
- impact of US federal tenure on permitting; and
- anti-development attitude by regulatory bodies – over regulation, too many bodies, lack of interest.

**Table 7. Strategies to overcome permitting and regulation challenges**

| Objective | Action strategies | Measures |
|---|---|---|
| Streamline the permitting process for aquaculture | • Hold meetings with all agencies involved.<br>• Compile all regulations into one document.<br>• Assistance and consultation to farmers for submission of permits. | Reduced permitting time for farmers. |

## 3.6 Socioeconomic (4.8% of respondents)

Specific comments from consultation participants on socioeconomic challenges include:

- lack of community coordinator to visit or inform villagers;
- political interference with proposed aquaculture projects;
- need for engaging new partnerships to share experiences and best practices;
- lack of cooperation between agencies and farmers;
- women's involvement is lacking;
- poaching in the lagoon;
- lack of cooperation in some villages to support aquaculture; and
- need for a village representative to relay information locally about new aquaculture projects.

**Table 8. Strategies to overcome socioeconomic challenges**

| Objective | Action strategies | Measures |
|---|---|---|
| Improve community involvement and coordination in aquaculture | • Formation of a farmers' cooperative. | • Stabilized prices and increased community coordination.<br>• Improved bargaining power, cooperative bulk purchasing (e.g. equipment, feeds, seeds).<br>• Improved marketing arrangements to share supply costs. |
| Increase women and youth involvement in aquaculture | • Engage women's groups in aquaculture training and demonstrations.<br>• Introduce aquaculture into 4-H, high school or other youth courses or programs. | More women and youth are engaged in aquaculture after five years. |
| Increase aquaculture production for subsistence and/or import substitution | • Demonstration and training in micro aquaculture systems.<br>• Source more local feed. | More people are growing their own aquaculture products within five years. |

## 3.7 Biosecurity (3.3% of respondents)

Specific comments from consultation participants on biosecurity challenges include:

- need to control aquatic diseases;
- general lack of biosecurity, disease surveillance and food safety in CNMI;
- lack of quarantine regulations for importation of live aquatics; and
- need to maintain environmental health.

**Table 9. Strategies to overcome biosecurity challenges**

| Objective | Action strategies | Measures |
|---|---|---|
| Minimize risk of disease import | • Laws and regulations reducing potentially harmful imports such as fresh or frozen shrimp.<br>• Increase public awareness of biosecurity issues through media such as posters or TV ads.<br>• Establish a quarantine facility.<br>• Improve disease diagnostic and observation capacity. | Biosecurity threats to aquaculture from imported products are eliminated within five years. |
| Minimize risk of harmful invasive species | • Risk assessment of any exotic species importation into CNMI.<br>• Publish and publicize a list of potentially invasive species for CNMI. | Biosecurity threats to aquaculture from potentially invasive species are eliminated within five years. |

# 4. Facilities necessary to fulfill the Aquaculture Development Plan

At present, NMC-CREES has an inshore facility (comprising an assortment of re-circulating systems) on the NMC campus. The newest component of the facility is a commercial-scale, three section, multi-species concrete grow-out system. The NMC-CREES facility is currently used for producing tilapia fry for distribution to farmers, and for commercial-scale grow-out trials of marine fish, tilapia and shrimp in re-circulating systems. The station also acts as a quarantine facility for imported species. There is no hatchery capacity for any commodities other than tilapia, although plans are in progress to convert some adjacent buildings into a live feeds laboratory.

*Figure 11. Commercial-scale concrete re-circulating system at the NMC-CREES facility on Saipan.*

*Figure 12. Experimental re-circulating tank systems for grow-out at the NMC-CREES facility on Saipan.*

The only other commercial producer of seedstock in CNMI is Saipan AquaCulture, which produces post-larval *P. vannemei* for its own use and for sale to other shrimp growers in the Commonwealth. Their facility on Saipan also acts as a quarantine area for imported shrimp for the operation.

During consultations on infrastructure necessary to fulfill the Aquaculture Development Plan, seedstock supply was considered to be of primary importance because the whole aquaculture industry depends on the availability of quality seedstock and juveniles for farming. In addition, Public Law 15-43, Subsection 102 states that "The plan shall include building and operating an aquaculture facility in the Commonwealth". To meet the demand for seedstock and juveniles for the aquaculture industry, the preferred solution was to create a hatchery. This hatchery will focus on the identified priority species (i.e. tilapia, shrimp, marine fish, giant clams and milkfish) and will, over time, eliminate the need for importing seedstock from foreign countries with all the associated problems (e.g diseases, unpredictable availability, and variable quality).

During consultations, the exact location of the future hatchery was not determined but the following key factors were considered to be important to the success of the hatchery.

- Access to both freshwater and seawater
- Isolation of the hatchery for reasons of biosecurity and security against human intrusion
- Ease of distribution of the seeds and juveniles to other islands

These technical concerns regarding the location of the hatchery are more important than political or local priorities because without these key factors, the hatchery cannot function properly.

Other key factors to success include:

- The hatchery should be modular so that different species could be raised at the same time even though their requirements are different.
- In order to lower the energy costs of running the hatchery, alternative energies or energy-saving technologies should be planned for and used as much as possible.
- In order to reduce environmental impacts and to minimize the use of water, re-circulating systems should be favored.
- Equipment and supplies such as pumps and filters should be standardized throughout the facility and be easily replaceable. In addition, supplies should be purchased from internationally recognized suppliers, or from local dealers who are reputable and reliable.
- Wherever possible, tanks should be produced locally.
- The broodstock supply (breeders used for larvae production) should use locally available species wherever possible. In addition, if imported species are to be used, then a quarantine facility is necessary along with disease diagnostic capacity.
- Hatchery staff should receive the best technical training, preferably overseas or from visiting specialists. With the exception of the manager, who may be from overseas, the hatchery technical staff should be from CNMI.

Photo: Oceanic Institute of Hawaii, finfish department

# 5.Human resources necessary to fulfill the Aquaculture Development Plan

At present, there is only the aquaculture program manager and two technical staff at NMC-CREES on Saipan. In addition, there is one non-specialist extension agent on each of the other islands (Tinian and Rota). Other technical expertise is present at NMC-CREES in terms of business development, economics and research, but none of this expertise specializes in aquaculture. In order to fulfill the Aquaculture Development Plan, human resources for aquaculture will have to be greatly expanded in the Commonwealth. The following is a list of expertise necessary to fulfill the Aquaculture Development Plan.

***Extension Assistance***. One full-time aquaculture specialist extension agent should be resident on Saipan, Tinian and Rota. These individuals would be available to assist clients with general enquires and, where possible or appropriate, help clients locate more specific assistance. Areas of expertise for the extension agents would be farm design, site and species selection, feed and equipment sources, permitting and regulation, grants and funding sources, community liaison, marketing and business plan assistance, and outreach for youth and women's groups. NMC-CREES would be the lead agency for extension agent assistance.

***Hatchery staff.*** A full time manager and two to three technical staff will be required to operate the hatchery for supplying seedstock to the industry. The manager will most likely be an overseas hire at first, due to the need for specific expertise. This knowledge will eventually be transferred to local staff. Hatchery technicians will be CNMI citizens. NMC-CREES will be the lead agency for hatchery staff.

***National Aquaculture Coordinator.*** This will be full-time position based at NMC-CREES, which is listed as the lead agency for aquaculture development in the Commonwealth under Public Law 15-43. The responsibilities of the coordinator would be to establish and lead the National Aquaculture Coordinating Committee, conduct public agency aquaculture education, liaise with overseas assistance agencies, supervise the extension program, lead aquaculture development planning and implementation.

***Aquaculture Economist***. This would initially be a part-time position but eventually become a full-time position. The aquaculture economist would be based at NMC-CREES and would work on business planning and marketing assistance to farmers. Specific tasks would be business planning training and assistance for farmers, market analyses for priority commodities, and generic and specific marketing campaigns for aquaculture products.

***Aquaculture Engineer.*** Because production costs were identified as a major constraint to aquaculture, an aquaculture engineer is necessary to work on ways to improve system efficiency through reducing energy costs, increasing grow-out densities, and improving system efficiency. This individual would be based at NMC-CREES.

***Aquaculture Veterinarian***. As the aquaculture industry grows, a full-time veterinarian specializing in aquaculture will be necessary. This individual would oversee quarantine, disease diagnosis and public health issues relating to aquaculture production.

***Public Awareness.*** NMC-CREES would also hire a communication specialist who works on public and farmer awareness campaigns, aquaculture education programs, and media coverage for aquaculture.

***Research and Development.*** A full-time aquaculture researcher at NMC-CREES will eventually be necessary to work on practical aquaculture development problems. In the interim, and in addition to the full-time researcher, other resources can be used to address research and development problems. These would include the use of overseas consultants to conduct market analyses, permitting and regulation overviews, short-term commodity training, and farmer training. Collaborations with overseas agencies such as those

listed earlier in this document and the use of graduate students from the University of Guam, would also bring research and development expertise to the Commonwealth.

***Small Business Development***. In addition to the aquaculture economist, there are also other agencies in CNMI that deal with small business development, namely the Commonwealth Development Authority, the Department of Commerce, and the Small Business Development Center at the University of Guam. It will be important for NMC staff to work with these agencies to ensure that they understand the issues surrounding aquaculture development in the Commonwealth, and have the tools to work with prospective farmers.

## 5.1 Timeframe for filling human resource needs

***Immediately***

- Extension agents on each island
- Hatchery staff hired
- Consultants on contract (e.g. create resource directory, permitting and regulation assessments)
- Part-time aquaculture economist (also to provide marketing support)
- Aquaculture Coordinator who will serve as the national focal point, and who will maximize outside resources such as technical assistance, grant funding and university collaborations.

***Within two years***

- Aquaculture engineer
- Marketing specialist.

***Within five years***

- Aquaculture veterinarian
- Aquaculture researchers.


Photo: Jacques Patrois

## Appendix I

# Contact details for stakeholders and agencies involved in aquaculture development in CNMI

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