Aquaculture Profile for Pohnpei Federated States of Micronesia

September 2004

Aquaculture Profile for Pohnpei
Federated States of Micronesia

September 2004

Publication #2004-1

Assembled under the guidance of the Pohnpei State Division of Marine Development, Office of Economic Affairs and the Conservation Society of Pohnpei

COASTAL RESOURCES CENTER
University of Rhode Island

UNIVERSITY
OF HAWAI'I
HILO

CONTENTS

ACRONYMS

CCO	Community Conservation Officers
CIP	FSM Capital Investment Project
CITES	Convention on International Trade in Endangered Species
COM	College of Micronesia
CRC/URI	Coastal Resources Center/University of Rhode Island
CSP	Conservation Society of Pohnpei
CTSA	Center for Tropical and Subtropical Aquaculture
DLNR	State of Pohnpei Department of Land and Natural Resources
DOI	United States Department of Interior
EDA	State of Pohnpei Economic Development Agency
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
FAO	United Nations Food and Agriculture Organization
FIB	Foreign Investment Board
FSM	Federated States of Micronesia
IFAFS	Innovative Future Agriculture and Food Systems
JICA	Japanese International Development Agency
MERIP	Marine and Environmental Research Institute of Pohnpei - Pohnpei Agriculture Training School
MPA	Marine Protected Area
NAC	FSM National Aquaculture Center (Kosrae)
NBSAP	National Biodiversity Strategy and Action Plan
OEA	State of Pohnpei Office of Economic Affairs
PATS	Pohnpei Agriculture and Trade School
PBCP	Pacific Business Center Program, UH
PACRC	Pacific Aquaculture Coastal Resources Center, UHH
PMRC	Pohnpei Resource Management Committee
SIDS	Small Island Developing States
TNC	The Nature Conservancy
UHH	University of Hawaii Hilo
UNDP	United Nations Development Program
USDA	United States Department of Agriculture

ACKNOWLEDGEMENTS

This profile is prepared under the joint guidance of the Pohnpei State Office of Economic Affairs, Division of Marine Development and the Conservation Society of Pohnpei. It was drafted by Dr. James Tobey (Coastal Resources Center, University of Rhode Island), Dr. Maria Haws (Pacific Aquaculture and Coastal Resources Center, University of Hawaii Hilo), and Simon Ellis with the financial support of the United States Department of Agriculture-Innovative Future Agriculture and Food Systems Program (IFAFS). We wish to extend our appreciation to all those who offered their time and invaluable insights. Special thanks to Scotty Malakai of the Department of Land and Natural Resources and Brad Phillip of the Conservation Society of Pohnpei for their assistance.

INTRODUCTION

This profile provides a comprehensive review of the status of aquaculture in Pohnpei, including key issues, needs, opportunities and constraints. It further suggests actions to advance the sustainable development of aquaculture in the State of Pohnpei, FSM. The profile is based on a review of existing literature and extensive consultations with stakeholders (see list of interviews).

This profile is the result of a collaborative process. The concept was developed from meetings of the Collaborative Alliance of the USDA-IFAFS project titled "Bridging Gaps to Insure Long-term Viability of Small Scale Mariculture in Hawaii and the U.S. Affiliated Islands". The Collaborative Alliance is comprised of aquaculture stakeholders from the public and private sectors and is open to all interested participants to serve as a regional forum for consideration of aquaculture issues. The first meeting of the collaborative alliance was held in Kolonia, Pohnpei in February 2002. Participants from FSM national government and Pohnpei identified the need for aquaculture planning and policy at meetings of the Collaborative Alliance. As a starting point, it was decided to begin with a focus on Pohnpei State, rather than tackle the nation as a whole. It is hoped that this profile can provide a model for similar efforts in the other FSM states.

This draft was reviewed by stakeholders and the Pohnpei Resource Management Committee (PRMC) and their comments and suggestions have been incorporated into this document. The PRMC is chaired by the lieutenant governor, vice-chaired by the Executive Director of the Conservation Society of Pohnpei, and has representatives from all the agencies that work on environmental and related issues in Pohnpei.

GOVERNMENT COMMITMENT

Aquaculture has been highlighted by the FSM national and state governments as a potential economic avenue that could provide economic benefits for the nation, including local job creation, increased domestic protein sources, enhanced populations of marine stocks and increased exports. National and state governments acknowledge that they have a leading role in promoting the development of a sustainable aquaculture industry (FSM, 2000). This includes ensuring that polices are in place to promote an aquaculture industry and to provide legal mechanisms to effectively regulate the industry as it develops.

More recently, recommendations formally adopted at the August 2002 meeting of the FSM Coastal Fisheries Consortium by representatives of State and National government at the highest level include (FSM, 2002):

- Encourage applied research, development and implementation of economically viable aquaculture programs in the FSM

- Coastal fisheries legislation and regulations should be implemented and updated as a matter of priority. Enforcement of all existing legislation and regulations should be strengthened at all levels

- Continue to improve public education and awareness-raising programs for the sustainable management of marine resources in all the States. Resource management activities should involve schools and communities

A national aquaculture profile recently produced by the Secretariat of the Pacific Community provides further support for these recommendations (Lindsay, 2002). The report concludes that selected aquaculture commodities have realistic potential within the nation, but require investment from the private sector and support, guidance and legislation from national and state governments.

It is widely acknowledged that private sector economic growth is imperative for long-term sustainable development of Pohnpei and other FSM States. Currently, government services dominate the Pohnpei economy with trickle down into the retail and service sectors. The aquaculture contribution to the GDP of the state is negligible. But as Compact assistance is reduced gradually over the next 20 years, key sectors such as aquaculture, fisheries, and tourism will need to provide the long-term growth potential for the State. Thus the major economic challenge is to assist in building and developing an environment conducive to private sector growth (FSM, 2000).

During 2004, the first year of funding under the new Compact period, $76 million will be provided for current government expenses. This represents a slight drop from the $80.2 million (excluding the "bump up" funds received during the past two years) that the US has recently been giving the FSM. What this means is that the government sector, which was already struggling to shrink its budget in keeping with US aid cuts, can expect no relief in the near future (Hezel, 2003). If the economy is to grow to any significant degree, it must look to something other than government employment to propel this growth.

Decline of the Reef Fisheries of Pohnpei

- "Before there were fish everywhere, now it's hard to find them. And they are getting smaller and smaller. "

- "People are fishing more at night now, using improved spears, flippers, even SCUBA. More people, more pressure."

- "It's really becoming different. Kitti Pass used to be a really abundant spot, not so much anymore."

- *Stakeholder interviews, September 2003*

Another reason that aquaculture development is important is that it is a component of ecosystem management. The inshore fisheries are overexploited. Fish are smaller and less abundant. Much of the pressure on reef fish comes from a growing population. From 1975 to 2000 the population of Pohnpei Island grew from about 20,000 to 35,000. The estimated population in 2002 was 38,000. The draft of the Pohnpei Land Use and Zoning Master Plan Task Force states that near-shore resources are being depleted as the demand for reef fish in the local subsistence economy increases (DLNR, 1996). Local fishers notice this change as they have to travel farther and break from their traditional harvest methods in order to harvest a catch.

Stagnant growth in government jobs impacts the entire population since those with public jobs are currently supporting extended families of which few have regular salaries. Dependence on inshore fisheries and the level of resource exploitation will increase as a consequence of the loss of the trickle down of public sector income. Environmentally sustainable aquaculture is a way to relieve some of the pressure of primary extraction.

STATUS OF AQUACULTURE IN POHNPEI

Site Availability and Species Options

The Federated States of Micronesia provide a wide range of habitats suitable for aquaculture. FSM has high islands and low atolls. Pohnpei State consists of a single, large high island (345 km^2) and 8 low atolls (Pingelap atoll, Mwoakilloa atoll, Sapwuahfik atoll, Nukuoro atoll, Kapingamarangi atoll, Pakin atoll, Oroluk atoll, and Ant atoll). Atolls possess enclosed or semi-enclosed lagoons providing calm water bodies suitable for many varieties of marine aquaculture. Marine resources are often the principal means of survival and production on small islands and low atolls since agriculture and freshwater resources are often limited.

The FSM has a high marine biodiversity index with many endemic species. High islands like Pohnpei have a wider range of aquaculture options since freshwater, brackish and marine environments provide potential sites for aquaculture. Pohnpei is also fortunate in having agricultural options and an abundance of freshwater. Pohnpei has a well-developed barrier reef surrounding a narrow lagoon with an area of about 181 km^2 . Off-shore aquaculture may also be a possibility.

Most aquaculture efforts in the past have focused on marine invertebrates such as sponges, pearl oysters, trochus, giant clams and corals. The emphasis on invertebrates is due primarily to their high value, low technology rearing methods and because these particular species are photosynthetic and/or filter feeders that do not need to be fed manufactured feeds as adults. Hatchery production of these species, when necessary, is also simpler than for marine fish. Culture of fish has been relatively limited. A shortage of finfish, the usual incentive for fish culture in other countries, has been absent as wild fish stocks have always sufficiently provided for the food needs of Pohnpeins. More emphasis on finfish culture is expected in the future as stocks become further depleted. Also, there has been little effort to exploit brackish or freshwater environments. To some degree this may have been fortunate since it is in these environments that possible environmental impacts have the greatest potential to occur through introduction of exotic species, land and mangrove clearing, diversion of streams or similar occurrences. As aquaculture and environmental protection advance, it may be possible to conduct aquaculture in these environments without impacts.

It is important to draw attention to two key features of aquaculture in Pohnpei:

- There has been an emphasis on using locally occurring species in aquaculture. This means that comparatively less is known about the basic biology, culture and ecology of these species as opposed to species such as tilapia or milkfish which have a long history of global domestication
- All aquaculture in Pohnpei relies heavily on wild stock at some point in the life cycle and is conducted in sensitive habitats. Thus, even for species with relatively well know culture technology such as giant clams, there is still much to learn from research and testing. While most species currently cultured have little potential for producing environmental impacts, it is still crucial to be vigilant and take a precautionary approach so that critical and vulnerable habitat such as coral reefs and mangroves are not affected.

Table 1. Pohnpei Aquaculture Operations and Their Current Status
*(*Programs not currently operating)*

For Profit Operations	**Locations/Institutions**
Milkfish (*Chanos chanos*)*	Pacific Water Resources
Marine Shrimp (*Penaeus stylirostris*)*	Pacific Water Resources
Giant Clams (*Tridacna sp.)*	Multiple individuals and locations
Wool Sponge (*C. matthewsi)*	Pohnpei Natural Products (3 farms at Dhepehk); community-owned farms at Enpein (2), Lenger (2), and Senpein (1)
Freshwater Aquarium Fish	Pohnpei Natural Products
Black-lip Pearl Oysters (*Pinctada margaritifera*)	Nukuoro atoll, Nukuoro Municipality
Educational and Demonstration Programs	
Giant Clams (*Tridacna spp.)*	Lenger Island hatchery and grow-out (Division of Marine Development); MERIP-PATS hatchery and grow-out
Trochus (*Trochus niloticus*)*	Lenger Island facility (Division of Marine Development)
Black-lip Pearl Oysters (*P. margaritifera*)	COM-Land Grant; MERIP-PATS
Rabbit fish (*Siganus sp.*)*	COM-FSM and Division of Marine Development
Seaweed (*Eucheuma sp.*)*	Pohnpei Economic Development Agency
Sea cucumber	Pohnpei Economic Development Agency
Hard Coral (various genera)	MERIP-PATS
Soft Coral (various genera)	MERIP-PATS
Wool sponge (*C. matthewsi)*	MERIP-PATS

Operations and Facilities

Giant Clams

Giant clams were one of the earliest Indo-Pacific invertebrates developed for culture because of their ease of hatchery production, their role as a traditional food and because all species were either endangered or threatened by the 1960's. Culture of giant clams originated for the purpose of providing a food source and to restock depleted populations. For some period of time, giant clams were served in restaurants in Pohnpei. Culture of food clams was never a significant financial success as giant clams take at least 5 years to reach the minimum size for consumption. It was also difficult to mobilize the live product to the target markets—the sashimi trade in the East. Later efforts have focused on rearing colorful giant clams, such as *T. maxima* as pets for the marine aquarium industry.

The Pohnpei state government through the Division of Marine Development operates a giant clam hatchery and land-based farm on Lenger Island. The Lenger hatchery and growout farm has 15 raceways and trains local farmers in giant clam spawning and culture. This facility has received external technical and financial assistance from the Overseas Fisheries Cooperative Foundation (OFCF) of Japan. The hatchery is currently not running but can be put back into operation if necessary.

Clams have been produced at the Lenger hatchery for reef restocking programs and community based commercial farming. The Lenger island hatchery has produced over a quarter of a million 6-month-old clams since its inception and has reseeded 30 percent of these. It is believed that clam reseeding has had very limited success to date. There has not been field verification of the reestablishment of juvenile clams on the reefs in Pohnpei from mature reseeded stocks.

T. maxima clams

High mortality rates have been reported for clams introduced for private and community-based ocean nursery culture in Pohnpei, which has been attributed to poor site locations, inclement weather conditions, predators and neglect. However, over the past several years colorful hatchery produced *T. maxima* clams have stimulated a small commercial industry targeting the international aquarium market. Shipping live products to distant markets is difficult and expensive, but if freight prices fall and regular production is established, this could grow into a significant trade. One possibility is to sell Pohnpei produced clams to marine ornamental traders in Palau or the Marshall Islands were they could be held, consolidated with clams produced in these areas, and re-exported. Shipping clams short distances (<12 hours door to door) is a cheaper process as clams can be packed in high densities in ice chests without water. This removes the burden of the expensive long-distance shipping process, which requires oxygenated, water-filled bags for transport and significantly greater paperwork.

Four species of giant clams can be produced at the Lenger Island facility; these are *T. maxima*, *T. derasa*, *T. squamosa* and *Hippopus hippopus*. The two latter species have not been produced in large numbers. All species except *T. derasa* and *T. squamosa* originate from native stocks. *T derasa* have been imported from Palau and Kosrae. The majority of clams currently cultivated at the hatchery are *T. maxima* and most clams are kept within the hatchery facility until provided to the clam farmers. The ocean nursery site for the facility houses only a small number of broodstock clams of all species destined for use in the hatchery.

Pohnpei state is part of the FSM National Aquaculture Centers (NAC) integrated aquaculture program and has received both giant clams and technical training from this program over the past decade. All clams

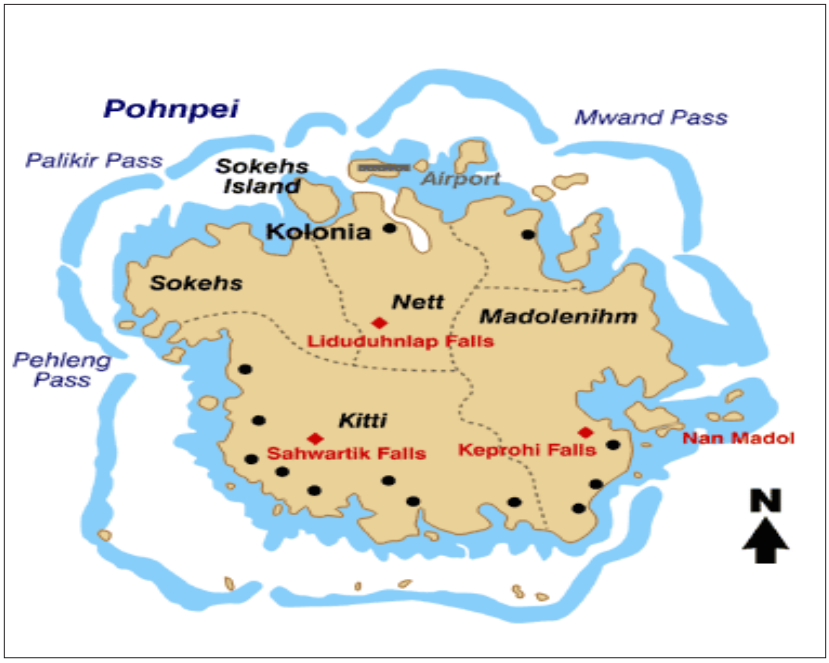
received have been held in the Lenger Island hatchery or provided to ocean nursery clam farms. The clams received by Lenger Island are destined for reseeding purposes. Two species of giant clam have been provided by NAC (*T. derasa* and *H. hippopus*).

A giant clam growout project was recently initiated in Pohnpei lagoon with the objective of generating income for local community members. The giant clams were provided by the NAC and training is being provided to fishermen to establish and maintain clam farms. To date, 10 have been trained and 6 have established small farms. Research is being conducted by the Division of Marine Resource Development on growth rates of various species of giant clams in lagoon and land-based farms.

The Marine and Environmental Research Institute of Pohnpei (MERIP) at the Pohnpei Agriculture and Trade School (PATS) also operates a small giant clam hatchery and growout raceways. The facilities are used for applied research, education and technical training.

Sponge Farming

Sponge culture originated in Pohnpei and Micronesia is still the only place in the world where bath sponges are commercially cultured. The sponges are used for bathing and washing, and as wild sponge decline throughout the world, demand has grown. Sponge farming takes advantage of a simple process where fragments of sponge are taken from a wild collected "seed" or broodstock sponge and planted on simple underwater string farms. Broodstock sponges are collected sustainably so that the cut stem regenerates in the wild. The technical feasibility of culturing sponges in Pohnpei was demonstrated with a CTSA-funded project initiated in 1989. The project undertook a series of applied research activities to develop farming techniques. The CTSA project did not support long term extension. After CTSA funding ended, the University of Hawaii Sea Grant Program provided technical assistance and extension to local communities through its Pacific Regional Aquaculture Extension Service (PRAES), funded by the U.S. Department of Interior. Funding for this program ended in 1998. By 1997 there were 50,000 sponges under cultivation. Levels dropped off after those were harvested because of a lack of appropriately sized markets and technical assistance.



Today there are eight farms on Pohnpei. These are operated at the community of family level with assistance from the Conservation Society of Pohnpei, PATS and a local company (Pohnpei Natural Products). Nearly all sponges produced are sold locally for the souvenir trade or to local residents, who use them for washing infants. The two former organizations receive external limited financial support to provide training, some supplies and marketing assistance. There is also a sponge farm in Senpein that was initiated by the Nature Conservancy (TNC) with UNDP funding. It is now run independently by people from the local community.

The MERIP program at PATS works with two sponge farming groups at Enpein community, Kitti Municipality to refine methods, provide sponge brood stock, train in processing techniques, and assist in marketing. MERIP also has its own demonstration farm for training students.

Cutting sponge

The Conservation Society of Pohnpei (CSP) works with community members to operate two sponge farms at Lenger Island. Parts of the reef surrounding Lenger Island were declared a marine protected area (MPA) in 2001 under the Marine Sanctuary and Wildlife Refuge Act. As mandated by the Act, a set of rules and regulations were developed and passed in 2003 to manage and enforce the MPA's of Pohnpei. The community on Lenger Island consists of approximately 50 people led by a community chief and is part of a larger municipality led by the municipal paramount chief. The community relies on the natural marine environment for subsistence fishing, which makes up approximately 90 percent of the community livelihood (Kostka et al., 2003). The sponge farms at Lenger Island are an example of how aquaculture can provide an alternative source of income for communities in and around MPA's. The Depehk Island MPA also has 3 associated sponge farms.

Among aquaculture species, some experts feel that sponge farming has the greatest long-term potential for Pohnpei. Sponge farming is a low-cost enterprise and sponges require little care and have no known predators. Since the sponges and lines are under water they do not interfere with boats and create marine resource use conflicts. There has been some theft of the lines for use as boat anchor line but it is rare and only occurs where the farm is not visible by farm owners. Sponges can be planted quickly (in 6 hours it is possible to plant 600-1000 sponges) and the earning potential is good. As a rough estimate, a family can earn $6-7 thousand per year with a farm of 20,000 sponges. A farm this size requires only 4-5 days of part-time work per month (Dick Croft, personal communication).

There is also a demonstrated local and international demand for this product. Pohnpei Natural Products sells about 100 to 150 sponges per month in Pohnpei alone, which may be about the capacity of local demand. At one time a company in the United Kingdom had a formal agreement to purchase 80,000 – 90,000 sponges a year to distribute to a British retail store ("Boots"). The contract was ended after a couple of years because the quantity that could be produced was too low (about 12,000 a year). The company couldn't afford to stock the product at such low levels. Evidence of the demand for this product is also demonstrated by the results of a market survey on Pohnpei sponges recently completed by the Pacific Business Center, University of Hawaii (PBC, 2003).

Black-lip Pearl Oysters

Black-lip pearl oysters produce large, dark iridescent "black" pearls commonly known as "Tahitian" black pearls. French Polynesia produces about $140 million in pearls annually and the Cook Islands realize about $9 million annually. Recent efforts have targeted replicating these economic successes in Micronesia.

Pearl culture in Micronesia was introduced by the Japanese prior to WWII, but none of these efforts survived. The first modern pearl farm in Pohnpei state was established on the remote outer atoll of Nukuoro. The atoll is located about 275 nautical miles SSW of Pohnpei and has a population of approximately 400. The project started with funding from the FSM Capital Improvement Project (CIP) fund and donor support from the Australian embassy ($31,000). Funding from the CIP is based on size of population. Since inception of the project, Nukuoro has received about $29,000 at three different times. The project also received grants

from the national government of about $50,000 in both 1995 and 1996. The Japanese international development agency (JICA) has also provided assistance for the purchase of equipment such as boats and a generator. Business and marketing technical assistance are currently being provided through the USDA IFAFS project.

The community owns and operates the farm under the direction of the Nukuoro municipal council. The farm relies on the collection of wild spat through the deployment of spat collectors, a method that provides a ready supply of cheap spat. There are about 10-14,000 spat being grown out in preparation for seeding. Six employees currently work the farm on behalf of the community. To date it has produced two small harvests of black pearls. In 1996 approximately 1,000 oysters were seeded. They were harvested in 1998 and yielded 600 marketable pearls out of 940 total seeded shell. A contracted specialist seeded 4,400 oysters in 2000 and they were harvested in the summer of 2002 to yield some 2,900 pearls. 4,500 oysters were seeded in 2002 and 9,200 in August 2003.

Nukuoro pearls

The Nukuoro lagoon is 2.5 miles in diameter and is estimated to have a farm capacity of 50,000 oysters. While the site has the advantage of feasible wild spat collection, the geographic location is a disadvantage. The atoll is only accessible by the State Field-Trip Ship one a month (when the ship operates). The island may go for periods of four or five months without a Field-Trip Ship visit. Despite logistical problems, the farm is expanding and nearing profitability.

The Municipal Council is preparing by-laws that will define the specifics of the community owned corporation and how profits are distributed. Local by-laws are approved by national government, not the state. The goal of the project is to provide income and employment that will support investments in the community and keep the community alive. Throughout the Pacific islands, traditions and culture are being lost on small, remote atolls as the youth move to urban areas of the larger islands. The primary economic activity of the Nukuoro Atoll was previously copra production, but with declining world prices this method of earning cash income has almost been given up by the residents. With the loss of the primary source of cash income, many Nukuoran families have migrated to the island of Pohnpei, increasing the burden of governance and social problems of the high-density population center of Kolonia Town. The pearl farm provides a sense of hope and community pride. It is thought to have reduced the out-migration of youth from the island.

The Nukuoro farm project has sparked an interest in other atoll communities to create their own pearl farm. However, the success of Nukuoro could not be easily replicated on other islands since Nukuoro is unique in that it has both a natural source of wild spat and the social organization to make the pearl farm feasible. It was recognized that in order to transfer pearl farming technology to other areas of the FSM, a pearl hatchery was needed.

In 2000, PATS received funding from the David and Lucille Packard Foundation and CTSA to start a small, low technology hatchery, conduct training and provide outreach about the importance of preserving local stocks of pearl oysters. Pearl oyster stocks are rare on most islands and research results from South Pacific

pearl populations suggest that they are genetically distinct (Benzie and Ballmont, 1994). Care must be taken to avoid the possibility of genetic swamping of rare stocks and transferring disease. The outcome of the PATS effort includes a small hatchery, a demonstration farm for training purposes, and development of Best Management Practices designed to enhance the benefits of pearl farming while protecting and restoring wild populations.

In 2001, the COM-Land Grant program established a small-scale pearl hatchery with funding support from the U.S. Department of Interior (DOI) and U.S. Department of Agriculture (USDA). A lease was obtained from the Pohnpei Port Authority (PPA) and a hatchery was constructed at the site of an abandoned warehouse at Nett Point. The first spawning of black-lip oyster was conducted in September 2001. This was a trial run was to test the hatchery's systems to ensure they were all operational. The spawning was a success. A second spawning in February 2002 was performed to simulate small commercial hatchery production and to determine the maximum number of larvae and spat that could be successfully produced given the hatchery's size and staff. It also proved successful. Four additional hatchery runs have been conducted as of March 2004. The hatchery is designed for production of up to 100,000 spat, but has proven capable of exceeding that amount. A primary objective of hatchery operations involves training of Micronesian staff. Micronesian staff conducted recent spawning runs with minimum supervision by the project's chief scientist.

Spat from the hatchery runs have been transferred to four community-based pilot farms. Two farms are located near Parem Island near the Nett Point hatchery. A third farm is located in the lagoon of Pakin atoll, which is about 20 miles from Pohnpei Island. A fourth demonstration farm is located in Sokehs municipality, Pohnpei. There are 25-30,000 oysters of different sizes being grown-out in the farm sites. Oyster growth is being monitored in the different farm environments. Different seeding techniques are also being tested and about 4-5,000 oysters have been seeded for round pearl production trials.

Training and technology transfer through learning by doing are key objectives of the COM-Land Grant project. Three core technicians have been trained to handle all aspects of hatchery-related skills, spat production and grow-out culture. These technicians will be capable of operating the Nett Point facility and replicating the process in other locations. A detailed hatchery manual is being produced and is expected to be available by mid-2004. Another component of training involves training people in the local communities at Parem Island, Pakin atoll, and Sokehs in grow-out farm techniques.

Trochus

Trochus are large snails whose shells, when polished, serve as materials for buttons, inlays and other decorative items. The meat is also consumed locally. In the past, the Division of Marine Development has cultured trochus at the Lenger Island hatchery for the purpose of reseeding on the reefs of Pohnpei. Trochus culture is no longer being undertaken because of the high mortalities of the animals reseeded. Relocation of adult stocks has also been undertaken in an effort to increase natural populations of trochus around the island of Pohnpei and several outer islands. A positive "spin off" of reseeding programs is improved public and community awareness of marine resource management and conservation practices, which has lead to the development of marine protected areas and sanctuaries. Several trochus sanctuaries have been created and are enforced by state legislation.

Trochus shells or *sumwumw*, are regulated under the Marine Resources Conservation Act of 1981, enacted by the Pohnpei State Legislature. The Director of the Department of Land and Natural Resources, in conjunction with the State Fisheries Officer (Chief, Division of Marine and Forestry Conservation), is charged with the responsibilities of specifying areas for trochus conservation sanctuaries, maintaining a conservation program designed to monitor the sanctuaries during open and closed harvest seasons, and supervising the distribution of marketing licenses to trochus harvesters. The harvest season is sporadic and determined by the level of existing stocks.

Other Species and Experience

Over the past decade there have been numerous small-scale government sponsored and educational demonstration projects on a wide range of marine and freshwater organisms. These include cultivation of seaweed, hard and soft corals, rabbit fish, and sea cucumbers. Most projects have been supported by external grants that have provided technical assistance, training and equipment. None have resulted in a sustainable economic business. The EDA seaweed pilot project in the late 80's failed due to marketing weaknesses. The rabbit fish project was supported with funding from the University of Hawaii Sea Grant Program. The effort ended when the cages were lost in a typhoon. Efforts that fail are rarely repeated even if the reason for failure could be corrected; thus very little learning is achieved. There is a historical pattern of discontinuous training and demonstration efforts. The lack of sustained and long-term demonstration models by any one institution or for any one species discourages successful adoption of production practices by stakeholders.

Subsistence fish farming at this point in time does not appear to be ready to take off since it is still much easier to catch wild fish. Several people interviewed said that milkfish and mullet are popular fish on the market. But cultured fish cannot compete with the price of wild caught reef fish ($2.50-$3.00 per kilo) or the high-demand terrestrial cash crop, sakau, which can be planted and harvested with little labor. Despite the reduction in stocks, it seems that the relative price of fish has not changed in 30 years (Dick Croft, personal communication).

One of the few privately funded projects involved raising milkfish for use as baitfish in the tuna long-line industry. This project was directed by a local businessman with a $160,000 loan obtained from the FSM Development Bank. The milkfish fry were purchased from Taiwan. Soon after the project started the price of bait for the long-line fishery dropped from about 50 to 15 cents a pound. After the contract with the National Fisheries Corporation expired the milkfish business soon closed. The milkfish were released to the wild and shrimp fry were purchased, imported, and raised in the 10 tanks. About 150 pounds of shrimp were grown in each tank and were sold locally for $20/kg heads on. Only one shrimp grow-out cycle was conducted at the farm.

The EDA has recently initiated an experimental sea cucumber culture project with the technical assistance of a Taiwanese expert. One of the initial sites will be in Madolenihmw Municipality. Culture techniques are very simple and involve fragmenting living sea cucumbers and returning them to wild for grow-out, a process more akin to ranching than farming. The project includes processing facilities to smoke the meat and prepare it for sale in Asia. This project got off the ground very quickly with the support of a local Chief Magistrate. An earlier sea cucumber harvesting project (mid-1990's) was stopped because it was not environmentally sustainable. Stocks of sea cucumber were diminished to the point that in 1996/97 a temporary ban was imposed on taking sea cucumber.

Future State plans include the possibility of upgrading the Office of Economic Affairs Division of Marine Development facility on Lenger Island to raise mangrove crabs and to spawn other species of clams (Lindsay, 2002, p. 9). OEA has submitted two proposals to the Governor's office for approval by the state legislature under the Fishing Finance appropriations. This is a budget that is funded by fishing fines imposed on foreign vessels illegally fishing in FSM waters. If the vessel is found fishing illegally in the 12 miles zone of Pohnpei state territorial waters, 30 percent of the fine is disbursed to the State of Pohnpei by national government. The first proposal is for a $70 thousand mangrove crab pilot project. The second proposal is for a $75 thousand seaweed project (*Eucheuma sp*).

The seaweed project would provide support for two years and establish three farm sites on Pohnpei Island and two on outer islands (with airstrips). The proposal includes six staff for extension to work with farmers who would be from local communities. An interested buyer from California has been identified. The same company currently purchases from other Pacific islands.

Educational Programs, Applied Research and Extension

The College of Micronesia - FSM (COM-FSM) has had a marine resources program in the Department of Math and Sciences since the late 1980's. An aquaculture course is offered every other semester and other courses in marine science are also offered as part of the academic curriculum of the school. COM-FSM had a Sea Grant extension agent until 1998 when DOI removed funding for the Pacific Sea Grant program. The agent, Ahser Edwards, had made significant contributions to marine science training and aquaculture development.

The COM- Land Grant program has had aquaculture training and extension programs in each state for over a decade, with most activities confined to Pohnpei state. Land Grant was, until 2002, the host agency for a regional aquaculture extension agent supported by CTSA. For over a decade this position provided technical assistance on a wide range of aquaculture activities across all the US affiliated pacific island countries. A small salt-water multi purpose laboratory is located at Nett point to assist in all activities related to marine science and aquaculture programs.

The Pohnpei Agriculture Training School (PATS) is a high school that provides vocational training courses in aquaculture and marine science as part of the academic curricula for their junior and senior students. With a yearly enrollment of 8 students, the program provides classroom and practical training. A small hatchery and several small ocean farm modules are used as a training tool for the students. Species cultured include wool sponges, pearl oysters, giant clams and hard and soft corals. In addition the school undertakes small-scale applied research projects and community-based extensions programs in aquaculture. Previous projects have included research into hard and soft coral culture techniques, black-lip pearl oyster hatchery methods and community-based sponge farming.

LEGISLATION AND INSTITUTIONAL FRAMEWORKS

The legislative and institutional framework of the FSM includes both national and individual state constitutions with each of the four states functioning as semi-autonomous governments. It is the prerogative of each state to enact their own legislation in line with their powers as defined by the FSM Constitution to address the concerns and issues of managing their own natural resources and sustainable development. The national government provides guidance and technical assistance to the states, when needed and requested, on matters related to planning, economic development, natural resources, fisheries, and the environment.

All waters located within twelve nautical miles (22.2 kilometers) of land falls under the jurisdiction of the respective state governments and therein all forms of foreign commercial fishing are excluded. These inshore resources are managed, conserved and developed by the respective state governments in association with resource owners. This includes all coral reefs and associated lagoons and coastal ecosystems. National government is responsible for the open seas of the Exclusive Economic Zone (EEZ).

National Agencies

Palikir village, Kitti municipality is the capital seat for the Federated States of Micronesia national government. At the national level the key agencies for aquaculture affairs are the Fisheries Section in the Department of Economic Affairs and the Department of Health Education and Social Services. State policies for fisheries and aquaculture should be submitted to the FSM Department of Economic Affairs for consideration.

The current national strategy for aquaculture and fisheries was developed at the 1999 FSM Economic Summit. Policy matrices were adopted at that time for national and state policy development of inshore

fisheries. The recommendations from the two meetings of the FSM Coastal Fisheries Consortium (2000 and 2002) build on the policy matrices. There is no long-term aquaculture development plan for FSM or the State of Pohnpei.

The Fisheries Section in the FSM Department of Economic Affairs promotes sustainable development, conservation, and management of marine resource programs and services, including aquaculture. The responsibilities of the Fisheries Section in the FSM Department of Economic Affairs include:

- Assist the states in implementing projects
- Provide technical support and information
- Facilitate contacts between state agencies and external organizations
- Coordinate programs and activities

The Fisheries Section also has administrative and financial responsibility of the National Aquaculture Center (NAC) located in Kosrae. NAC was established to assist the States in the development of aquaculture projects and to promote aquaculture research, training and extension services. This facility has targeted the propagation of giant clams for a nation wide reseeding program and in more recent times (1999 onwards) the export of clams to international marine aquarium markets. The goal is to develop an export industry for giant clams; this has not yet got off the ground. In addition, the center has assisted the Kosrae State Fisheries Division to culture several marine gastropod species (Trochus and Turbo) for a Kosrae state reseeding program.

At one time, an NAC employee helped get efforts started to make handicrafts out of giant clam shells. The University of Hawaii Sea Grant Program provided funding for a couple of handicraft workshops and CTSA produced a manual (Heslinga, 1996). The NAC successfully sold a substantial amount of shell handicraft to tourists and visitors, but this activity died out when the NAC employee leading the effort left.

The NAC regularly undertakes training programs on giant clam cultivation techniques both within Kosrae and in the other three states of the nation. Farmers are taught the necessary protocols for ocean nursery culture and are provided, free of charge, clams and equipment (wire mesh) to on-grow clams in their home states. In general, 4000 8-12 month old juvenile *T. derasa* are provided to each farmer. This program has been undertaken since the inception of the facility in 1991. Unfortunately, the NAC has suffered many problems in getting small-scale farming started.

The national government is exploring ways to privatize the NAC. So far, there have not been any serious negotiations or offers. Getting out of the export business and privatizing government ventures is a trend across the board in national government.

There are no national laws specific to aquaculture and no national level environmental impact assessment (EIA) requirements. However, the National Fisheries Section has been assisting the states with EIA's on an as needed basis.

Issues related to the introduction of aquatic exotic species or the importation of chemicals and the release of chemicals and toxic substances would be of concern to the FSM Department of Health, Education and Social Services.

State of Pohnpei

The island of Pohnpei is divided up into several political municipalities (*wehi*) that include Nett, Uh, Sokehs, Madolenihm, Kitti, and the main population center, the town of Kolonia. About 21 percent of the population live in or near Kolonia. The *Nahnmwarki*, traditional leader of each *wehi*, is assisted by the second most

prestigious traditional leader, the *Nahnken*. The two chiefs are titled positions inherited through the mother's side of the family. Within each *wehi* are divisions or *Kousapw* traditionally managed by the *Soumesenkousapw* under the direction of the *Nahnmwarki*.

Contemporary nontraditional leaders of each municipality include the Chief Magistrate and councilmen who are voted into office by popular municipal elections. A governor, lieutenant governor and legislature are also voted into office and conduct government administrative affairs of Pohnpei Sate for Pohnpei island, Pingelap atoll, Mwoakilloa atoll, Sapwuahfik atoll, Nukuoro atoll, Kapingamarangi atoll, Pakin atoll, Oroluk atoll, and Ant atoll.

There are many existing state laws regarding conservation of the natural resources of Pohnpei. There are few laws that specifically refer to aquaculture. The Conservation and Resource Enforcement Act gives the Department of Land and Natural Resources (DLNR) and the Office of Economic Affairs (OEA) the authority to enforce conservation laws and ordinances for which the State has enforcement responsibility. These laws involve marine and forest resource use restrictions and enable the State to protect the terrestrial and marine environment law for conservation, recreation and tourism, historical values, and educational purposes. They provide species protection and enable sustainable harvest levels of certain species.

For marine and aquaculture issues the relevant agencies are the Division of Forestry and Marine Conservation in DLNR and the Division of Marine Development in OEA. Aquaculture operations should consult and collaborate with DNLR and OEA in project development, especially where there is potential to impact coastal marine resources and the environment.

State legislature created the Marine Sanctuary and Wildlife Refuge Act in 1999, which allowed the creation of a trochus sanctuary at Lenger Island. Lenger Island is one of 11 MPA's established by the State of Pohnpei as no-take areas.

Permitting

State and municipal governments are empowered to manage land and water in Pohnpei. One of the management policies of the State of Pohnpei codified in the Conservation and Resource Enforcement Act is that development activities shall remain consistent with conservation goals. In principle, aquaculture operations should obtain a land use permit whether it is on private or public land to guarantee use of the area for the particular activity. Land is both privately and state owned, while marine areas are managed by the state as public trusts.

To legally obtain a permit for aquaculture operations on private land two agencies of DLNR (Division of Marine and Forestry Conservation and Division of Historical Preservation) and the EPA must inspect the site and decide if a study is required. All three agencies provide their own permit. If an aquaculture operation does not obtain permits, these agencies have the legal right to prosecute and fine the operation. During our interviews it was observed that while technically permits are needed, in practice the only reason to obtain them is to prevent another applicant from getting a permit and usurping the area. If the aquaculture industry in Pohnpei were to expand, there may be competition for prime sites and the permitting process would become more critical.

If the aquaculture activity is on public land (including all marine areas), then in addition to the three agencies mentioned above, the DLNR Division of Public Land must also approve. Once a positive recommendation is given by all four State government bodies, the land use proposal goes to the Pohnpei Public Land Board of Trustees for approval. The Board is a seven-member body appointed by the Governor. With a positive decision, the Board is empowered to issue a Development Lease of public lands under the Development Leasehold Act Title 41, State Law Chapter 5. Chapter 10 of State Law on Conservation and Resources provides special rights to nonprofit educational institutions to lease public lands.

Other permitting requirements:

- State law also provides permission for taking marine life for scientific, educational, or propagation purposes with a permit from the DLNR. Licenses are obtained upon written application and are valid for one year from the time it is issued. The license fee is $10.
  There are limits on the seasons and numbers of organisms that can be taken.

- The taking of aquarium fish and corals from any of the waters within the jurisdiction of the state is prohibited, except under a license or permit from DLNR. Monetary and jail fines for violations of the law are specified in the State Law.

- A business license is required to export

- A retail license is required to sell locally. The cost is $100 per year

- Trade in ornamental giant clams is controlled by the Convention on International Trade in Endangered Species (CITES). Giant clams are an Appendix 2 listed species, which means that they can be shipped and traded with a combined export permit and in lieu of CITES permit from the Office of Economic Affairs, Division of Marine Development. If shipping to the United States, a CITES form is also completed at the destination and signed by the U.S. Fish and Wildlife Service.

- Foreign owned aquaculture projects are permitted to lease land, but should also obtain a foreign investment permit.

- The Governor, legislators and the Public Land Board can also review special development needs and may decide to designate an area to a development project

Enforcement

Current conservation laws, zones, and management strategies are not well enforced. Priority must be given to enforcing these laws as well as current and future zoning ordinances and management plans. The Directors of OEA and DLNR have the power to establish conservation and enforcement programs, including issuing warrants, summons and citations to violators. The police force is also authorized to enforce these laws.

DNLR has five marine conservation officers in the state, but there are few operational boats for monitoring and enforcement purposes. In some cases Community Conservation Officers (CCO's) volunteer to work through municipalities to help with monitoring and enforcement. This is the case at the Lenger Island MPA for example. CSP is working both with local communities and the State to improve enforcement mechanisms and to promote community ownership of marine resources.

CULTURAL ISSUES

Cultural issues are clearly important for successful aquaculture activities. Traditions and culture based on extended family relations and subsistence lifestyle go back many generations. To ensure viability, the development of new aquaculture programs needs to include consideration of traditional cultural parameters as they influence motivation for conducting aquaculture activities. In rural areas there are long standing cultural norms that dictate the pace of life and schedule of work. A minimum requirement for aquaculture activities in rural areas is that they can provide substantial time schedule flexibility.

With a few exceptions, experience indicates a limited understanding of aquaculture's potential on the part of the people of Pohnpei. Sponge farming is an example. Although sponge farming has low start-up costs and

has time schedule flexibility there are probably other reasons why it has not taken off. In some cases it seems that communities were not approached beforehand to ensure that community members really understood what it entailed and embraced the idea. While the people of Pohnpei do not lack entrepreneurial spirit, there is often a poor understanding of natural resource exploitation in the Western sense. Structured terrestrial and aquatic farming are not a part of Pohnpein culture.

Sponge collecting off a boat

Also, due to the lack of consistent technical assistance, capital and business/marketing training, many entrepreneurs tend to copy existing businesses, which are based primarily around retail and service industries. The long lag between planting and harvesting (2-3 years for sponges) may also be a deterrent to aquaculturedevelopment in the state. People have to see a benefit from culture of marine organisms. Once a market is created there will be more incentive to grow because people will see the benefits at the end of the road.

Despite these challenges, one expert in Micronesia business concludes that is possible to marry internationally competitive aquaculture enterprise with traditional culture (Cheshire, 2001). The evidence to back up this statement is the fact that there are examples today of successful businesses in Micronesia with features of both value systems. Many successful businesses in the FSM begin small and expand by "bootstrapping," or using resources available within the family economy, in part due to the difficulty and risk involved with obtaining loans (Cheshire, 2001). While the same strategy might be applied to some aquaculture businesses such as sponge farming, other activities such as pearl farming require an approach that dictates an initially larger scale and greater capital resources.

Another cultural factor possibly influencing economic development of all kinds in Pohnpei is the lack of a large cash economy and a culture that does not put a high value on money. Despite growth in the cash economy of Pohnpei in recent years, only about 10 percent of the population are employed with a regular salary. The mild climate, local availability of fish and subsistence crops, and extended family structure make it possible for many to live without a cash income. Health and education is provided by the State and most homes are simple and have little electrical needs.

This picture is slowly changing. The exigencies of modern life have made it difficult for the population that lives a village life to remain without at least a small cash inflow. The market economy is growing. With the crash of copra people are looking desperately for a cash crop (Hezel, personal communication). There are fewer government jobs. Without a replacement for copra, there is the danger that the rural population will become increasingly uprooted and add to the stream of emigrants abroad. At the same time, there is the danger that villagers may satisfy the need for cash income in a way that does violence to the natural resources from which their children must live (Hezel, 2003).

Customary Marine Tenure vs. Government Legal Methods

Other cultural issues that are relevant to the development of aquaculture include the role of customary practices in aquaculture management. A survey was conducted about 10 years ago in Pohnpei to help understand community member's perceptions of authority, conservation and protection of marine natural resources (Foster and Poggie, 1992). Three communities were surveyed that include Pehleng village (Kitti Muncipality), Pingelap atoll and Nukuoro atoll.

Topics dealt with three issues. The first topic dealt with was whom fishermen perceived as the primary authority over marine resources in the lagoon and outside the reef of their community. The second topic dealt with the degree of confidence in government legal methods and customary marine tenure practices as a means of conserving marine resources. The third topic dealt with the degree of confidence in government legal methods and customary marine tenure practices as a means of protecting individual family mariculture projects in the community.

The findings showed that customary marine tenure practices are much more important in the atoll communities than in Pehleng village. For Pehleng, 97 percent of the respondents considered the government to have authority over marine resources; while only 3 percent felt fishermen had authority. But, only 37 percent of the respondents had confidence in the government's ability to conserve and only 7 percent had strong confidence in customary practices to conserve marine resources. In contrast, for Nukuoro, 96 percent felt strong confidence in customary marine tenure practices.

Finally, in Pehleng, 20 percent felt that the government could provide sufficient protection to individual family mariculture projects; while 60 percent felt customary practices (e.g. arrangements between community members) and a line of sight from the family's home to the proposed site could help ensure the project's protection. For Nukuoro, 100 percent of the respondents considered customary practices, such as *dai mada hale* as the most appropriate management scheme for individual family mariculture projects. *Dai mada hale* is a well established system in which families claim ownership over marine resources found within the sea space immediately in front of their shoreline property.

The implication for the island of Pohnpei is that families who establish aquaculture growout sites should create informal arrangements among families, clans and neighbors as a means of ensuring security. The traditional leaders and Municipal government can also help support the creation of these informal arrangements.

DEVELOPING AN EXPORT INDUSTRY

Marketing, transportation, and finance are critical, but by all accounts are weak elements of aquaculture development to date.

Marketing

There is an overwhelming consensus that marketing has always been the weak point of aquaculture development in the region and is the key to future success. After many years of pilot projects and technical assistance, the "traps" of aquaculture are well known. The technology and natural resource suitability have largely been proven. But the successful production of an organism does not directly lead to a profitable industry. The next frontier is to demonstrate the commercial feasibility of aquaculture ventures.

The local market in the State of Pohnpei is very small. Regardless of what the product or service is, the market is soon saturated. To expand outside the local market, aquaculture producers need to know how to contact foreign buyers. Marketing regionally and internationally is a big challenge in Pohnpei. For several reasons, producers are at a competitive disadvantage. Small size means limited ability to exploit economies of scale, and remoteness means that transportation and communication costs are high. It also means time delays and unreliability in transport services for both import and export of goods.

There are ways to overcome these problems. One way is to incorporate aquaculture enterprises into successful companies that have diversified into an array of related goods and services (Cheshire, 2001). Companies such as these have already solved many of the complexities of marketing and transportation and benefit from economies of scale (as with Robert Reimers Enterprises in the Marshall Islands). They know

how to manage and motivate a local workforce. They know how to develop a new product or service. And they know how to make a profit.

A second opportunity is to pool together similar products of aquaculture producers and market them under a unified label. Once a number of pearl farms are operating there could be opportunities to increase overseas market visibility and competitiveness by marketing the products as a consortium or cooperative. Similarly, scale of production has been a problem with marketing sponges, although not necessarily a limiting problem. To promote the development of sponge farming, for example, funding from a government or private source might be obtained to stockpile the product in order to go to the foreign market to sell in bulk.

Other options include:

- Develop aquaculture markets for niche products
- Provide an enabling environment for the private sector with government marketing assistance of aquaculture products
- Bundle various types of Micronesian products, such as coconut oil soap and sponges, or a general "market place" of diverse products offered at the same time
- Tap into the demand for community-based or environmentally "green" products
- Develop networks to market to other Micronesian countries, e.g. pearls and pearl shell to Palau, ornamental products to RRE in the Republic of Marshall Islands.

Transportation

International and inter-island transportation is a major impediment to aquaculture trade. Continental Airlines, the only air carrier in the FSM, has limited cargo space, which is not consistently available, even for small volume shippers. Continental has a stated policy that priority for cargo comes after passengers and mail. PM&O, the only surface carrier that serves all of Micronesia is set up to bring goods into Micronesia rather than take goods out. PM&O requires that exporters ship in container loads. A twenty-foot container holds twenty thousand to thirty thousand pounds, which has to be full or almost full before per pound shipping costs are economical.

Given the uncertainties of shipping, the product must be hardy: it must have an indefinite shelf life and be immune to the effects of delay. This requirement automatically eliminates many live and fresh products or forces the producer to develop an expensive transportation system to get the product to the market. Light, small volume and high-value products are the only feasible aquaculture export products for the State of Pohnpei at this time. By these criteria, among current species cultured in the State of Pohnpei, sponges and pearls are the most feasible for export markets because they are easy to ship, high value, and non-perishable. Giant clams and cultured corals have the advantage that culture techniques are simple and grow-out is nearly labor-free. But, shipping live animals from Pohnpei, while technically feasible, remains impeded by erratic and costly air cargo mechanisms.

The situation for air cargo may improve somewhat in the near future. Continental Airline freight costs were recently reduced. Also, Palau Micronesia Airlines, a Palauan company is scheduled to begin service to Pohnpei in 2004. While competition does not necessarily reduce prices, as has been evidenced by the addition of an extra carrier in the RMI, it does tend to lead to better and more consistent cargo capacity.

Financial Capital and Investment Climate

The FSM Development Bank has supported at least one aquaculture commercial activity (milkfish project) that we are aware of. A linked institution is the State of Pohnpei Small Business Guarantee office that can provide the guarantee required for Pohnpei businesses to obtain a loan from the FSM Development Bank. The Small Business Guarantee office also provides small loans (up to $5,000). The current portfolio of loans is about $700,000 (Yalmer Helgenberger, personal communication). A further source of Pohnpei lending is the Pohnpei Development Loan Fund. Overall, the availability of venture capital in the economy is very limited.

The Office of Economic Affairs has recently signed a Memorandum of Understanding with the University of Guam, Pacific Island Business Development Center, to establish an office in Pohnpei. This project will provide information and training for the local business community.

Currently, there are neither tax incentives nor other regulative exemptions for aquaculture companies that we are aware of. The investment climate is not attractive for foreign entrepreneurs considering doing business in the islands. Restrictions on the length of land leases, unpredictable court enforcement of contracts, lack of tax incentives, and multiple bureaucratic requirements imposed on outsiders all make investment unattractive (Hezel, 2003). In addition to these investment constraints, it is also the case that few people know about the investment opportunities in Micronesia in general, and even less about aquaculture opportunities.

SYNTHESIS OF KEY FINDINGS AND SUGGESTED ACTIONS

Aquaculture Planning and Decisionmaking

Many decisions continue to be made on aquaculture development in an ad hoc manner. There is no long-term aquaculture development plan. Under the current legal and institutional framework, projects can get approved without review and input from the Division of Marine Development or the Division of Marine and Forestry Conservation. The consequence is that transparency and accountability in the development of aquaculture ventures are low and success rates are poor. When efforts fail, key agencies as well as the community of responsible aquaculture entrepreneurs lose credibility. Lack of priorities for development and criteria for assessing the benefits of proposed projects means that there is no way to determine whether projects are desirable or credible.

Communication and access to information on aquaculture is weak not only between organizations in the State, but also between national government, state government and international donor organizations. Enhanced communications and coordination of all government, educational, and private agencies involved in aquaculture would be mutually beneficial for all participants.

Another gap is the lack of a unified aquaculture research agenda. People with expertise in various areas are not working together very consistently. The US federal agencies are also working in a manner that is fragmented and not mutually supportive. There are gaps in communications and coordination between US federal agencies and Micronesian government agencies. Other foreign donors promote their own interests often with little regard to local priorities.

Possible actions:

1. Provide training in how to conduct feasibility studies of aquaculture projects, including training in environmental impact assessment (EIA)

2. Prepare case studies of successful aquaculture development models

3. Conduct a planning workshop to determine key species and aquaculture development objectives. Have the plan adopted by the state government

4. Establish the PRMC as a legal entity by order of the governor or legislative action. Mandate this entity to be responsible for coordinated reviews of aquaculture projects; to uphold National and State legal processes and standards for aquaculture ventures; and, to provide the State, US federal agencies and other foreign donors with guidance on aquaculture development issues.

5. Organize a group of advocates for sustainable forms of aquaculture development. For example, a Micronesia aquaculture association. One of the strengths of Pohnpei is that there is a group of people on the island with significant technical, educational and practical experience in aquaculture. This includes people from public and private educational institutions, public office, government agencies, and individuals who are employed privately or retired. This group should have a partner relationship with the PRMC.

Aquaculture as a Component of Ecosystem Management

The need to push for conservation and economic development has grown over the decades and Pohnpei must find the right balance to satisfy both elements.

It is internationally recognized that small island developing states are ecologically fragile and vulnerable. Their natural environments are more vulnerable to natural and human-induced hazards. In addition, hazards adversely affect the health of ecosystems at rates and intensities above those found elsewhere around the globe. This tendency for damage sets small island states apart from most other countries and translates into greater challenges and complexities for sustainable development. Small islands are microcosms for our world. If we can find solutions to the special vulnerabilities of islands, it will help us address more global problems.

Promoting aquaculture from the perspective of resource management and sustainable livelihoods may open new and additional sources of donor funding and connect with local and international conservation initiatives. Sponge, giant clam and pearl farming are all examples of economic development activities that can be viewed as promoting environmental sustainability. In many cases (such as sponge and giant clam production) aquaculture is an alternative to wild harvest that depletes natural stocks.

Possible actions:

6. Hold a workshop on linking coastal and marine conservation with aquaculture-based sustainable livelihoods. Prepare outreach materials on the same.

Extension

Everyone agrees that the tendency for projects to cease once donor-funded support is removed must change. The answer that most people give is to place more attention on technical assistance and training in the areas of marketing and business skills, and to ensure that directed extension training to build local skills is provided over the long-term. To be successful, activities should be located where local communities embrace them. Each project must consider technical, business and social acceptability.

For many years, funding agencies such as CTSA and Sea Grant provided only technical assistance and did not address business and marketing issues. Species were promoted for culture before proper market feasibility studies had been conducted. This is viewed as one of the key reasons that they have not passed the test of long-term commercial sustainability. Both government and lending institutions also provide very little financial advice and assistance.

Current technical assistance and extension efforts in the business and marketing development area include activities of the UHH PACRC in collaboration with the Pacific Business Center Program (PBCP). Actions include development of combined economic and biological (bioeconomic) models of pearl and sponge production, training in marketing and business management, and efforts to link producers with markets and buyers in the U.S., Asia and Europe.

In general, the aquaculture extension capacity of the FSM has seen a steady decline in recent years. Both CTSA and the University of Hawaii Sea Grant Program have been removed from the scene as significant and long-term sources of technical assistance and funding. While several agencies have attempted to cover the needs of Pohnpei state, the level of funding and effort are not adequate. The only aquaculture extension agent (associated with the UHH) is part time. COM-Land Grant has one pearl oyster hatchery trainer, but the focus is limited to two small demonstration farms. More support of aquaculture extension and the institutions that conduct extension and applied research are needed so that at least some core functions can be maintained in the face of fluctuating external funding. COM could conceivably play a role in this—as does the College of Marshall Islands in RMI—but so far their efforts have been limited to higher education.

In addition to increasing the number of extension agents and support to institutions, another option is to work towards developing a system of community based promoters as has been done in many countries for public health or agriculture. In the case of Pohnpei, CSP has been successful in tapping into local leadership to promote environmental causes and this could be a model for aquaculture as well.

Possible actions:

7. Provide training on community-based extension through a "training of trainers" approach. Target participants with field-based activities such as relevant government offices (Division of Marine Development, Division of Marine and Forestry Conservation), Conservation Society of Pohnpei, MERIP-PATS, COM-Land Grant, and Peace Corps

8. Prepare awareness building pamphlets for community use focusing on how to do things right (such as starting a sponge farm)

9. Seek new sources of funding for long term aquaculture extension, including technical assistance in marketing and business management

Public Policy and Regulations

The special economic and development vulnerability of small island states has been a prominent topic of the international Small Island Developing States (SIDS) network. The smallness, remoteness, and limited and vulnerable resource base provide compelling reasons for a relatively greater supporting role of the public sector in assisting private sector development.

A lack of coordinated and directed government support for aquaculture from key agencies has been identified by many people as an impediment to industry development in the past. Successful aquaculture requires not only engagement of the private sector, but also provision of an enabling environment through planning and support from the FSM national and Pohnpei state governments.

There needs to be clear and consistent regulatory guidance for sustainable development. The islands of Pohnpei State are too small and vulnerable to risk environmental damage from unsound aquaculture development.

A project of the United Nations Food and Agriculture Organization (FAO) is about to begin a review of the national and states aquaculture and fisheries laws in FSM, RMI, and several other Pacific states. This project

was initiated with the recognition that the current laws are outdated and cannot be enforced. The first regional meeting of partners is scheduled for October 2003 in Palau with project completion anticipated at the end of 2004. This project is being lead by the FAO sub-regional office for the Pacific Islands in Samoa.

Future work on resource policy and regulations should also build from the recent efforts of the Land Use and Zoning Master Plan Task Force. The Task Force has conducted an extensive review of State Law on terrestrial and marine conservation and development. The Pohnpei State Land Use and Zoning Master Plan will be presented for adoption by the Pohnpei State legislature at the next session.

More informal and voluntary approaches to management and regulation of aquaculture may also be promoted. For example, many regions and industries have been successful in developing and voluntarily adopting Best Management Practices (BMPs) that are sound and compatible with environmental, social and development goals. BMPs also help producers lower risks and educe the chance of losing crops.

An example of BMP's from Micronesia are the draft BMPs for pearl culture developed by the Pearl Research and Training Program with funding from the David and Lucille Packard Foundation and USDA (Haws and Ellis, 2003). These BMPs were developed jointly with pearl culture stakeholders in the RMI and FSM and reviewed by stakeholder groups. While none of the BMPs carries the force of law, they can assist in raising awareness of what good practices are and encourage voluntary adoption. They can also be used as a starting point for development of formal policy and regulations.

Possible actions:

10. Improve and strengthen appropriate National, State and Municipal policies and legislation to ensure the effective management of aquaculture. Coordinate with FAO sub-regional office in Samoa to ensure that Pohnpei is actively involved in the fisheries and aquaculture legal review of the Pacific Islands

11. Prepare BMP guidelines for key aquaculture species through a Pohnpei working group that includes government, non-government and private sector representatives

Business Promotion

There is a need to provide packages of information to people in the business community with successful businesses as well as to the public to increase awareness of the potential of aquaculture as a commercial enterprise.

Possible actions:

12. Prepare an investors guide and outreach materials to instruct and promote aquaculture investment opportunities in the State

Transportation Infrastructure

The single greatest barrier to export development in general in Micronesia is the lack of transportation conduits to target markets. The current transportation industry in Micronesia will continue to view Micronesia export as a secondary concern until there is sufficient freight volume to justify providing more service. But until there is a transportation system in Micronesia that supports export development, potential exporters will continue to struggle.

Possible actions:

13. Government can play a role in helping break out of the transportation "chicken and egg" predicament by identifying the transportation exporters need to get their products to market. Once this is done, they can

begin to explore with the various members of the region's transportation industry how these services can be provided.

14. Government can also expedite transportation by facilitating permitting processes for export of product and import of aquaculture supplies and equipment, with consideration for reducing or eliminating taxes for the latter.

15. Government can enhance control of exports of wild aquatic products that compete with aquaculture products. For example, transportation of wild giant clams is regulated under CITES, but they have been exported from Pohnpei in the past. Aside from the environmental effects of harvesting and exporting wild clams, they also compete with the legitimate trade of sustainably cultured clams.

LITERATURE

Adams, C., J. Stevely, and D. Sweat (1995), "Economic Feasibility of Small-scale Sponge Farming in Pohnpei, Federated States of Micronesia," *Journal of the World Aquaculture Society*, Volume 26, No. 2, pp. 132-142.

Benzie, J.A.H., E. Ballment (1994), "Genetic differences among black-lipped pearl oyster (*Pinctada margaritifera*) populations in the western Pacific," *Aquaculture*, 127:145-156.

Cheshire, C.L. (2001), "Family and Business in Micronesia," *Micronesian Counselor*, Issue 37, November 24, 2001, 18 pp., Micronesian Seminar, Pohnpei.

Cheshire, C.L. (2003), "Developing an Export Industry in Micronesia," *Micronesian Counselor*, Issue 47, June 2, 2003, 18 pp., Micronesian Seminar, Pohnpei.

Croft, R. (1987), "Aquaculture Potential for Micronesia," developed for CTSA/COM.

Croft, R. (1990), "Pohnpei Commercial Sponge Survey," South Pacific Aquaculture Development Project, Food and Agriculture Organization of the United Nations, Suva, Fiji.

Croft, R. (2001), "Report on the Status of Aquaculture in the Federated States of Micronesia," paper presented at the Center for Tropical and Subtropical Aquaculture Industry Advisory Council Meeting, 21-22 February 2001, Honolulu, Hawaii.

DLNR (1996), "Pohnpei State Land Use and Zoning Master Plan," assembled by the Land Use and Zoning Master Plan Task Force for the citizens of Pohnpei State and the Land Use Planning and Zoning Commission, State of Pohnpei Department of Land and Natural Resources, September 1996.

Foster, K. and J. Poggie (1992), "Customary Marine Tenure Practices for Mariculture Management in Outlying Communities of Pohnpei," *Coastal Aquaculture in Developing Countries*, ICMRD, University of Rhode Island, Kingston, RI.

FSM (2000), "The FSM Coastal Fisheries Consortium," Report of Proceedings, National Government of the Federated States of Micronesia, 102 pp.

FSM (2002), "2nd FSM Coastal Fisheries Consortium," Report of Proceedings, National Government of the Federated States of Micronesia, Department of Economic Affairs, August 27-29, 2002, Kolonia, Pohnpei, 102 pp.

FSM (2002), The FSM National Biodiversity Strategy and Action Plan, National Government of the Federated States of Micronesia, 65 pp.

Haws and Ellis (2003), *Best Management Practices For Pearl Culture in Micronesia: Protecting Livelihoods and Habitats of Pacific Islands*, Pacific Aquaculture and Coastal Resources Center, University of Hawaii Hilo, 10 pp.

Heslinga, G. (1996), "Clams to Cash. How to Make and Sell Giant Clam Shell Products," CTSA Publication #125, Center for Tropical and Subtropical Aquaculture, Honolulu, HI, 75pp.

Hezel, F. (2003), "Making the New Compact Work," *Micronesian Counselor*, Issue 45, February 3, 2003, Micronesian Seminar, Pohnpei.

Kostka, W., E. Joseph, S. Ellis, T. McAdam, and L. Watson (2003), "Lenger Island: A Demonstration Case," WCPA, NOAA and WWF Marine Protected Area Management Effectiveness Initiative, Draft, September 2003, 15 pp.

Lee, C. S. and K. Awaya (2003), "Viable Aquaculture Development in the U.S. Affiliated Islands—Lessons from Giant Clam and Sponge Farming," *Aquaculture Economics and Management*

Lee, C. S. (1999), "Some Considerations for the Sustainability of Aquaculture Development in US-Affiliated Pacific Islands," *Aquaculture Economics and Management*, Vol. 3, No. 1, pp. 71-82.

Lindsay, S. (2002), "Federated States of Micronesia: Aquaculture Country Profile," prepared for the Secretariat of the Pacific Community, Aquaculture Technical Paper Series, New Caledonia, November 2002, 33 pp. (http://www.spc.int/aquaculture/site/home/index.asp, accessed March 12, 2004).

Pacific Business Center (2003), "Marketing Sources and Recommendations for Farmed Sponges from the Federated States of Micronesia and Palau," report prepared by the College of Business Administration, University of Hawaii at Manoa, 19 pp.

Riley, J. (1993), "Long Range Strategic Plan for FSM National Aquaculture Center," FSM National Aquaculture Center, Kosrae.

Tomezak, J (2001), "The Senpehn Community Sponge Farming Project, Pohnpei," UNDP Small Grant Scheme Final Report, UNDP Program, Suva, Fiji.

Van't Slot, J. and B. Raynor (1995), "Compatible Development Opportunities for Pohnpei State, Federated States of Micronesia," prepared for The Nature Conservancy, July 1995.

APPENDIX

List of Contacts

Herson Anson
Chief, Division of Marine Conservation
Department of Land and Natural Resources
Pohnpei State Government

Youser Anson
Director, Department of Land and Natural Resources
Pohnpei State Government

Dick Croft
Pohnpei Natural Products
Pohnpei High School Teacher

Donald David
Chief, Division of Marine Development
Office of Economic Affairs
Pohnpei State Government

Ahser Edwards
College of Micronesia-FSM
Palikir, Pohnpei

Simon Ellis
Marine Advisor, Conservation Society of Pohnpei

Senator Gerson
Pohnpei State Senator for Nukuoro

Francis Hezel, Director
Micronesian Seminar

Yalmer Helgenberger
Administrator, Office of Economic Affairs
Pohnpei State Government

Masahiro Ito
Pearl Aquaculture Project
COM-Land Grant

Kenichi Kikutani
FSM Department of Economic Affairs
Overseas Fisheries Corporation Foundation (OFCF)

Willy Kostka
Director, Conservation Society of Pohnpei

Ishmael Lebehn
Secretary (Acting)
FSM Department of Economic Affairs

Valentine Martin
Fisheries Unit
FSM Department of Economic Affairs

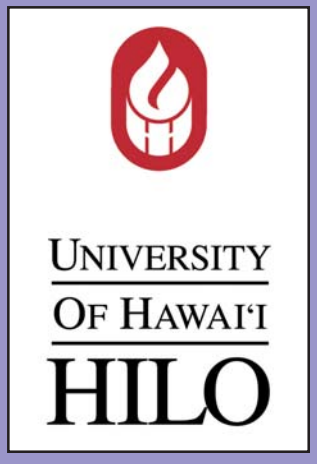
Father Greg Muckenhaupt
Director, Pohnpei Agriculture and Trade School

Moses Pretrick
Environmental Health Specialist
Division of Health Services
FSM Department of Health, Education and Social Affairs

George Stephens
Chief Magistrate of Nukuoro Municipality and manager of Nukuoro Black Pearls
Nukuoro Atoll


UAF
UNIVERSITY OF ALASKA
FAIRBANKS


Coastal Resources Center
University of Rhode Island


University
Of Hawai'i
HILO