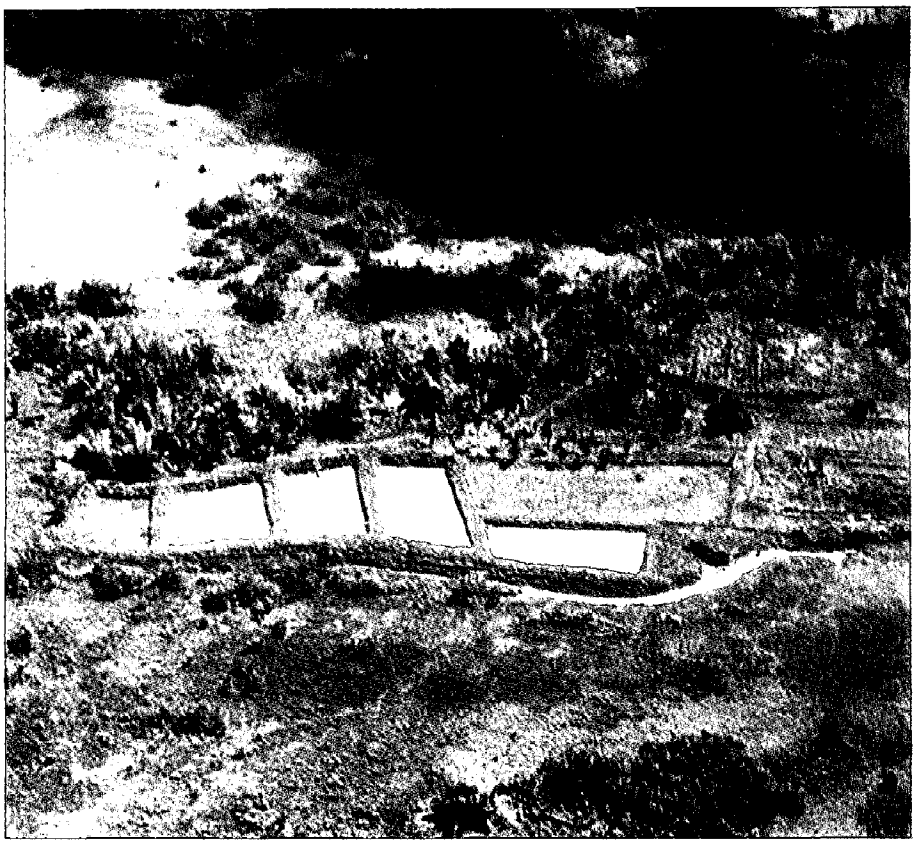

AN INTRODUCTION TO AQUACULTURE ON GUAM:
PROSPECTS, PERMITS AND ASSISTANCE

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DEPARTMENT OF COMMERCE

Guam Coastal Management Program
Bureau of Planning
Government of Guam

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PROSPECTS AND OPPORTUNITIES

Aquaculture is a relatively new and potentially significant industry on Guam. Aquaculture, which is the cultivation of aquatic animals and plants, can be in freshwater, brackish water, or salt water depending upon the species being raised. The term mariculture refers specifically to marine aquaculture.

Guam can become a major island producer of aquaculture products and technology in the Western Pacific. The production from aquaculture can assist in import substitution and develop into a major export product for Guam. The technology can also be exported to other islands in the Western Pacific region to assist in the development of their aquaculture industries.

There is no historical record of the ancient Chamorros practicing aquaculture around Guam. However, remnants of a structure located in Sasa Bay (Apra Harbor) has recently been found that appears to be a type of ancient fish weir or enclosure. Further examination of the site is necessary to determine the exact nature of the structure.

Investigation into the prospects of commercial aquaculture on Guam was initiated in 1973 with the government's experimental demonstration ponds located in Talofofo. The species examined included the Malaysian giant prawn *(Macrobrachium rosenbergii)*, freshwater eel, *(Anguilla japonica)*, Chinese and common carp *(Hypophthalmichthys molitrix, Aristichthys nobilis, Ctenopharyngodon idella,* and *Cyprinus carpio)*, milkfish *(Chanos chanos)*, hybrid tilapia *(Sarotheradon niloticus* x *S.*

mossambicus), catfish *(Pangasius sutchi)*, the mangrove crab *(Scylla serrata)*, and the Pacific oyster *(Crassostrea gigas)*. Other species have been cultured on a small scale by local farmers. These include the soft-shell turtle *(Trionyx sinensis)*, marine shrimp *(Penaeus monodon* and *P. merguiensis)*, Catfish (**Clarias batrachus**) and the eel *(Anguilla rostrata)*. Since that initial work, great interest has been generated in the potential of aquaculture to aid the island in its quest for economic self-sufficiency.

The approximate pond area that is presently constructed for aquaculture amounts to 50 acres. Of this total, approximately one acre is for eel, twelve acres for tilapia, twenty-seven acres for prawns and ten acres for marine shrimp. However, of this total area only about 60 percent is actually being utilized. The major reason for this is a lack of a consistent and adequate supply of postlarvae and fry of the species being cultured.

Guam's year-round warm climate is very conducive to the rapid growth of many cultured species. Guam's climate is tropical, with mean daily temperatures averaging between 24°C and 30°C (75°F to 86°F) and a mean annual temperature of 27°C. These year-round warm temperatures are significantly higher than those in Hawaii and contribute to Guam's increased growth rate of cultured aquatic species as compared to the growth rate obtained in Hawaii. The marine waters around Guam have an annual temperature range of 27°C to 29°C. Rainfall averages from 85 to 100 inches per year. The majority of this rainfall occurs during the months from June through November. Easterly tradewinds predominate throughout most of the year and are generally strongest during the period from December to May. However, Guam also lies in the path of occasional tropical storms and typhoons. Therefore, proper construction and management of the aquaculture facility is necessary to minimize potential losses during periods of high wind and rain.

The northern portion of the island is a raised, gently undulating limestone plateau which gradually slopes southward. No permanent streams exist on this plateau because of the permeability of the limestone soil. The southern portion of the island has rugged terrain which is dissected by numerous streams. This area has clay soil of volcanic origin. The western slope is short and steep while the eastern slope has a gentle slope with wide valley flats. The latter is the area which is most suitable for the development of aquaculture. Selection of a site must consider the presence of an adequate water supply, not only for the initial pond area, but also for planned future development. The water requirements will depend on the species and the type of culture system used. An extension agent from the College of Agriculture and Life Sciences (CALS) should be contacted to evaluate all site requirements. A survey of potential sites has

revealed that there is a minimum area of 900 acres suitable for aquaculture ponds with an adequate water supply.

For the aquaculture industry to become viable and further expand, there will have to be a permanent on-island hatchery established to produce the needed postlarvae and fry for those species cultured. Until such a hatchery is in operation, investment in the culture of species dependent on a hatchery should be postponed. There is a temporary hatchery at the Marine Laboratory; however, this hatchery is not intended to meet the needs of a growing industry. There are two farms that are attempting experimental hatcheries for *Macrobrachium rosenbergii;* however, neither has been successful to date. An experimental hatchery for catfish, carp and tilapia is under construction at the Department of Agriculture.

Financial assistance can be obtained from the Guam Economic Development Authority, which has two loan programs. These are the Agriculture Development Fund (ADF) and the General Development Fund (GDF). Aquaculture is eligible for both these Funds. The Farmers Small Loan Revolving Fund administered by the Department of Agriculture would be very suitable as would the ADF to assist aquaculture; however, both of these Funds have been exhausted of unobligated funds. The Farmers Home Administration (FmHA) has a number of loan programs, with moderate interest rates and flexible terms which aquaculture can qualify for. There is a FmHA Office on Guam, which should be contacted for full information. Private investment capital and commercial bank loans are additional alternatives. The latter is generally not practical due to the high interest rates required and the lack of flexibility afforded the borrower.

There are a number of methods of culture that can be applied to the various species. Earthen pond culture is the most commonly used impoundment (i.e., for prawns, tilapia, carp, catfish). Earthern ponds are constructed by excavating soil from the pond area to form dikes. The drainage system can be designed in a number of ways, but the objective is to be able to completely drain the pond within a reasonable period of time. Concrete ponds are utilized for various species (e.g., eels) or in intensive culture systems. Raceways can be used in the intensive culture of various fish, marine shrimp and mollusks. Raceways are designed to allow a continuous large flow of water through the enclosure to facilitate flushing of wastes, maintenance of high oxygen levels, and in the case of circular design raceways, the movement with the current of species of fish that tend to swim continuously. Floating cage culture can be used to confine species, usually fish, within a larger body of water. Raft and stick culture can be used in the culture of oysters and mussels. From a raft, a line is hung down that supports the substrate (shell or net bag) on

which the oysters or mussels are attached. In stick culture, a stick (wood or metal) is driven into the bottom usually in shallow water (4-10 ft. deep) from which the substrate for the oysters or mussels are attached.

The terms monoculture and polyculture refer to the number of species being cultured within a single impoundment. Monoculture is the culture of a single species, while polyculture is the culture of two or more species within an impoundment. A number of advantages are associated with the use of polyculture such as a fuller utilization of the food resources and habitat, increased production, population control and as a pond management tool. However, care is needed to assure proper stocking of compatible species in both number and kind.

All aquaculture products presently produced on Guam are marketed on Guam with the exception of eels. With the preference for fresh high quality seafoods by the consumer, the aquaculture product is expected to replace a large portion of the present seafood imports. The civilian, tourist and military markets represent the major markets on Guam. Eventually, an export market will have to be established for the main species cultured (e.g., prawns, shrimp and various finfish). Proximity to the Japanese market gives Guam the opportunity to enter and compete in this large market for fishery products.

PERMITS

For the construction of an aquaculture facility on Guam a series of permits, both local and federal, may be required depending upon the location and type of aquaculture facility being built. Table 1 summarizes the responsible agencies for the issuance of permits for various activities involved in the construction and operation of an aquaculture facility. The agency issuing the permit often calls upon other agencies to review and comment on the permit application before approval or denial to see if there is any major contradiction to that agency's policy. The Bureau of Planning, Department of Parks and Recreation and Department of Agriculture usually function as reviewing agencies and not as the permit issuing agency.

The Bureau of Planning, as mentioned, would serve as a reviewing agency of permits when requested. However, if an aquaculture project requires any federal permits (e.g., U.S. Army Corps of Engineers) or is wholly or partially federally funded, then a finding of consistency with the Guam Coastal Management Program (approved August 11, 1979) is required. This means that the policies of the Guam Coastal Management Program (GCMP) must be complied with to the maximum extent practicable. The Bureau of Planning is the lead agency in the implementation

of the GCMP; however, this would not involve an issuance of a permit by the Bureau of Planning, but instead an approval or denial of an application for a permit submitted through the appropriate issuing agency for review as to whether or not the application complies with the GCMP. Guam's "coastal zone" includes all non-Federal property within the Territory of Guam, including offshore islands and submerged lands and waters extending seaward to a distance of three (3) nautical miles. Hence, the use of all non-Federal land must comply with the GCMP.

The Department of Parks and Recreation (DPR) serves mainly as a review agency that examines permits and environmental impact statements from the Territorial Planning and Seashore Protection Commission and the U.S. Army Corps of Engineers. However, they are the issuing agency for a permit that involves the erection of facilities within a unit of the Guam Territorial Park System or affects a cultural or historic resource. An aquaculture facility within the Guam Territorial Park System would require a permit from DPR under Section 26003 and 26011 of the Government Code of Guam. Protection of cultural and historic resources (includes underwater sites) is a responsibility of the DPR by virture of Chapter XIII, Government Code of Guam. Section 13985.19 states the requirement for clearance by DPR prior to construction.

The construction of earthern ponds requires an excavation permit from the Department of Public Works. The construction of structures such as a storage shed, living quarters, water storage tanks, and concrete wall ponds would require a building permit from Public Works. This requires the applicant to submit a detailed draftman's drawing of the proposed facility. Guam Environmental Protection Agency would be involved with permits for a sewer connection or septic tank construction. Land Management must also issue a permit denoting that the proposed construction does not violate the zoning law. All building construction requires a permit from Public Safety's Fire Department. Guam Power Authority (GPA) must inspect the premises before installing electrical power outlets. If a power line and power poles are required into private property, an easement must be signed by the owner of the property. The current charge to install poles and power lines is approximately $700 to $1,000 per pole; however, this charge can be reduced depending on the projected usage over a 30 month period. Special power rates are given to consumers rated on KVA usuage. To obtain potable water, Public Utility Agency of Guam (PUAC) must inspect the premises. Reduced agricultural water rates are available. An access road constructed within private property does not require a permit. However, if major excavation is involved, then an excavation permit is required from Public Works.

The Department of Revenue and Taxation does not have the responsibili-

ty of issuing permits or reviewing permit applications for aquaculture-related operations. The Department of Revenue and Taxation does not require an aquaculture operation, once it starts to market its product, to obtain a retail or wholesale business license, since aquaculture is an agricultural activity, Section 16024(b) of the Government Code of Guam, stipulates that an agricultural producer that markets or sells his own farm produce in its natural state is not required to purchase a business license. Title XX of the Government Code of Guam Section 19543 (P.L. 9-124) states that agricultural producers and fisheries are exempt from the payment of the Gross Receipts Tax. Aquaculture would qualify for such an exemption. A qualification for this exemption is that it applies only to producers who sell their produce directly to the market. Section 19572.01 of the Government Code of Guam (P.L. 6-94) provides for a drawback on the liquid fuel tax for fuel utilized on the farm site (e.g., for pumps, aerators, generators, tractors). Liquid fuel purchased solely for agricultural purposes and not used on public roads is allowed a drawback of two cents ($0.02) per gallon on diesel fuel and a drawback of four cents ($0.04) on all other liquid fuels. Agriculture equipment and supplies imported into Guam are exempt from the Use Tax. Section 1960(i) as added by P.L. 10-87 provides for the exemption of the use or retainment of property by a bonafide farmer engaged in agriculture on Guam and used or held for use only for agricultural purposes.

The Department of Agriculture issues permits for the importation of live aquatic animals and plants. The aquatic animals must also be accompanied by a certificate of health from a certifying agent in the country of origin verifying that the animals are free of disease. The importation of a new species of an aquatic animal (and terrestrial animals) to Guam is reviewed by an importation review committee consisting of members from the Department of Agriculture, University of Guam, Guam Environmental Protection Agency,. Department of Commerce, Department of Public Health, and the private sector.

The Department of Land Management in which the Territorial Planning Commission and the Territorial Seashore Protection Commission are located serves as a review and approving agency for permits involving land use. It is not a permit issuing agency. The Territorial Seashore Protection Commission is composed of the same seven (7) members who serve on the Territorial Planning Commission.

The seashore reserve, which is under the jurisdiction of the Territorial Seashore Protection Commission, is the "land and water area of Guam extending seaward to the ten (10) fathom (60 foot) contour. This includes all islands within the Government's jurisdiction except Cabras and those villages wherein residences have been constructed along the shoreline

prior to the effective date of the Seashore Act, and extends inland to the nearest of the following points:

1. From the mean high water line for a distance on a horizontal plans of ten (10) meters.
2. From the mean high water line to the inland wedge of the nearest public right-of-way, Public Law 13-154, 1976."

Any development within the seashore reserve, whether on land or under water, must obtain the Commission's approval. Since such development activities require the issuance of a permit from one or more government agencies, these permits must be approved by the Commission before being granted by the permit issuing agency.

Permits required by the U.S. Army Corps of Engineers for a development action that does not fall within the jurisdiction of the Territorial Seashore Protection Commission must be cleared through Land Management as a procedural process before the U.S. Army Corps of Engineers will issue the permit.

All development on a proposed site must comply with the zoning laws. For example, Chapter 3 Title XVIII of the Government Code of Guam Section 17103 "A" rural zone states that development in this zone must comply with the permitted use within this zone. This includes all types of activities and pursuits customarily carried on in the field of agriculture and fisheries. This would apply to adquaculture activities also.

The Guam Environmental Protection Agency (GEPA) must review various permits before they are to be issued by the issuing agency. For example, all clearing and grading permits (Public Works) must be reviewed and approved by GEPA for compliance with the Guam Soil Erosion and Sediment Control Rules and Regulations. In land zoning, GEPA would have input into requests for conditional use permits or zoning variances through the Subdivision and Development Review Committee. A well driller's license, also a well drilling and well operating permit, is required from GEPA and falls under the Rules for Protection, Development and Conservation of Water Resources in the Territory of Guam. Issuing permits for discharge of effluent through an injection well, which is restricted to an area within 2000 feet of the coastline of Guam, is the responsibility of GEPA. This action is enforced through the Underground Injection Control Regulations. Discharge of effluent to surface waters must comply with the Guam Water Quality Standards. It is to the overall benefit of the aquaculture industry that the enforcement of the Guam Water Quality Standards be diligently carried out to maintain the water

quality of the surface waters used by the industry and ensure that they are free of pesticides and toxins. In addition, if the aquaculture facility is large enough it may be necessary to apply for a federal permit under the National Pollutant Discharge Elimination System (NPDES). Key relevant statements in the portion concerning aquaculture facilities of Federal Regulations 40 CFR 122 Environmental Protection Agency Consolidate Permit Program Regulations, which applies to State NPDES programs are: "Concentrated aquatic animal production facilities, as defined in this section are point sources subject to the NPDES permit program." "A hatchery, fish farm, or other facility is a concentrated aquatic animal production facility...if it contains, grows or holds aquatic animals in either of the following categories...(b) Warm water fish species or other warm water aquatic animals in ponds, raceways, or other similar structures which discharge at least 30 days per year, but does not include:

1. Closed ponds which discharge only during periods of excess runoff; or
2. Facilities which produce less than 45,454 harvest weight kilograms (approximately 100,000 pounds) of aquatic animals per year."

The U.S. Army Corps of Engineers has jurisdiction over structures that lie in, on, over or under all tidal waters and for all dredging and/or filling in all tidal waters under Section 10 of the River and Harbor Act of 3 March 1899. Permits are also required for the discharge or placement of all fill and/or dredged material into tidal and nontidal waters and their adjacent wetlands under Section 404 of the Clean Water Act of 1972. Section 103 of the Marine Protection Research and Sanctuaries Act of 1972 requires a permit for the transportation of dredged material which are to be dumped into ocean waters.

The following is a clarification and elaboration on the actions above (numbers correspond to actions in Table 1) and their requirement for a U.S. Army Corps of Engineers, Department of the Army (DA) permit.

1-2. Construction of earth or concrete ponds requires a DA permit if the earth fill or concrete for the ponds, or temporary or permanent earth fill for the construction of the ponds, is placed into tidal areas and their adjacent wetlands, or into certain nontidal waters and their adjacent wetlands.

3. Construction of a drainage system in tidal waters requires a DA permit, and construction of drainage systems in wetlands adjacent to tidal areas or in certain nontidal waters and their adjacent wetlands requires a DA permit if the system involves the discharge or placement of any permanent or temporary fill or

dredged material.

4. Pumping of water from wells does not in itself require a DA permit.

5-6. Pumping of water directly from streams, lakes or the ocean does not in itself require a DA permit. The construction of an influent line or pump station in ocean waters requires a DA permit. Construction of influent lines or pump stations in other areas may require a DA permit if discharge or placement of fill or dredged materials is involved.

7. The discharge of effluent through an injection well does not in itself require a DA permit. A DA permit may be required for the structure.

8. The discharge of effluent into surface waters does not in itself require a DA permit. A DA permit may be required for the structure.

9. Land zoning requirements are strictly a matter under local jurisdiction and not under the Army Corps of Engineers.

10. Construction of an aquaculture facility in a flood hazard area does not in itself require a DA permit unless the facility is to be located in water or in a wetland under the Corps of Engineers jurisdiction.

11. Construction of an aquaculture facility in a wetland does require a DA permit if any discharge or placement of fill or dredged materials is involved.

12 13. The use of fish cages or pens in all tidal waters requires a DA permit, and the use of fish cages or pens in nontidal areas may require a DA permit if any discharge or placement of fill material is involved.

14. No DA permit required.

15. The construction of farm access roads may require a DA permit if the construction of the road involves the temporary or permanent discharge or placement of dredged or fill material into tidal and certain nontidal waters and their adjacent wetlands. The construction of some minor road crossing fills is covered by a Nationwide permit described in 33 CFR Sec. 323.4-3(a)(3), pro-

vided the conditions described in 33 CFR Sec. 323.4-3(a)(b) (1-7) are met. The Nationwide permit does not apply to tidal waters or tidal wetlands. The conditions which must be met on Guam are: the discharge will not be located in the proximity of a public water supply intake, the discharge will not occur in areas of concentrated shellfish production, the discharge will not destroy a threatened or endangered species as identified under the Endangered Species Act, or endanger the critical habitat of such species, the discharge will not disrupt the movement of those species of aquatic life indigenous to the waterbody, the discharge will consist of suitable material free from toxic pollutants in other than trace quantities, and the fill created by the discharge will be properly maintained to prevent erosion and other non-point sources of pollution.

A proposed list of "Categorical Exclusions," that is, "a category of sections which do not individually or cumulatively have a significant effect on the human environment and which have been found to have no such effect in procedures adopted by a Federal agency in implementing the National Environmental Policy Act regulations and for which, therefore, neither an environmental assessment nor an environmental impact statement is required" (U.S. Army Engineer District, Special Public Notice 11/7/80) is currently being reviewed for approval. Two proposed "Categorical Exclusions" that would apply to aquaculture which are:

1. Installation or removal of minor seawater intake and discharge pipes for aquaculture projects, marine laboratories, and research facilities; and
2. Minor canals, ditches, dikes, retarding structures, etc., used in connection with fish and wildlife development programs, and agricultural or aquaculture projects.

These categorical exclusions, if approved, would be applicable to Guam.

TABLE 1

AGENCIES RESPONSIBLE FOR ISSUANCE OF PERMITS FOR AQUACULTURE RELATED ACTIVITIES

	ACTION	ARMY COE	PUBLIC WORKS	LAND MANAGEMENT AND SEASHORE PROTECTION COMM. & TERRITORIAL PLANNING COMMISSION	GEPA	BOP	DOA	PARK & REC.	REV & TAX	PUBLIC HEALTH	PUAC
1.	Construction of earthen ponds	Yes*	Yes	No	No	No	No	No	No	No	No
2.	Construction of concrete ponds	Yes*	Yes	No	No	No	No	No	No	No	No
3.	Construction of drainage systems	Yes*	Yes	No	No	No	No	No	No	No	No
4.	Pumping water from wells	No	No	No	Yes	No	No	No	No	No	Yes
5.	Pumping water directly from streams or lakes	No*	No	Yes	No	No	No	No	No	No	No
6.	Pumping water directly from the oceans	No*	No	Yes	No	No	No	No	No	No	No
7.	Discharge of effluent through an injection well	No	No	No	Yes	No	No	No	No	No	Yes
8.	Discharge of effluent to surface water	No	No	No	Yes	No	No	No	No	No	No
9.	Land zoning requirements	No	No	Yes	No	No	No	No	No	No	No
10.	Construction of an aquaculture facility in a flood hazard areas	No	No	No	No	No	No	No	No	No	No
11.	Construction of an aquaculture facility in a wetlands area	Yes	Yes	Yes	No	No	No	No	No	No	No
12.	The use of fish cages in streams, lagoons or bays	Yes	No	Yes	No	No	No	No	No	No	No
13.	The use of fish pen in bays or lagoons	Yes	No	Yes	No	No	No	No	No	No	No
14.	Importation of live aquatic animals and plans	No	No	No	No*	No*	Yes	No*	No*	No	No
15.	Construction of farm access roads	No*	Yes	No	No	No	No	No	No	No	No

* Refer to further explanation under appropriate agency.

ASSISTANCE: AGENCIES AND ASSOCIATIONS INVOLVED IN AQUACULTURE ON GUAM

It is recommended that prior to initiating an aquaculture project the major government agencies that lend support to the industry be contacted.

Department of Commerce

The Department of Commerce has been involved in the economic and planning aspect of aquaculture development and has also been given the responsibility of seeking funding for a proposed government permanent hatchery or assist in the establishment of a private hatchery. The Department has conducted a number of important studies on aquaculture which include:

Aquaculture Development Plan For the Territory of Guam (FitzGerald, 1982)

Recommendations For An Aquaculture Financing Program For the Territory of Guam (Warner, 1980)

Multiple-Use Options for a Prawn Hatchery on Guam (Aquatic Farms, Ltd., 1979)

General Feasibility Analysis Prawn Aquaculture on Guam (Aquatic Farms, Ltd., 1978)

Department of Agriculture

The Division of Aquatic and Wildlife Resources of the Department of Agriculture has been involved with the development of aquaculture on Guam since its earliest stages. However, its current involvement has been reduced to a minimum with the growth of other agencies' participation. The present program's main concern is the establishment of a temporary facility for the propagation and subsequent rearing through the larval stages of *Pangasius sutchi,* tilapia, and Chinese carp. The Department does provide an important reference source in their annual reports of past and present work in aquaculture. Assistance in the construction of ponds can be provided through the Department's Agricultural Development Services Division.

College of Agriculture and Life Sciences (University of Guam)

The College of Agriculture and Life Sciences (CALS) has an extension

agent for aquaculture. This position was created in 1980 to meet the increasing interest in aquaculture and to expand the scope of the CALS extension service program. The main duties consist of technical assistance to established farms and to entrepreneurs interested in starting an aquaculture farm. The agent also acts as coordinator between the temporary hatchery located at the Marine Lab and the farms. Assistance in the operation of the temporary hatchery is also provided. The office is located at the Marine Lab along with the Sea Grant Marine Advisory Program. Both of these programs coordinate their aquaculture activities. CALS also has the capability of conducting soil analysis which provides pertinent information on the permeability and fertility of the soil.

Marine Laboratory (University of Guam)

The Marine Laboratory has been involved with a variety of projects in aquaculture. Work in aquaculture started in 1973 with the siganid project. Since then, work in aquaculture has diversified and expanded to the current program. An undergraduate/graduate course in aquaculture is offered through the Marine Lab. Numerous publications, reports and theses have been produced at the Marine Laboratory relavant to aquaculture. The major current research in aquaculture focuses on the seaweed, *Gracilaria*.

The Marine Laboratory has constructed and has been operating a temporary hatchery for the production of *Macrobrachium rosenbergii* postlarvae to fill the needs of the existing commercial prawn farmers on Guam, since January 1981. This temporary hatchery is expected to have a maximum annual production of 1.0 million postlarvae, which would be adequate to stock 13 acres of ponds. A charge for the postlarvae is expected to cover operating costs. This is a temporary hatchery to serve in the interim until a permanent full scale hatchery is constructed and operational. Due to the limited production capability, this hatchery is not adequate to support a growing aquaculture industry.

Sea Grant Marine Advisory Program

The Sea Grant Marine Advisory Program (SGMAP) was initiated on Guam in October, 1979. As part of its program, it has become involved in aquaculture as an information reference source drawing upon the expertise and information produced through Sea Grant funded aquaculture programs nationwide as well as information from other sources. SGMAP has conducted a number of seminars on aquaculture to inform the public of this potential industry.

Guam Aquaculture Association

The Guam Aquaculture Association was established in May, 1980 as a non-profit organization. Its membership is open to anyone who is interested in aquaculture. The major purpose of the association is to promote aquaculture development on Guam and to gain the assistance of the government in specific areas such as the establishment of a permanent hatchery, marketing, and research and development programs. The Association assists its members in obtaining shipments of fry and postlarvae of cultured species. It also assists in obtaining feeds.

4-H Aquaculture Career Development Program

The 4-H Aquaculture Career Development Program is a branch of the 4-H Club which is part of the College of Agriculture and Life Sciences' (CALS) program to promote interests in agricultural and animal husbandry fields. The Club consists of both children and adults. It is headed by an extension agent from CALS.

To cite an example of the Club's many projects, the Club operated a 2-acre pond site located along the Talofofo River. There they raised *Macrobrachium rosenbergii,* and mullets *Liza* and *Neomyxus* in a polyculture system.

Soil Conservation Service (USDA)

The USDA's Soil Conservation Service (SCS) gains its authority for activities in aquaculture from the Soil Conservation Domestic Act (U.S. P.L. 74-76), which does not include Guam. SCS can work on private lands and assist in (1) the efficient use of soil and water, (2) protection of the basic resource, including soil and water, and (3) meeting the environmental needs of the community.

The extension of SCS programs to Guam was made possible under the Territorial Omnibus Act (U.S. P.L. 96-597) along with other U.S. Department of Agriculture programs that could be extended to Guam and were previously excluded. In connection with the Soil Conservation Service and the Forest Service, USDA has placed a resource conservationist in a field office at the University of Guam. This resource conservationist will coordinate work on natural resource inventories and condition assessments. Following completion of these assessments, SCS together with the territorial government will work towards developing a comprehensive natural resource plan. Upon completion of this work, similar assessments and plans will be done with the other territories of the Western Pacific.

The SCS provides technical assistance in conservation, development,

and utilization of land and water areas for the production of fish and wildlife as either the principal or secondary use. Even though SCS has no specific program for aquaculture, it is incorporated in its conservation programs and includes:

1. basic biological matters pertaining to stocking, feeding, water quality, waste disposal, and other biological aspects of fish production;

2. engineering assistance in design of ponds, reservoirs, raceways, dams, waste disposal and water supply systems, and related facilities; and

3. interpretation of soil information in the selection of sites for facilities such as ponds, reservoirs, and waste disposal systems.

Assistance is primarily with freshwater fish farming. Assessment of resources includes:

1. water quality;
2. water quantity;
3. cost-return analysis (break-even point);
4. stocking and habitat management;
5. specific soil information;
6. site limitations (physical); and
7. facility design and layout.

Other Agencies

The Bureau of Planning's Coastal Zone Management (CZM) program has played a role in identifying and providing guidelines to preserve the islands resources. CZM sponsored the study entitled, *Aquaculture and Its Potential Environmental Impact on Guam's Coastal Waters* (FitzGerald, 1977). This study identifies aquaculture's potential and limitations along with the precautions and means to avoid adverse effects to the island's natural resources.

In addition, the CZM program provides funding for positions in other Government of Guam agencies that are concerned with the planning and implementation of projects for the development of the local fisheries. Most of this effort is directed towards commercial fisheries; however, aquaculture does receive some attention, especially in the areas where aquaculture can be of benefit to commercial fisheries.

The Guam Enivornmental Protection Agency (GEPA) provides assistance to aquaculturists in planning for and designing pollution abatement

systems. In addition, as part of their regulatory function in monitoring Guam's waters, the regular collection of data on water quality can provide information on historic trends of water quality fluctuations that can be useful to some aquaculturists near regular monitoring sites.

The University of Guam's Water and Energy Research Institute of the Western Pacific (WERIWP) is involved with research into a wide range of water use and quality studies. Research has been sponsored through WERIWP relevant to the nutrient cycle in aquatic systems for freshwater and marine macrophytes as well as the freshwater prawn *Macrobrachium lar*. Research into the occurence and utilization of ground-water in Guam's river valley flood plains has been recently proposed. The results of this study would assist aquaculturists in obtaining an adequate water supply as well as identifying a source free of pest or predator species that are often associated with surface waters. The other area of assistance to aquaculture is mainly in WERIWP's capability of providing a wide range of water quality analysis tests.

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