

AQUACULTURE DEVELOPMENT PLAN

**For the Territory
of Guam**

prepared by:

William J. FitzGerald, Jr.

**Department of Commerce
Government of Guam**

June 1982

TABLE OF CONTENTS

Executive Summary

PAGE

SECTION I HISTORICAL AND POTENTIAL DEVELOPMENT

1.	Introduction	1
2.	Natural Resources/Opportunities	3
3.	Historical Development of Aquaculture on Guam	7
4.	Territorial Government Aquaculture Policy	9
5.	Economic Effects of Aquaculture Development on Guam	11
6.	Revenue Generation	14
7.	Fisheries Enhancement	16
8.	OTEC and Aquaculture	17

SECTION II INSTITUTIONAL ORGANIZATION

8.	Agencies and Associations Involved in Aquaculture on Guam	19
	A. Other Government Agencies Indirectly Involved in Aquaculture	23
	B. Local Legislation	25
9.	Organization of the Aquaculture Program on the National Level	30
10.	Aquaculture Support Programs of Federal Agencies	33
	A. Department of Agriculture	33
	1) USDA Aquaculture Plan	38
	B. Department of Commerce	40
	C. Department of the Interior	41
	D. U. S. Agency For International Development	42

	PAGE
E. Other Federal Agencies	43
F. Federal Legislation	45
1) Omnibus Territories Act of 1980	45
2) National Aquaculture Act of 1980	46
3) Federal Crop Insurance Act of 1980	49
4) Food and Agriculture Act of 1981	50
5) Ocean Thermal Energy Conversion Research, Development Act	50
6) Amendment to the Consolidated Farm and Rural Development Act	51
7) Title XIII Amendment to the Foreign Assistance Act of 1961	51
8) Water Research and Development Act of 1978	52
11. Regional Commission and Foundation	53
12. Pacific Inter-Regional Cooperation	58
 SECTION III DEVELOPMENT STRATEGY	
13. Facilities for Aquaculture.....	59
A. Infrastructure	59
B. Aquaculture Grow-Out Facilities	61
14. Support Services	74
A. Financial Support	74
B. Aquaculture Insurance	79
C. Hatchery	81

	PAGE
D. Extension Service	85
E. Research and Development	87
F. Feed and Fertilizer	89
G. Establishment of a Fish Health Monitoring Program	92
H. Manpower	94
I. Utilities	98
J. Law Enforcement	99
15. Market	100
A. Marketing Program	100
B. Local Market	103
C. Assessment of Consumer Preference	108
D. Outlet Structure of the Local Market	109
E. Military Market	111
F. Foreign Market	11111
G. Blocklisting	115
16. Riparian Rights and Submerged Lands Ownership	120
17. Permits for Aquaculture	124
SECTION IV IMPLEMENTATION STRATEGY	
18. Industry Organization	133
A. Growth Pattern of the Industry	133
B. Aquaculture Advisory Council	135
C. Lead Agency	138
19. Aquaculture Infrastructure Development Revolving Fund	141
20. Scenarios for the Development of the Aquaculture Industry	143

A.	Scenarios for Hatchery Operation	146
1)	Scenario I, Government Owned/Operated Hatchery	146
2)	Scenario II, Cooperative Owned/Operated Hatchery (Agricultural Development Fund Loan)	155
3)	Scenario III, Cooperative Owned/Operated Hatchery (General Development Fund Loan)	159
4)	Scenario IV, Cooperative or Private Owned/ Operated Hatchery with a Reduced Scope of Purpose	162
21.	Bibliography	164
22.	Appendices	173
A.	Listing of Aquaculture, Agriculture and Fisheries Legislation of Guam	173
B.	Private Aquaculture Operations of Guam	177
C.	Construction Cost Estimate for Hatchery	179
D.	Abbreviations	181

LIST OF TABLES

TABLES		PAGE
i	Establishment of An Aquaculture Industry: Summary of Constraints and Recommendations	xiii
1	River Minimum Flow and Long-Term Average Flow Rates Recorded from Permanent Monitor Stations	5
2	River Discharge Measurements at Low Flow of Partial Record Stations	6
3	The Original Introduction to Guam of Various Species Intended for Aquaculture	8
4	Annual Tax Revenue Generated by Prawn Industry	14
5	Tilapia Imports Summary 1980 - 1981	107
6	Responsible Government Agencies for Issuance of Permits for Aquaculture	125
7	Scenario I: Government Owned/Operated Hatchery Annual Operating Costs	149
8	Cost Breakdown of Individual Expense Categories	150
9	Anticipated Revenues and Expenditures Government Operated Hatchery	154
10	Scenario II: Cooperative Owned/Operated Hatchery Annual Operating Costs (ADF Loan, three percent interest rate)	157
11	Scenario III: Cooperative Owned/Operated Hatchery Annual Operating Costs	160
12	Comparison of Annual Payment of a \$750,000 Loan Between an Agriculture Development Fund Loan (3%) and a General Development Fund Act Loan (15-5/8%) through the Guam Economic Development Authority	161
13	Scenario IV: Cooperative or Private Owned/Operated Hatchery With a Reduced Scope of Purpose Annual Operating Costs	163

LIST OF FIGURES

FIGURE		PAGE
1	Guam and Its Major Surface Drainage Systems	4
2	Organization of Federal Government Aquaculture Program	31
3	Aquaculture Coordination, U. S. Department of Agriculture (Aquaculture A Program For the Eighties, USDA).....	39
4	Guam's Total Shrimp Imports: January 1979 through June 1981. Large Class Size Imports: January through December 1980.....	105
5	Number of Visitor/Tourist to Guam: 1979 and 1980	106
6	Wholesale Prices of Frozen Shrimp Imports, Tokyo Central Wholesale Market, for Indonesian White Shrimp <i>Penaeus sp.</i>) 16-20 pound (head-off, shell-on) (Foreign Fishery Information Release, NMFS)	113
7	An Integrated System for the Aquaculture Industry	134
8	Interaction Between Government and Private Industry Facilitated by the Aquaculture Advisory Council.	136
9	Proposed Government of Guam Aquaculture Development Organization	139
10	Scenario for the Development of an Aquaculture Industry on Guam.	144
11	Interaction Between the Three Major Actions (hatchery, farm and market) in the Aquaculture Industry	145

GOVERNOR'S MESSAGE

Aquaculture planning should be conducted as an integral part of a comprehensive multi-sector overall development plan for our Island. The *Aquaculture Development Plan for the Territory of Guam* is such a document and should be incorporated into *Guam's Comprehensive Development Plan* as one of the lead economic sectors. This planning effort is coordinated with the Capital Improvements Program and has also taken into account Federal programs and the *National Aquaculture Plan*.

Guam can develop into the 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 industry.

Proximity to the Japanese market gives Guam the opportunity to enter and compete in this large market for fishery products. Guam's year round warm climate is very conducive to the rapid growth of many cultured species. However, to fully realize the economic and social benefits of aquaculture, we need to give our full support to the orderly development of our aquaculture industry as put forth in the *Aquaculture Development Plan for the Territory of Guam*. Initially, a well coordinated program of government sponsored aquaculture development projects and incentives will be needed. Following this stimulation to the industry, the private sector should rapidly expand its role into all aspects of the industry.

The *Aquaculture Development Plan for the Territory of Guam* is an important step in assuring that the people of Guam are able to derive maximum benefit from their island's natural resources and should prove to be an important step in expanding Guam's economic base and increasing Guam's self-sufficiency. The challenge and opportunities are clearly here and it is now up to us to act. The implementation of this Plan is necessary to ensure that the Territory's aquaculture development proceeds in an orderly and efficient manner.

PAUL M. CALVO
Governor

EXECUTIVE SUMMARY

Aquaculture's feasibility and viability as an industry has long been established in a number of developing and industrialized countries. More recently, aquaculture's importance and potential as an industry has been recognized at the national level in the United States. The enactment of the National Aquaculture Act of 1980 has declared aquaculture to be in the national interest and adopts the national policy to encourage the development of aquaculture in the U. S. The adoption of this plan by the Government of Guam signifies its recognition of the potential of aquaculture as an industry and an important economic sector on Guam.

The properly planned, managed and implemented development of aquaculture could wisely utilize Guam's few natural resources, mainly its waters (both fresh and marine), its warm uniform climate, and its land in a manner that would be conducive to the maintenance of environmental quality. The establishment of an aquaculture industry on Guam has the potential for a significant import substitution in fishery products. Present fish imports are approximately 5 million pounds annually. In addition, aquaculture is expected to develop into an export industry. The economic benefits to Guam from an aquaculture industry would include:

- 1) economic growth and diversification;
- 2) increased investment opportunities for both domestic and foreign capital;
- 3) increased employment opportunities;
- 4) self-reliance;
- 5) additional import substitution;
- 6) potential exportation of a product (including technology);
- 7) increased tax revenue;
- 8) a higher economic multiplier effect as compared to service oriented industries;
- 9) non-polluting industry;
- 10) productive utilization of natural resources; and
- 11) fisheries enhancement.

Once developed aquaculture would assist in stabilizing the economy and work towards economic self-reliance for Guam along with providing the alternative of maintaining a rural life style and its associated cultural practices.

The major economic sectors (e.g., tourism and the military) on which the island's present economy is based are traditionally fragile economic systems which are dependent upon outside influences. Even though these industries are important contributors to the present economy, broadening the economic base by a resource based industry is preferable. Fully developing Guam's limited natural resources will help maximize the potential economic and social development of the island community and provide a more stable economy based on a commodity production industry rather than a service oriented industry. This document provides recognition of these conditions and provides specific policies and dynamic programs that pursue the development of the island's natural resources through aquaculture.

Under this Plan, the Government's role would be limited to basic infrastructure, technical assistance, financial assistance, and the establishment of policies necessary to provide the basic incentives and stimulation of investment from the private sector to develop the industry. Once the industry is firmly established, the Government's role will be limited to promoting further expansion mainly through a market development program.

Aquaculture development on Guam will mainly emphasize the culture of prawns and shrimp (uhang, Chamorro name); however, the culture of alternative species should also be developed to fully exploit the local market potential and suitable export markets. This will involve local research and development complemented by assistance and coordination with regional organizations (e. g., South Pacific Commission, Pacific Basin Development Council, SEAFDEC, and ICLARM) to maximize production per unit of effort and expenditure.

This Plan assesses the potential, identifies constraints and needs, recommends government action to assist development, and provides a process to coordinate governmental actions to develop the industry. The Plan opens with a section on the history and potential benefits from aquaculture development on Guam. The importance of establishing a positive action oriented policy towards aquaculture is addressed. Section II covers local and federal aquaculture programs including legislation regarding aquaculture. The recent realization of the importance of aquaculture as an industry at the national level is in the process of materializing in the form of grants for research and development, financial assistance, crop insurance and reduction of restrictive governmental regulations, all of which are intended to stimulate the growth of the aquaculture industry. Many of these programs identified can substantially assist Guam develop an aquaculture industry. However, an overdependence upon federal assistance can significantly delay and hamper aquaculture's development on Guam. Section III deals with the major development needs of the industry and the constraints to its development. This section includes recommendations on what infrastructure and services are needed and how to alleviate the major constraints to development. The primary conclusion from this Section III is the need for an on-island supply of postlarvae and fry of cultured aquatic species. This would be accomplished by the construction of a proposed permanent hatchery facility. This is of utmost importance, since without a permanent hatchery the industry cannot develop. This is the base of the aquaculture industry. Section IV provides

insight into how the industry should be organized and includes scenarios for the development of the industry including the provision of a hatchery. A major detriment to the development of the aquaculture industry is the lack of a coordinated government program for aquaculture. This constraint is fully discussed in Section IV with the recommendations for action to correct the problem.

This Plan provides for a coordinated program of government sponsored aquaculture development, and a permanent hatchery facility. These have been the major lacking elements which have resulted in the inability of aquaculture to progress beyond its present disjointed state on Guam.

This Plan provides the guidance for the implementation of the major key programs and actions required for the success of an aquaculture industry on Guam which are summarized in Table i.

TABLE 1. ESTABLISHMENT OF AN AQUACULTURE INDUSTRY
SUMMARY OF CONSTRAINTS AND RECOMMENDATIONS

CONSTRAINTS	RECOMMENDATIONS	ACTION AGENCY	ACTION LEVEL
1. Lack of an on-island permanent hatchery facility	1. Establishment of an on-island hatchery to meet the needs for the supply of postlarval and juvenile stages of species cultured. Options are: a. Government operated hatchery, b. Private operated hatchery with government assistance, or c. Cooperative operated hatchery with government assistance.	1. LA, DOC, DOA GEDA	1. Immediate
2. Lack of an organized governmental Lead Agency for Aquaculture	2. Establish a Lead Agency for the aquaculture program to advocate and coordinate research, development, planning and economic aspects of the industry.	2. GOVERNOR, DOC, DOA, UOG	2. Immediate
3. Coordination of government programs with industry needs.	3. Establish the Aquaculture Advisory Council	3. GOVERNOR	3. Immediate
4. Lack of capital to implement government programs and capital improvement projects	4. Establishment of the Aquaculture Infrastructure Development Revolving Fund a. Deposit funds into the Aquaculture Infrastructure Development Revolving Fund in the amount of \$600,000 for the first year and \$300,000 per year for the next four years. b. Utilize monies derived from the Territorial Lottery Fund or tapping a percentage of a special tax revenue (e. g., liquid fuel tax, excise tax)	4. LA, DOC, GOVERNOR, LEGISLATURE	4. Immediate
5. Inadequate financial assistance programs.	5. Establish the Guam Aquaculture Loan Program. a. As an alternative consolidate the Farmers Small Loan Revolving Fund and the Agriculture Development Fund with the revision of its rules and regulations and adequate capital provided. b. Provide an interest rate subsidy program for commercial loans that are guaranteed through GEDA.	5. GEDA, DOA	5. Immediate

TABLE I. ESTABLISHMENT OF AN AQUACULTURE INDUSTRY (continued)
SUMMARY OF CONSTRAINTS AND RECOMMENDATIONS

CONSTRAINTS	RECOMMENDATIONS	ACTION AGENCY	ACTION LEVEL
6. Inadequate crop insurance	6. Revamp the existing Agriculture Expense Insurance Fund to a full coverage program a. Evaluate insurance needs of aquaculture farmers. b. Collection of statistical data on production. c. Expedite establishment of the Federal Crop Insurance Act of 1980 on Guam.	6. GEDA, DOA	6. Priority 1
7. Inadequate infrastructure to aquaculture sites	7. Construction of year round access roads. a. Installation of power lines. b. Installation of water lines.	7. DOA, DPW	7. Priority 2
8. Permit requirements	8. Provision of a Master Aquaculture Permit Application.	8. LA, GEPA, DLM, DPW	8. Priority 1
9. High cost of utilities	9. High prioritization to aquaculture facilities for the installation of power and water lines. a. Special electrical power rates to aquaculture and agricultural users. b. Extension of agriculture water rates to aquaculture. c. Investigation into alternative energy sources to replace or supplement conventional energy sources.	9. GPA, PUAG, DOE, LEGISLATURE	9. Priority 2
10. Economical feed source	10. Evaluate nutritional needs of cultured species with the formulation of specific diets that will give optimum conversion rate. a. Economic production of ingredients and utilization of existing by-products for formulation of commercial feeds. b. Determination of methods to increase production of natural foods within the culture system.	10. UOG - CALS	10. Priority 2

TABLE I. ESTABLISHMENT OF AN AQUACULTURE INDUSTRY (continued)
SUMMARY OF CONSTRAINTS AND RECOMMENDATIONS

CONSTRAINTS	RECOMMENDATIONS	ACTION AGENCY	ACTION LEVEL
11. Economical fertilizer source	11. Investigation into alternative fertilizers includes the use of agricultural, fishery and industrial by-products. a. Investigation into the application of aquaculture in the treatment and utilization of sewage waste..	11. UOG - CALS	11. Priority 2
12. Restriction of exotic fish importation (for aquaculture purposes).	12. Facilitate the importation of species that show high potential for commercial aquaculture on Guam. a. The Animal Import Screening Committee should give high priority to commercial aquaculture species.	12. DOA	12. Priority 2
13. Fish health monitoring	13. Establishment of a fish health monitoring program. a. Provision of a disease management program for the aquaculture industry.	13. LA	13. Priority 2
14. Research and development	14. Establishment of a cooperative government and private Research and Development Program. a. Coordination of the government research efforts in aquaculture being centered at the Marine Laboratory and the hatchery. b. Examine endemic marine fin fish for mariculture prospects.	14. UOG - ML, LA	14. Priority 2
15. Extension Service	15. Strengthening of the extension program with coordination of services between hatchery and farm. a. Training program. b. On site assistance. c. Dissemination of technical information. d. Coordination of production and marketing.	15. UOG - CALS, DOA	15. Priority 1

TABLE I. ESTABLISHMENT OF AN AQUACULTURE INDUSTRY (continued)
SUMMARY OF CONSTRAINTS AND RECOMMENDATIONS

CONSTRAINTS	RECOMMENDATIONS	ACTION AGENCY	ACTION LEVEL
16. Manpower	e. Coordinate and assist farmers in obtaining benefits and meeting requirements of various Government of Guam and federal programs and agencies. f. Expand financial support to the program through grants and federal assistance programs. g. Publication of a quarterly newsletter on current relevant market and technical information on aquaculture. 16. Periodic evaluation of the manpower needs of the aquaculture industry in relation to the labor force. a. Establishment of a technical training program to meet the manpower requirements. b. Coordination of governmental and private bodies in the training and employment of residents of Guam. c. Promotion of aquaculture as a career. d. Placement of stringent limitations upon the use of alien labor in aquaculture.	16. LA, DOA, DOC, AHRD, GCC	16. Priority 3
17. Market development	17. Implementation of Marketing Program. a. Promotion of locally produced aquaculture products in the local market. b. Secure the military market.	17. LA, UOG - CALS, DOC, PHD	17. Priority 1

TABLE I. ESTABLISHMENT OF AN AQUACULTURE INDUSTRY (continued)
SUMMARY OF CONSTRAINTS AND RECOMMENDATIONS

CONSTRAINTS	RECOMMENDATIONS	ACTION AGENCY	ACTION LEVEL
18. Counterproductive property tax	c. Investigation of foreign markets for aquaculture products produced on Guam. d. Continuous monitoring of the world shrimp market. e. Guam Customs Office and Public Health Department should become aware of current Food and Drug Administration restrictive provisions affecting the importation of aquaculture and fishery products, with the enforcement of these provisions. f. Quality Control standards should be established and administered. 18. Change the provisions in property tax law for agricultural zoned land so that developed productive agricultural land is taxed at a lower rate than idle land.	18. GOVERNOR, LEGISLATURE	18. Priority 3

SECTION I

Historical and Potential Development

INTRODUCTION

This document is a projection of a five (5) year aquaculture development plan for Guam which includes identification of needed input by both government and private entities. This plan utilizes completed work and work in progress as the foundation to proposed future work in the development of aquaculture on Guam. It is necessary to make this plan as flexible and dynamic as possible, since the interplay of various events during the development of aquaculture will progress with varying speed and effectiveness. For this reason a number of scenarios will be presented with the intention of incorporating possible major policy changes towards aquaculture while maintaining the basic scheme of development.

As pointed out by Pillay (1973) aquaculture has technologically advanced to the stage where it does and will increasingly play a vital role in worldwide fisheries production. However, well planned and implemented development strategy is necessary for long range success. In a study projecting the future of the global fish catch (CIA report, The New Global Fishing Regime: Impact and Response, Stock No. GC 80-10029 National Technical Information Service), it suggests that traditional fisheries as a whole may have peaked in terms of maximum productivity. An estimate by the United Nations Food and Agricultural Organization is that more than twice the current world production of seafood will be needed by the year 2000. The study mentions the potential of aquaculture in meeting this demand with an estimate of possible global production by the end of the century ranging as high as 50 million tons, which is 80% of the current ocean catch. Aquaculture in the U. S. is expected to grow rapidly into a major industry within the next ten years.

Investigation into the prospects of aquaculture on Guam was initiated in 1973 with the government's experimental demonstration ponds located in Talofofo. Since that time great interest has been generated in the potential of aquaculture to aid the island in its quest for economic self-sufficiency. Numerous studies have been completed (FitzGerald, 1975, 1976, 1977a, 1977b, 1978, Bryan, 1975, Tobias, 1976, Jameson, 1976, Dickinson, 1977, Tsuda and Bryan, 1973; Tsuda et al., 1974; Callaghan, 1978; FitzGerald and Nelson, 1979; Aquatic Farms, Ltd., 1978, 1979; Warner, 1980); these studies will serve as the overall base for the design and recommendations for aquaculture development on Guam. However, there are three (3) basic precursor papers that play a vital role to the major elements of this plan. They are (1) *Aquaculture and its Potential Environmental Impact on Guam's Coastal Waters* (FitzGerald, 1977) which covers the land and water resources, site development, species suitable for culture, pollution abatement, and environmental constraints; (2) *Feasibility of Prawn Culture on Guam* (Aquatic Farms, Ltd., 1978) which deals with the economics and marketing of prawn culture, but is also relevant to other species; and (3) *Recommendations for an Aquaculture Financing Program for the Territory of Guam* (Warner, 1980) which deals with the financial needs of an aquaculture industry. These papers are important supplements to this plan.

The development of aquaculture on Guam will not supply a significant variety of inexpensive protein to the market. However, it will supply the residents with a fresher higher quality product that is comparable in price with the imported item. The high cost of land,

labor, and material gives Guam a disadvantage in the competitive Asian market. However, Guam's warm uniform climatic conditions which are very conducive to the rapid growth of many cultured species, along with its strategic location near the Japanese market, gives



Freshly harvested *Macrobrachium rosenbergii* from a farm on the Talofoto River.

Guam the opportunity to enter and compete in this large market. The application of high technology intensive aquaculture systems to high value crops should prove to be a more productive method per unit area so as to allow Guam to compete in the world market. Development of aquaculture products will therefore be mainly directed towards the high demand, high price products of prawns and shrimp (freshwater and marine respectively), and eels. Application of appropriate advanced intensive culture techniques could also allow for the culture of various species of marine finfish, bivalves and gastropods. The innovative co-development of an Ocean Thermal Energy Conversion (OTEC) plant on Guam with the utilization of the effluent in salmonid culture, marine colloid algae and other species could be possible in the future.

This plan is intended to fulfill the requirement set forth in the *U. S. Department of Agriculture (USDA) Aquaculture Plan* in which a special grants program for aquaculture research by state agricultural experiment stations at land-grant institutions requires the state to develop a comprehensive aquaculture plan.

NATURAL RESOURCES/OPPORTUNITIES

Guam is the westernmost territory of the United States and the largest and most populated island between Hawaii and the Philippines. It is approximately 48 kilometers long, ranging from 6 to 18 kilometers in width with a land mass of approximately 549 square kilometers (Figure 1). Being the largest island in the Mariana archipelago, Guam lies at 13°28' north latitude and 144°44' east longitude, 2,500 kilometers south-southeast of Tokyo, 3,400 kilometers east-southeast of Hong Kong, 2,600 kilometers east of Manila, 5,000 kilometers north-northwest of Sydney, and 6,000 kilometers west-southwest of Honolulu. Guam's location facilitates access to major Asian markets by being only 3 to 4½ hours by regular air service to Japan, Korea, Okinawa, Taiwan, Hong Kong, China and the Philippines.

Guam's climate is tropical, with mean daily temperatures averaging between 24 and 30 degrees Celsius (75 to 86 degrees Fahrenheit) 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 that obtained in Hawaii. The marine waters around Guam have an annual temperature range of 27°C to 30°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.

Guam's population is cosmopolitan consisting of 105,800 people (1980 census) including 21,500 military personnel and dependents and approximately 4,000 temporary aliens. The island's annual population growth rate is about 2.2 percent with a 24.5 percent increase over the last decade.

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. A Ghyben-Herzberg ground-water lens exists in this area which forms the main source of potable water for the island populace (Mink, 1976).

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.

Large-scale pond development would require construction of dams to assure an adequate flow of water during the dry season (January-May) and to allow the full potential of the area to be developed. If no dams are constructed then the maximum area that can be developed would be based on the minimum water flow months of the year as shown in Table 1. Tables 1 and 2 also show the maximum area that could be developed based on damming of the rivers with options of 25, 50 and 75% water usage for pondage. These figures are based on the average flows over a number of years for river systems monitored by the U. S. Geological Survey (1953-1975).

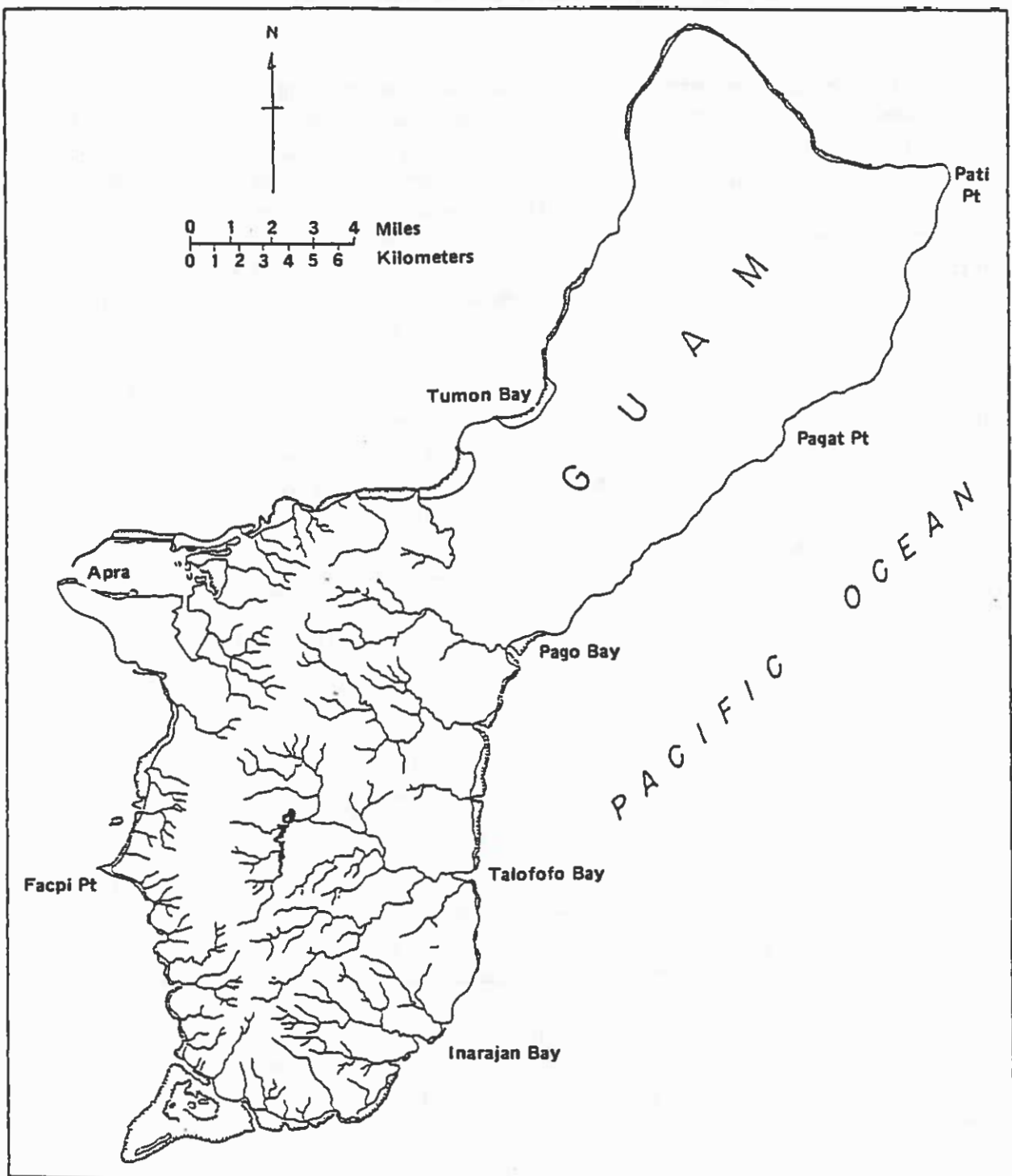


FIGURE 1. GUAM AND ITS MAJOR SURFACE DRAINAGE SYSTEMS
(modified from Tracy et al., 1959).

TABLE 1

RIVER MINIMUM FLOW AND LONG-TERM AVERAGE FLOW RATES RECORDED FROM PERMANENT MONITOR STATIONS,^a
AND THE POTENTIAL POND AREA WHICH COULD BE SUPPORTED. WATER REQUIREMENTS BASED ON AN AVERAGE
DAILY LOSS OF 129,000 LITERS/HA/DAY (1.3% EVAPORATION-SEEPAGE/DAY)

Stations Monitored	Number of years monitored	MINIMUM FLOW RECORD		LONG-TERM AVERAGE FLOW RECORDED			
		Liters x 10 ³ /day	Pond area supported hectares (100% utilization)	Liters x 10 ³ /day	Pond area supported hectares (25% utilization)	Pond area supported hectares (50% utilization)	Pond area supported hectares (75% utilization)
Finile River	15	265	2.1	3,425	6.7	13.3	19.9
Umatac River	23	514	4.0	20,525	39.9	79.7	119.6
Geus River	22	0	0	7,389	14.4	28.7	43.1
Inarajan River	23	2,682	20.8	41,832	81.3	162.5	243.8
Pauliluc River	23	606	4.7	13,601	26.4	52.8	79.3
Imong River	14	1,500	11.7	24,267	47.1	94.3	141.4
Amalgosa Spring	19	23	0.2	8,807	17.1	34.2	51.3
Amalgosa River	4	821	6.4	13,846	26.9	53.8	80.7
Maulap River	4	1,014	7.9	10,544	20.5	40.9	61.5
Ylig River	23	385	3.0	68,986	134.0	278.0	402.0
Pago River	24	206	1.6	58,711	114.1	228.0	342.2
Total			62.4		528.4	1,066.2	1,584.6

^aU. S. Geological Survey (1953-1975).

TABLE 2

RIVER DISCHARGE MEASUREMENT AT LOW FLOW OF PARTIAL RECORD STATIONS,^a
AND THE POND AREA WHICH COULD BE SUPPORTED. WATER REQUIREMENTS
BASED ON AN AVERAGE DAILY LOSS OF 129,000 LITERS/HA /DAY

River	Years measured	Liters/Day	Pond area supported hectares (50% utilization)
Fonte River	15	511,278	2.0
Masso River	11	450,120	1.7
Faata Springs	13	457,459	1.8
Taleyfac River	17	1,724,647	6.7
Cetti River	8	792,605	3.1
Lagafua River	23	1,560,745	6.1
Piga Springs	21	371,838	1.5
Astaban River	16	354,715	1.4
Laclac River	16	1,440,878	5.6
Toguan River	25	413,428	1.6
Siligin Spring	19	149,224	0.6
Ajayan River	14	702,087	2.8
Agfayan River	14	1,636,581	6.3
Aasamano River	16	2,338,672	9.1
Yledigao River	16	2,331,333	9.0
Fintasa River	16	1,893,442	7.3
Fensol River	16	415,869	1.6
Acalanso River	25	1,022,556	3.9
Ugum River (above Bubulao)	16	6,717,565	26.1
Bubulao River	16	9,215,249	35.8
Ugum River	16	17,442,188	67.7
Mangengon River	16	1,558,300	6.0
Tolaeyuus River	6	12,295,152	57.7
Lonfit River	3	3,574,058	13.9
Sigua River	3	3,965,469	15.4
Atantano River	5	2,358,244	9.1
Madag River	16	609,131	2.3

^a U. S. Geological Survey (1953-1975).

HISTORICAL DEVELOPMENT OF AQUACULTURE ON GUAM

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

The Division of Aquatic and Wildlife Resources of the Guam Department of Agriculture initiated investigation into the prospects of commercial aquaculture on Guam in 1973. The initial phases of the program dealt with the determination of the feasibility of several species for culture on the island. Experimental demonstration ponds were constructed for these studies along the Talofofo River in southern Guam. 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 (*Sarotherodon niloticus* x *S. mossambicus*), 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-shelled turtle (*Trionyx sinensis*), shrimp (*Penaeus monodon*), and the eel (*Anguilla rostrata*). The following discussion deals with the constraints and merits for the development of aquaculture of these and other species on Guam.

In 1972, the University of Guam Marine Laboratory initiated its work into aquaculture with the Siganid Project. The siganid (rabbitfish) being a popular reef fish throughout Micronesia and its fry (*manahac*), which are considered a local delicacy, are heavily fished as they enter the reef flats. Thus this genus receives fishing pressure at both stages in its life cycle with the high probability of eventually becoming overfished. The siganid, therefore, has become a prime candidate for investigation into its aquaculture possibilities. This project was broken down into a number of studies covering food preference, culture of the preferred food, habitat, digestive system, assimilation, behavior, growth rate, diet manipulation, environmental parameter limitations and adaptability to various culture methods. This was a Pacific wide study involving a number of other countries that had an interest in the culture of *Siganus* sps. From this initial work into aquaculture, the Marine Laboratory has continued and branched out into studying a variety of shellfish and algae for their aquaculture potentials.

Table 3 lists all of the aquatic animals introduced for the purpose of aquaculture. The earliest recorded attempt at commercial aquaculture on Guam was in 1956 at a site near the mouth of the Talofofo River. Tilapia were imported from the Philippines, but this project was unsuccessful. Even though this was not the first introduction of tilapia into Guam's waters it was the first importation and attempt at commercial fish culture for this genus.

TABLE 3
THE ORIGINAL INTRODUCTION TO GUAM OF VARIOUS SPECIES INTENDED FOR AQUACULTURE PURPOSES

Species	Date Introduced	Country of Origin	Quantity	Importer
<i>*Sarotherodon</i>	1954	Philippines		Gov. Guam
<i>Anguilla japonica</i>	11/1973	Taiwan	19,857	Gov. Guam
<i>**Chanos chanos</i>	4/1974	Philippines	200-250	Gov. Guam
<i>Macrobrachium rosenbergii</i>	9/1974	Hawaii	34,000	Gov. Guam
<i>Aristichthys nobilis</i>	10/1974	Taiwan	300	Gov. Guam
<i>Ctenopharyngodon idella</i>	10/1974	Taiwan	1,600	Gov. Guam
<i>Hypophthalmichthys molitrix</i>	10/1974	Taiwan	1,750	Gov. Guam
<i>Cyprinus carpio</i>		Taiwan		Gov. Guam
<i>**Scylla serrata</i>	1975	Taiwan	270	Gov. Guam
<i>Crassostrea gigas</i>	5/1975	Taiwan	431 collector shells	Gov. Guam
			(11,550 spat)	
<i>Trionyx sinensis</i>		Taiwan		Sunrise Co.
<i>Pangasius sutchi</i>	12/1975	Thailand	17,000	Gov. Guam
<i>Anguilla rostrata</i>	5/1977	South Carolina	—	Guam Marine Products, Inc.
<i>Penaeus monodon</i>		Taiwan		Guam Marine Products, Inc.

* Hybrid (*Sarotherodon mossambicus* x *S. niloticus*) a reddish orange variety was introduced in January 1974 (50 fry from Taiwan). This was for aquaculture purposes at the Government of Guam Experimental fish ponds at Talofofo.

** Endemic species to Guam's waters, but low population numbers.

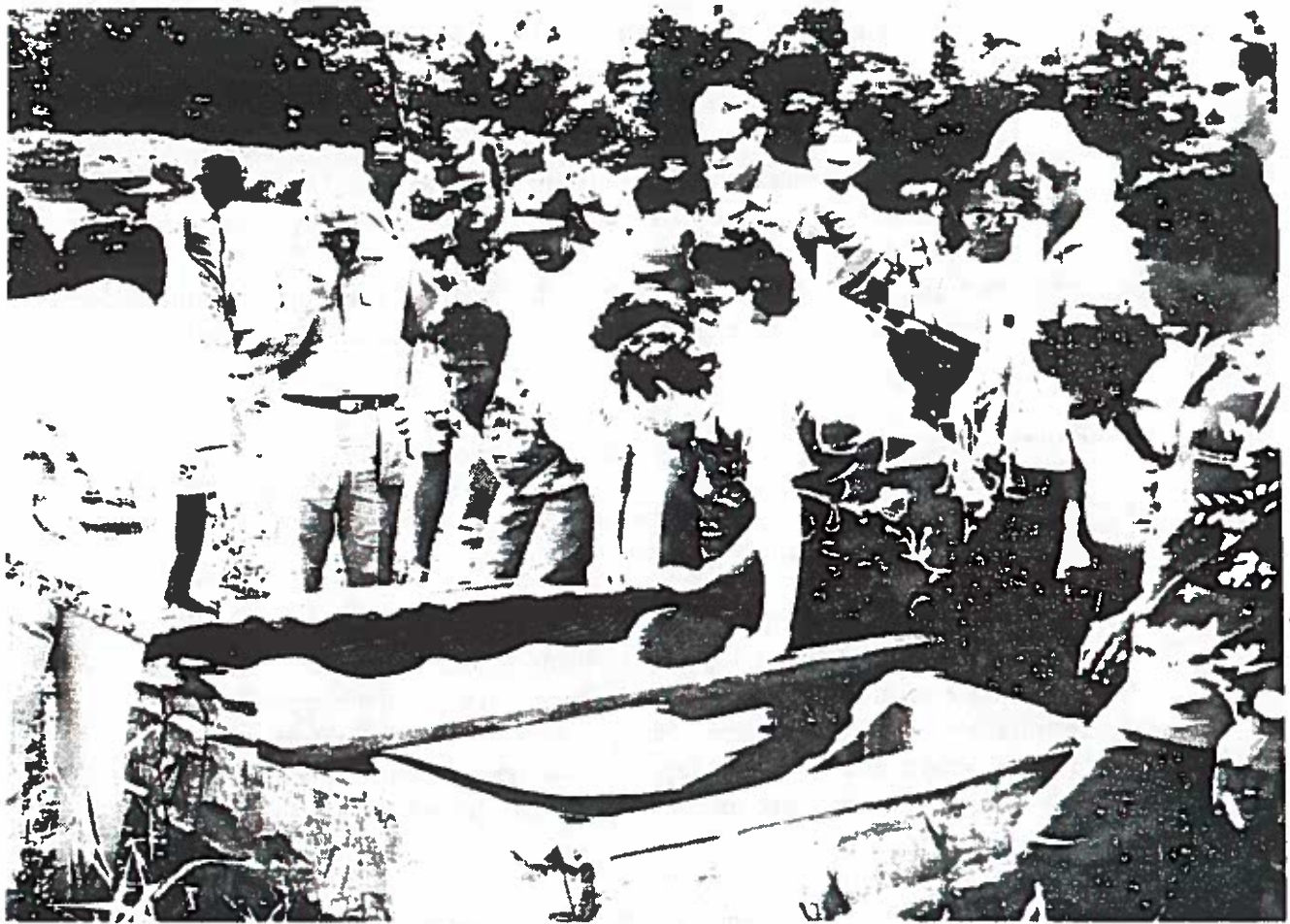
TERRITORIAL GOVERNMENT AQUACULTURE POLICY

U. S. aquaculture development has been identified as being in the national interest and given priority status through congressional mandates (e. g., National Aquaculture Act of 1980; National Academy of Science, 1978; Committee on Merchant Marine and Fisheries, 1975). It is the responsibility of the state to encourage the investment of the private sector (local and foreign) into the development of aquaculture. The Government of Guam must adopt an aquaculture policy that is conducive to aquaculture development. This has been exemplified in Hawaii with its supportive legislation and programs in aquaculture. California has recently followed this course with the passage of the California Aquaculture Development Act of 1979.

The aquaculture policy should recognize aquaculture as a very desirable form of economic activity which would be advantageous to the economy, environment and culture of Guam and include but not be exclusive to:

- 1) Extending all programs and services available to agriculture to aquaculture. This has been seen in recent agricultural legislation in which aquaculture is defined as under an activity of agriculture.
- 2) Passage of legislation similar to the California Aquaculture Development Act of 1979 as a statement of support to aquaculture development by the government.
- 3) Preference given to the lease of Government of Guam land for aquaculture use where designated by the Department of Land Management for agricultural use (P. L. 15-18).
- 4) Provision for the practice of aquaculture within the 100 m coastal setback zone when its practice would not adversely effect the environment. If properly sited and designed, mariculture is a coastal-dependent use that can be compatible with other existing coastal land uses.
- 5) Mariculture should be identified as a coastal-dependent activity and therefore so acknowledged in coastal land use plans. Coastal-dependent developments should have priority over other development on or near the shoreline. A simple definition of coastal-dependent can be taken from the California Coastal Act (1976) Section 30255 which defines coastal-dependent development or use as that "which requires a site on, or adjacent to, the sea to be able to function at all."
- 6) Aquaculture should be given high priority consideration in all land use plans. This should include the use of conservation areas for aquaculture where suitable,

- 7) Aquaculture should receive priority consideration in the use of water supplies from surface waters such as those created by reservoirs (e. g., proposed Ugum River Reservoir).
- 8) To encourage the best utilization of Guam's natural resources for the development of the island's economy, aquaculture will play a major role. It should be realized, the positive contribution aquaculture can provide to the ecologically sound utilization of the natural resources, while providing for human nutritional needs and serving as a functional increment of the social economic structure of the island.
- 9) Designate a government lead agency responsible for aquaculture development. This is necessary to prevent over division of responsibilities to different agencies which could lead to costly duplication of efforts and facilities and a bureaucratic bottleneck in the development of the proper support to the industry.



Island dignitaries on tour of aquaculture farms (Photo by D. Crisostomo).

ECONOMIC EFFECTS OF AQUACULTURE DEVELOPMENT ON GUAM

Guam's economy has a very narrow base which needs to be broadened. The economy is based mainly on military, other government and tourism expenditures. Aquaculture has the potential if developed in an organized, comprehensive, and dynamic manner to add to Guam's economic stability and self-reliance.

The goals and objectives as stated in the 1980 *Overall Economic Development Plan* (OEDP) for the economic lead sector of agriculture are also applicable to aquaculture. These include less dependence upon imports, improving the economy of Guam through keeping spending in the local economy, reduction in cost while upgrading the quality of the products, increased employment, promotion of exportation, and strengthening and diversifying the economic base. These basic goals and objectives are common to all commodity production oriented industries and aquaculture on Guam has the potential of filling all of them in a relatively short period of time (5-7 years) with aggressive and proper planning, management and implementation. This plan presents a guide to the development of aquaculture on Guam and discusses existing constraints, potential problems and their solutions.

The majority of food products consumed on Guam are imported. Fish and seafood products are no exception with approximately 5.0 million pounds imported annually (Department of Commerce, Annual Economic Review 1980). The local production from both fisheries and aquaculture amounts to an estimated 427,000 pounds (Aquatic and Wildlife Resources Annual Report, 1979). This is less than ten percent (10%) of the total consumption of fish and seafood products on Guam. This high reliance on imports has a definite detrimental effect on the economy. This can be simply illustrated by the effect on the basic economic income multiplier principle between an import based economy vs. a self-sufficient economy. The basic formula for the "Multiplier Effect" is:

Non-Importing Economy

$$K = \frac{1}{1-MPC}$$

K = Multiplier Effect - Non-Importing Economy

K* = Multiplier Effect - Importing Economy

MPC = Marginal Propensity to Consume i.e., the proportion of income spent on buying food, clothing, entertainment, etc.

d = Marginal Propensity to Import i. e., the proportion of income spent on imported goods.

Importing Economy

$$K^* = \frac{1}{1-MPC+d}$$

Assuming as a hypothetical example an economy where eighty percent (80%) of one's income is spent on the purchase of various commodities and services and sixty percent (60%) of that income is spent on imported goods, the following multiplier effects would occur.

Non-Importing Economy

$$K = \frac{1}{1 - MPC}$$

$$K = \frac{1}{1 - 0.8}$$

$$K = 5$$

Importing Economy

$$K^* = \frac{1}{1 - MPC + d}$$

$$K^* = \frac{1}{1 - 0.8 + 0.6}$$

$$K^* = 1.25$$

This exemplifies the potential difference between a non-importing economy vs. an importing economy based heavily on imports (e. g. Guam). For every \$1000 in income put into the economy (e. g., government salaries) this would generate \$5000 in income in an economy that does not rely on imports, while an economy based heavily on imports generates only \$1250.

Considering that of these expenditures an average of 23.15% is spent on food (Guam Consumer Price Index Quarterly Report Vol. VII, No. 2, April 1980), the reduction of reliance on imported food products would have a significantly positive effect on Guam's economy. The closer Guam comes to replacing imported goods with products produced on Guam and/or increasing exports so as to increase the Net Island Product, the stronger the economy becomes with more of the income generated benefitting the residents of Guam plus a larger revenue base for the government to draw upon. Development of Guam's aquaculture industry provides a means to progress towards self-sufficiency and the development of a sounder economy.

In addition to the substantial benefits of import substitution on the economy, and the diversification of Guam's basic industries there is the potential of developing an export industry for the aquaculture products produced. The major anticipated aquaculture export products are the prawns (freshwater) and shrimp (marine). The freshwater eel and various marine finfish as well as technology could also contribute to the exports. The establishment of an intermediate size (180 acre) prawn industry on Guam has been estimated to produce export earnings (net after imports of feeds and fertilizers) of between \$530,000 and \$1,700,000 depending upon the price variations in the Japanese market (Aquatic Farms, Ltd., 1978). For 500 acres of prawn ponds, a larger scale mature industry, export earnings (net of imported feeds and fertilizers) can be expected to be between \$2,100,000 and \$6,200,000 annually (Aquatic Farms, Ltd., 1978). It is difficult to determine the extent of the benefit Guam's economy will receive, since much of the information needed is not available; however, it would have a positive effect on the foreign trade multiplier through establishing an export product and also by reducing imports along with increased capital investment in Guam's economy.

The multiplier effect of a seafood industry, which aquaculture could be considered part of, is relatively high compared to most other industries, which makes a single additional job in fisheries more significant than a new job elsewhere. This is attributed to the handling, packing, processing, and the support activity to the fish catching or culturing process. A Rhode Island study (Coastal Resource Management Council, Rhode Island, 1978) indicated a seafood industry multiplier of 4.24 as compared to 1.69 for the average industry of that state. Similar calculations for other states vary according to the amount of onshore fisheries related activity. For example, in Oregon it was calculated at 2.7 to 3.0 (Joint Standing Committee on Marine Resources, Maine, 1979) and in Maine it was estimated at 7.0 (Maguire, Inc., 1978).

Manpower requirements for aquaculture have been estimated on the basis of past observations to be 1.2 full time equivalent jobs (FTE) for each five-acre farm increment (Aquatic Farms, Ltd., 1979). In addition to these newly created direct positions, 1.7 FTE indirect jobs will be established for each direct job. The 100 acres of prawn ponds supported by the proposed hatchery will therefore create 24 FTE direct jobs and 41 FTE indirect jobs for a total of 65 FTE jobs.

Investment by the private sector to develop the 100 acres of ponds that could be supported by the proposed hatchery would be approximately \$1.0 to \$1.5 million in capital costs with an annual operations expenditure of \$600,000 to \$900,000 (Adopted from Aquatic Farms, Ltd., 1978; and Shang, 1981). This is exclusive of possible private investment in hatchery facilities. These costs will fluctuate with the site of an individual farm, the type of culture system and species utilized. For example, the use of raceways (either earthen or concrete) or concrete walled ponds such as those used in eel culture would increase both capital and operating costs per area.

REVENUE GENERATION

A study conducted by Aquatic Farms, Ltd. of Hawaii entitled, the *General Feasibility Analysis Prawn Aquaculture on Guam* provides estimates of income generated and the revenue returned to the Government from a prawn aquaculture industry. For example, an intermediate size prawn industry (180 acres) would generate \$5.2 million in income and 97 full-time jobs as a result of this new industry (Aquatic Farms, Ltd., 1978, 1979).

Table 4

ANNUAL TAX REVENUE GENERATED BY PRAWN INDUSTRY (based on data from Aquatic Farms, Ltd., 1978)

	Guam Based Industry (50 pond acres)	Intermediate (180 pond acres)	Mature Industry (500 pond acres)
Income Tax	\$ 32,000 - 62,000	\$140,000-250,000	\$380,000-680,000
Gross Receipts Tax	\$ 16,800*	\$ 16,800*	\$ 16,800*
Property Tax	<u>\$ 2,015**</u>	<u>\$ 6,870**</u>	<u>\$ 20,010**</u>
TOTAL TAX REVENUES	<u>\$ 50,815-80,815</u>	<u>\$163,670-273,670</u>	<u>\$416,810-716,810</u>

* Estimated maximum based on the local additional consumption of prawns by 5,000 pounds a month over the current quantity locally consumed and retained at \$7.00 per pound. The balance of production goes for replacing imports and supplying the export market. Gross receipts tax is not applicable to export products.

** Based on a developed agricultural land value of approximately \$6.00/square meter and a 1.5 ratio of total land area to actual pond area.

The sources of revenue include income tax revenues resulting from the increased incomes of prawn growers, wholesalers, and retailers; tax revenues occurring from increased gross receipts of wholesalers and retailers marketing prawns who do not specialize exclusively in agricultural and fisheries products and any increase in property taxes resulting from improvements on prawn farms. However, there should be a replacement of this counterproductive property tax on agricultural land, which increases property taxes as the land is developed, with a tax law that acts positively as a incentive to develop idle agricultural land.

and put it in to production by taxing idle undeveloped agriculture zoned land at a higher rate than that charged producing agricultural land. An initial implementation of such a modification to the property tax law could involve the elimination of property tax on producing agricultural land while maintaining the current tax on idle agricultural zoned land. The greater the disparity between such a taxation rate the greater the effectiveness as an incentive. The revenue generated by property tax on agricultural zoned land is rather low as illustrated in Table 4. The revenue lost by the elimination of property tax on developed agricultural land would be minimal compared to the total revenue from the industry. This total revenue could actually be significantly increased by additional revenue generated through income tax and gross receipts with the implementation of such incentives to expand the industry at different stages of development. It becomes apparent (Table 4) that tax revenue under the current taxation laws can off-set the total operating costs of a Government operated hatchery (refer to Table 7) at the Guam Based Industry size (filling the demand of the local market, 50 pond acres) and produce a positive revenue flow at the intermediate and mature industry levels.

Recommendations (Revenue Generation):

Change the provision in the property tax law for agriculture zoned land so that developed producing agricultural land is taxed at a lower rate than idle land.

FISHERIES ENHANCEMENT

Aquaculture has historically played a role in supplementing and enhancing natural fisheries which have been dramatically reduced in the case of the U. S. salmon and oyster industry. Aquaculture can be of assistance in the management of the natural fisheries stocks especially those that experience high pressure from subsistence and commercial fisheries. For example, rabbitfish (*Signus spinus* and *S. argenteus*) fry runs have decreased substantially over the past years (Kami and Ikehara, 1976). The unregulated heavy subsistence harvesting of these species during periods when the fry enter the reef flats has attributed, along with other possible environmental factors, to the population's decline. Since the artificial propagation culture of the larval stages for siganids has been completed (May, Popper, and McVey, 1974 ; Bryan, Madraisau, and McVey, 1975), the culture of the species to the fry stage followed by their release to the reef flats around the island can assist in the replenishment of these species. Another example of a species that has experienced a decrease in its abundance from subsistence fisheries pressure is the topshell *Trochus* (Stojkovitch and Smith, 1978; Smith, 1979). The culture through the larval stage of this species has been completed (Heslinger, In Press) so that a program could be implemented to replenish this species to the reef flats and reef fronts. Similarly, the giant clam (*Tridacnid*) population could be bolstered through aquaculture (Jameson, 1976; Yamaguchi, 1977).

A key factor in the development of a pole and line fisheries for surface species of tuna, (i.e., skipjack and yellowfin) in this area of the Pacific is the availability of a suitable supply of bait fish. A number of species have been considered and used as bait fish including *Sarotherodon mossambicus*, *Dorosoma petenense*, *Poecilia vittata*, *Poecilia mexicana*, *Sardinella melanura*, *Engraulis japonicus*, *Chanos chanos*, *Kuhlia sandvicensis*, mullets, and cypriids (Gopalakrishnan, 1976). Important factors influencing the selection of a suitable bait fish are: to be prolific, continuous breeding, gregarious, of good growth rate, hardy (both in culture and during holding in bait wells), show suitable behaviour, size, color, and shape to attract tuna, and must be accepted by fishermen for use. A promising genus that has been worked on in Hawaii, American Samoa and Palau is *Poecilia* (Baldwin 1972; 1974; Swardloff, 1973; Bryan 1978; Baldwin and McGrenra, 1979). Also, *Chanos chanos*, which has been shown to be an excellent bait fish (Gillett and Kearney, 1980), will most likely become a major bait fish species cultured when its artificial propagation becomes economically viable. With the establishment of a suitable species and the refinement of its culture methods into an economically viable source of bait fish a pole-and-line tuna fishery on Guam could become feasible and an important component of commercial fisheries development. Aquaculture in the form of bait fish production therefore has the possibility of developing into an auxiliary industry for commercial fishing in the tropical Pacific as it has developed in the U. S. into a multi-million dollar industry for bait minnow culture for sport fisheries.

OTEC AND AQUACULTURE

Ocean Thermal Energy Conversion (OTEC) as a means of generating electricity from a renewable energy source has potential on Guam due to the large temperature difference between surface waters (27° to 30° or 81° to 86°F) and deep waters (4.4 to 7°C or 40° to 45°F). Specifically, this temperature difference ($\Delta 22^{\circ}\text{C}$ or 40°F) is utilized to control the physical state of ammonia or a similar intermediate liquid (e.g., freon, or propane) between a liquid and a gaseous form. The stored energy in the form of heat from the sun in the warm surface waters is used to evaporate the ammonia. The energy liberated in changing from the liquid state to the gas is utilized by a turbine to generate electricity, while the cold deep water transfers the gaseous ammonia back to the liquid form producing a net energy gain. In this process very large quantities of cold, nutrient enriched, deep water is pumped through the system and discharged. This large cold water supply (approximately 500,000 gallons per minute for a 50 megawatt OTEC plant) has the potential for use in a number of secondary applications of which one of these is aquaculture. The U. S. Congress has found it to be in the national interest to accelerate the development of OTEC and has included aquaculture operations as a potential coexistent form of energy conversion, with electrical energy being the main form of energy conversion (see U. S. Public Law 96-310 under Federal Programs).

Aquaculture as a user of the effluent from a shore based OTEC facility opens up the potential of mariculture development on Guam significantly. Large quantities of flowing water are involved at virtually no cost to an aquaculture facility. The establishment of a sophisticated culture system taking advantage of this large water flow and the application of appropriate species taking into consideration the biological, physical, and economic aspects of the system so as to maximize production of a commercially valuable species would be appropriate. Such a system would most likely utilize a raceway culture system with a very intensive stocking density from which a very high production can be obtained per unit area. Potential species for such a system would be salmon or possibly trout. In a well managed trout raceway culture system, annual production can reach 10,000 pounds of fish per cubic foot per second (450 gallon per minute) of water flow at 50 to 65°F . Coho salmon culture in conjunction with OTEC is currently being investigated in Hawaii. Additional species for culture would include a variety of marine fish, clams, oysters, lobsters and algae. The culture of warm water species as suggested in some reports (Buch and Roney, 1980) would not be the best use of such a system due to the lower temperature of the effluent (approximately 50°F) which would stress the species and depress its growth rate or possibly even be lethal.

Effluent flows would have to be carefully regulated and possibly mixed with warmer surface water to optimize water quality and temperature in the system for the particular species.

Whatever species or system is utilized the system would have to be workable around the operational procedures of the OTEC plant. For example, at periods when the system is flushed with chlorine or other antifouling agents the toxic level in the effluent may ex-

ceed that tolerated by the cultured species, therefore temporarily necessitating the diversion of the effluent flow. Also, in cases where the OTEC plant is shut down or malfunctions, the effluent supply may be curtailed necessitating an alternative supply or a recirculating system to maintain adequate water quality and temperature during this period.

Due to the restriction of land area next to the proposed OTEC facility on Cabras Island, the use of ponds as a means of aquaculture production in which the pumped effluent is allowed to stand so that phytoplankton and macro-algae could utilize the nutrient enriched water would not be the most prudent application of aquaculture to such a situation. Such a practice would only be possible if the effluent could be pumped to an area inland that provided a larger expanse of land for aquaculture use. A portion of the inner Pití Channel area could be sectioned off to provide impoundments or netted off with cage culture being utilized; however, this would be in competition with other possible uses as well as a possible adverse environmental effect upon the area. Thus the utilization of the nutrient enriched aspect of the effluent from an OTEC plant would be dependent upon a sufficiently larger area available for pondage. In such a case the utilization of a serial system including phytoplankton or macro-algae and shellfish or herbivorous fish could be established.

SECTION II

Institutional Organization

AGENCIES AND ASSOCIATIONS INVOLVED IN AQUACULTURE ON GUAM

DEPARTMENT OF COMMERCE

The Department of Commerce has been involved in the economic and planning aspect of aquaculture development and is responsible for seeking funding for the proposed permanent hatchery. The Department has conducted a number of important studies on aquaculture which include:

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

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

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

DEPARTMENT OF AGRICULTURE

The Department of Agriculture's Division of Aquatic and Wildlife Resources has been involved with the development of aquaculture on Guam since its earliest stages. However, the Department's 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.

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. Work in aquaculture has diversified and expanded to the current program. An undergraduate/graduate course in aquaculture is offered through the Marine Lab. Publications, reports and theses produced at the Marine Laboratory relevant to aquaculture are:

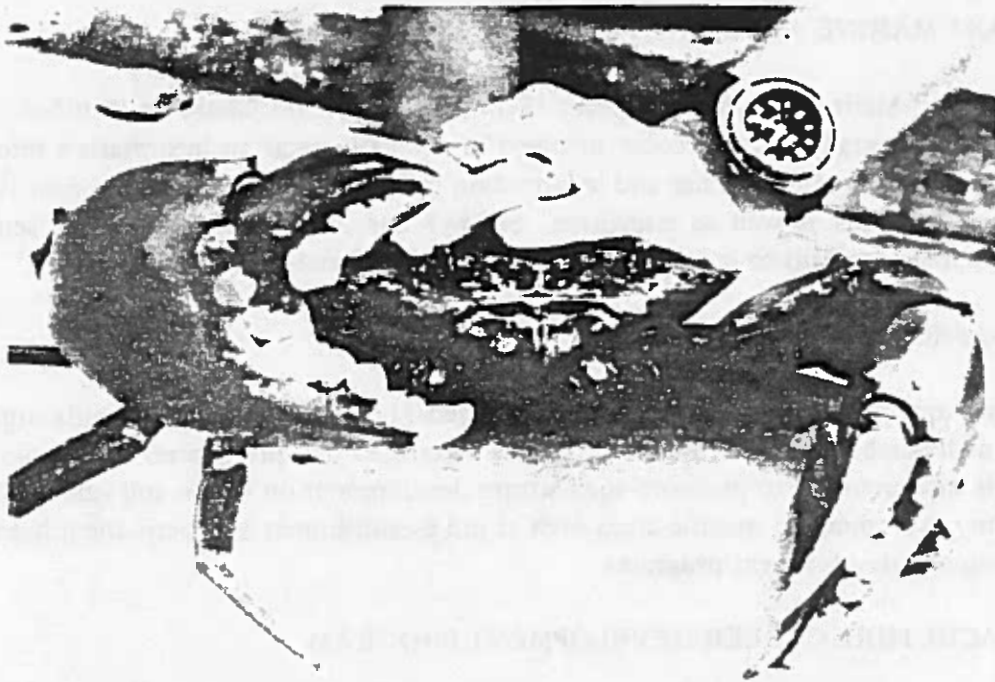
Food habits, functional digestive morphology and assimilation efficiency of the rabbit-fish *Siganus spinus* (Pisces, Siganidae) on Guam. (Bryan, 1975).

Bangus fishponds in the Philippines. (Cushing, 1979)

The occurrence and natural habit of the mangrove crab *Scylla serrata* (Forsk.) at Ponape and Guam. (Dickinson, 1977).

Development of aquaculture in an island community: Guam, Mariana Island. (FitzGerald and Nelson, 1979)

- Environmental parameters influencing the growth of *Enteromorpha clathrata* (Roth) J. Ag. in the intertidal zone on Guam. (FitzGerald, 1978).
- Early life history of the giant clams *Tridacna crocea* (Lamarck), *Tridacna maxima* (Roding) and *Hippopus hippopus* (L), (Jameson, 1976)
- Nitrogen uptake by tropical freshwater macrophytes. (Nelson, Smith and Best, 1979)
- Evaluation of seaweed mariculture potential on Guam: I. Ammonium uptake by, and growth of two species of *Gracilaria* (Rhodophyta). (Nelson, Tsutui and Best, 1980)
- A preliminary evaluation of the mariculture potential of *Gracilaria* (Rhodophyta) in Micronesia: Growth and ammonium uptake. (Nelson, Tsutui and Best, 1980)
- Ecology of *Siganus argenteus* (Pisces; Siganidae) in relation to its mariculture potential on Guam. (Tobias, 1976)
- Food preference of juvenile *Siganus rostratus* and *S. spinus* in Guam. (Tsuda and Bryan, 1973)
- Studies on the genus *Siganus* (rabbitfish) in Guam waters. (Tsuda, Tobias, Bryan, FitzGerald, Kami and Ikehara, 1976)
- Conservation and cultivation of giant clams in the tropical Pacific. (Yamaguchi, 1977)
- The kinetics of ammonium uptake by Micronesian species of *Gracilaria* (Nelson and Tsutui, 1981)
- Kinetics of nitrate and ammonium uptake by the tropical freshwater macrophyte *Pistia stratiotes* (L.) (Nelson, Smith and Best, 1981)
- Ammonium excretion by the freshwater prawn *Macrobrachium lar* in relation to diet. (Nelson and Kropp 1981)
- Agosnitic behavior of the freshwater prawn *Macrobrachium lar* in relation to size and sex. (Donaldson, 1981)
- Browsing by herbivorous reef-fishes on the agarphyte *Gracilaria edulis* at Guam, Mariana Islands. (Nelson and Tsutui, 1981)
- Interspecific variability within the genus *Gracilaria* on Guam. (Matlock and Romeo, 1981)
- Reproduction periodicity in the indigenous oyster *Saccostrea cucullata* in Sasa Bay, Apra Harbor, Guam, with reference to cultivation. (Braely, 1981)



The Coconut crab, *Birgus latro* and the mangrove crab (*Scylla Serrata*) were investigated by the Marine Laboratory for their possible culture.

The Marine Laboratory was appropriated \$25,000 (Public Law 15-129, Section 30) to construct and operate a prawn hatchery for the production of postlarval *Macrobrachium rosenbergii* to fill the needs of the existing commercial prawn farmers on Guam. This is a temporary hatchery which 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.

COLLEGE OF AGRICULTURE AND LIFE SCIENCES (University of Guam)

The College of Agriculture and Life Sciences 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 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 coordinates between the temporary hatchery located at the Mairne 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.

SEA GRANT MARINE ADVISORY PROGRAM

The Sea Grant Marine Advisory Program (SGMAP) started 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 the Sea Grant funded aquaculture programs as well as elsewhere. SGMAP has conducted a number of seminars on aquaculture as a means to inform the public of this potential industry.

GUAM AQUACULTURE ASSOCIATION

The Guam Aquaculture Association was established 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 gain the assistance of the government in specific areas such as the establishment of a permanent hatchery, and research and development programs.

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 a College of Agriculture and Life Science Program (CALS) 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.

The Club operated a 2-acre pond site located along the Talofoto River as a Club project. They raised *Macrobrachium rosenbergii*, and mullets (*Liza* and *Neomyxus*) in a polyculture system.



4-H Aquaculture Career Development Program. *Macrobrachium rosenbergii* pond, Talofoto.

OTHER GOVERNMENT AGENCIES INDIRECTLY INVOLVED IN AQUACULTURE

The Bureau of Planning's Coastal Zone Management (CZM) program has played a role in identifying and providing guidelines to preserve the island's resources. CZM sponsored the study entitled, "Aquaculture and Its Potential Environmental Impact on Guam's Coastal Waters" (FitzGerald, 1977). This study identifies the resource, 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 Environmental 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 would 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 occurrence and utilization of groundwater in Guam's river valley flood plains has been recently proposed. The results of such a study would be of assistance to aquaculturists in obtaining an adequate water supply as well as being 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.

LOCAL LEGISLATION

A limited amount of local legislation in the form of resolutions, executive orders, and public laws both through the Governor's Office and the Legislature have been passed that directly mention aquaculture; however, a number of the legislation for agriculture applies to aquaculture also. Appendix A provides a listing of such local legislation from the 10th Legislature to the present.

Synopsis of Aquaculture Related Bills and Resolutions Passed and Adopted by the 10th Through 15th Guam Legislature

10th Guam Legislature

Public Law 10-67 - An Act Making Amendments To Public Law 9-121, Ninth Guam Legislature to Increase the Amount of the Revolving Loan Fund of the Guam Farmers Cooperative and For Small Loans to Farmers, Respectively, to \$150,000.

Public Law 10-87 - An Act to add Subparagraph (i) to Section 19601 of the Government Code of Guam to Exempt from the use tax property used for Agricultural purposes. This allows the importation of equipment and supplies that would be used exclusively for agricultural purposes without the payment of the Use tax. This would also apply to equipment used for aquaculture.

Public Law 10-139 - An Act Making Amendments to Section 2 of Public Law 9-121 Ninth Guam Legislature, To Increase The Amount Of The Loans For Farmers To \$10,000 And To Permit A 10-Year Term For Such Loans. This Act appropriates \$150,000 to the Farmer's Small Loan Revolving Fund and sets a maximum limit of \$10,000 on a loan and the term of the loan not to exceed 10 years. Note: Aquaculture operations can qualify for a loan.

12th Guam Legislature

Public Law 12-28 - An Act Making Appropriations To the Farmer's Small Loan Revolving Fund . . . This act in part appropriates \$100,000 to the Farmer's Small Loan Revolving Fund. Note: This Fund is administered by the Department of Agriculture. Aquaculture operations are eligible under this loan program. However, currently this Fund is nearly exhausted.

13th Guam Legislature

Public Law 13-84 - An Act To Add Chapter VII To Title XIII Of The Government Code Of Guam To Provide For The Labeling Of Feeding Stuffs Distributed Within The Territory, To Promote The Production Of Livestock And For Related Purposes.

This act requires the proper labeling of animal feeds in regards to the type and quantity of ingredients and the amount of protein, and minerals provided by the feed. Feed supplements and custom mixed feeds must be appropriately labeled. Feeds are subject to analysis, with penalties for mislabeling or deficiencies. Note: Since aquaculture normally utilizes commercial animal feeds (e.g., turkey starter feed for prawn culture), this act also applies to aquaculture feeds (commercial standard or custom mixed feeds) so as to assure the user of the contents.

Public Law 13-154 (Section 2) - This redefines the Seashore Reserve to include the area extending seaward to the 10 fathom contour and extending inland to the nearer of the mean high water line or the inland edge of the nearest public right of way. Note: Since the Seashore Reserve constitutes the major area where mariculture would be practiced, it is restrictive as written.

Public Law 13-161 (Sections 5, 6, and 7). This provided assistance to farmers after Typhoon Pamela in the form of an appropriation of \$15,000 to assist farmers of Guam in restoring agricultural programs. A grant of \$300 per farmer is provided for the purchase of seeds, seedlings, pesticides and fertilizer. Note: Aquaculture farmers have qualified under agricultural relief programs.

Public Law 13-195 - An Act To Amend Sections 53604 and 52558 Of The Government Code of Guam To Authorize The Guam Economic Development Authority To Insure Livestock Producers Against Loss Of Their Livestock And For Other Purposes. This act provides GEDA with the additional powers to insure bona fide farmers of Guam including those raising vegetables/fruits, livestock, and aquaculture products. Specifically, operators of commercial fish, eel, and shrimp farms can be insured against loss due to natural disaster such as typhoon, rain or flood but shall be limited only to loss of the insured arising from labor costs, land and pond preparation costs, algicides costs, cost of fish fry, eel fry and shrimp fry. Note: This does not cover loss of the actual or potential value of the crop.

Resolution 90 - Relative To Concurring With The Governor's Request For Economic Development Administration Funds Under Title IX Of The Public Works And Economic Development Act Of 1965, As Amended, For The Purpose Of Providing Special Economic Development And Readjustment Assistance Programs To Guam Based On The Development Of Agriculture In The Southern Region Of The Island. In part, this calls for the construction of roads to open up agricultural areas in the south and to construct dams on the Ugum and Talofoto Rivers for irrigation and other purposes. Note: This addresses a need which is important both to agricultural and aquacultural development.

14th Guam Legislature

Public Law 14-22 - An Act To Repeal And Reenact Chapter VI and VII Of Title LXI Of The Government Code Of Guam, To Renumber Chapter VIII Of Title LXI

And To Amend Section 57004 Of The Government Code, Relative To The Guam Pesticide Act. This in part is known as the "Guam Pesticide Act". It provides the guidelines and designates the responsible authority for the regulation of the use of pesticides on Guam. Note: As part of the definition for "pest" aquatic plant or animal life is included. "Animal" is defined to include fish and shellfish. Thus this would cover the use of pesticides (e. g. *piscicides*, *herbicides*) in the practice of aquaculture.

Resolution 61 - Relative To Approving Agricultural Leases. This legislation restates the government's intent in leasing government property for agricultural purposes which includes fish farming.

Resolution 89 - Relative To Requesting The Congress Of The United States To Amend Various Federal Agricultural Loan And Credit Acts To Extend These Programs To The Farmers Of Guam Whose Growing Capital Needs Cannot Be Met From Local Source. This would also be applicable to aquaculture farmers as part of Guam's agriculture community.

Resolution 169 - Relative To Requesting The Governor Of Hawaii To Continue To Provide Guam With Malaysian Prawn Until A Local Shrimp Hatchery Is Built. This requests the Governor of Hawaii to continue the supply of prawn postlarvae to Guam from Hawaii's State hatchery. Note. The Hawaii State hatchery was unable to meet this request.

Resolution 185 - Relative To Approving Agricultural Leases. Restates the government's intent in leasing government property for agricultural purposes, which includes fish farming.

15th Guam Legislature

Public Law 15 - 18 - An Act To Authorize The Government Of Guam To Enter Agricultural Leases. The Department of Land Management with approval by the Governor can make available for lease suitable government owned land for agriculture that is not required for other uses. Such land is transferred to the Department of Agriculture for the administration of the lease program. The use of this land is solely for agricultural purposes. "Agriculture" is defined to include aquaculture practices.

Public Law 15-74 (Section 3 and 4) - This provides for the establishment Of The "Emergency Farm and Fishery Financial Assistance Grant Funds". The Act appropriates \$400,000 to this Fund which is to be administered by the Department of Agriculture. \$20,000 of the \$400,000 is allocated to subsidize the importation of freshwater prawn postlarvae. That portion of the fund not expended prior to March 1, 1980 shall revert to the General Fund. Note: This provided financial assistance to farmers (including aquaculture farms) and fishermen that received damages to their operation during tropical storm Tip.

Public Law 15-101 - An Act To Add A New Chapter 1A To Title XIV Of The Government Code Of Guam To Provide For Conservation Of Agriculture Lands. This Act sets government policy to minimize the rezoning of agricultural lands. Minimize expansion of industrial activities into agricultural areas that have an adverse effect on agricultural resources. Assess the effects of major government actions on agricultural lands, such as land use planning, roads and urban development. It identifies the most significant agricultural land in the territory and to coordinate governmental activities, including formulation and implementing state policies, providing technical and financial assistance and regulatory actions, which affect agricultural lands in order to minimize the adverse impact upon such lands. Note: This Act does not make specific reference to aquaculture; however, it is of importance since aquaculture takes place on agricultural lands and is defined as an agricultural activity in other legislation and is affected by land use plans as well as Water Quality Standard plans that adversely affect agricultural development. This Act sets a positive government policy towards the conservation and use of agricultural lands.

Public Law 15-107 - An Act To Add New Sections 12227.1, 12227.2, 12227.3, And 12227.4 To The Government Code To Provide A Subsidy To Individual Persons Leasing Certain Heavy Equipment For Agricultural Purposes. This Act provides that through the Department of Agriculture who administers the program a farmer may be reimbursed for 50% of the cost of heavy equipment leased for agriculture land clearing and other agricultural purposes. The rental of such equipment must be from private companies licensed by the Director of Agriculture to participate in this program. \$30,000 is appropriated to carry out this program. Note: Aquaculture farms can benefit from the program during the construction or maintenance of the farm for that portion using heavy equipment in accordance with the rules and regulations of the program.

Public Law 15-114 - An Act To Establish The Territorial Boundary And Economic Zone For The Jurisdiction Of Guam. This declares that an economic zone from the shoreline of Guam to 200 miles seaward is formed. The Territory of Guam has exclusive rights to determine the conditions and terms of all scientific research, management, exploration and exploitation of all ocean resources and all sources of energy and prevention of pollution within the economic zone, including pollution from outside the zone which poses a threat within the zone. Note: This encompasses broadly all activities within 200 miles of Guam's shoreline and thus would be applicable to mariculture practices within this economic zone. This, in effect, is only a statement declaring the economic zone, not setting up rules and regulations for the guidance of its use, thus does not affect or succeed other rules and regulations applicable within this 200 mile zone.

Public Law 15-129 (Section 30) - This Act appropriates \$25,000 to University of Guam Marine Laboratory for setting up and operating a temporary hatchery for the production of prawn (*Macrobrachium rosenbergii*) postlarvae to supply the commercial prawn farmers.

Resolution 62 - Relative To Requesting The United States Department Of Labor And The United States Department Of Justice To Reinstate The H-2 Program For Agricultural And Aquacultural Developmental Activities On Guam. Note: A Governor's task force (DOC, DOA and UOG) reviewed (10/80) the reinstatement of the H-2 program for aquaculture workers and found it to be contrary to the goal of establishing an aquaculture industry which would provide employment and an alternative lifestyle to the residents of Guam.

Resolution 22 - Relative To Expressing The Fifteenth Guam Legislature's Support of HR 12636 And S. 3209 Relative To Extending Crop Insurance To And To Respectfully Petition The U. S. Congress To Pass And The President Of The United States To Approve Either Bill. Note: U. S. Public Law 96-365 Federal Crop Insurance Act of 1980 passed September 16, 1980. Within this Federal Act Guam is included in the crop insurance program and aquaculture is defined as an agricultural practice and is eligible for crop insurance under this program.

Resolution 459 - Relative To Approving That Certain Proposed Transfer Of Government-owned Land Under The Department Of Parks And Recreation To The Department Of Agriculture For The Purpose Of Developing A Prawn Hatchery. This transfer lot 11-2 Mano Beach, Ipan, Talofofo, which is 2 hectares, to the Department of Agriculture as the site of the proposed permanent prawn hatchery.

ORGANIZATION OF THE AQUACULTURE PROGRAM ON THE NATIONAL LEVEL

The responsibilities of the federal aquaculture program lie divided among three (3) major agencies, Department of Commerce, Department of Agriculture and Department of the Interior. Each has been designated specific areas in aquaculture. Department of Commerce is in charge of mariculture, but will coordinate its work on anadromous species, with both Agriculture and Interior. Department of Agriculture will concentrate on freshwater aquaculture while the Department of the Interior will be responsible for technical research and development of freshwater finfish for recreational and commercial purposes.

In 1978 President Carter created the Joint Subcommittee on Aquaculture. This is an Executive Advisory Subcommittee of the Federal Coordinating Council for Science, Engineering and Technology. The Subcommittee is concerned with all federally supported programs in aquaculture. The purpose of the Joint Subcommittee on Aquaculture (JSA) is to increase the overall effectiveness and productivity of federal aquaculture research, development, and assistance programs. The new Subcommittee replaces the Subcommittee on Aquaculture of the former Interagency Committee on Marine Science and Engineering. The JSA will work in three (3) areas:

- 1) the creation of a national aquaculture plan;
- 2) a study of the financial needs of the aquaculture industries; and
- 3) a study of the regulations that are restricting the growth of aquaculture.

The National Aquaculture Act of 1980 assigns specific tasks as well as setting general policy and objectives of the federal aquaculture programs. This legislation along with others provides the basis of support to aquaculture on the national level. Figure 2 shows the organizational flow chart for federal agencies involved in aquaculture.

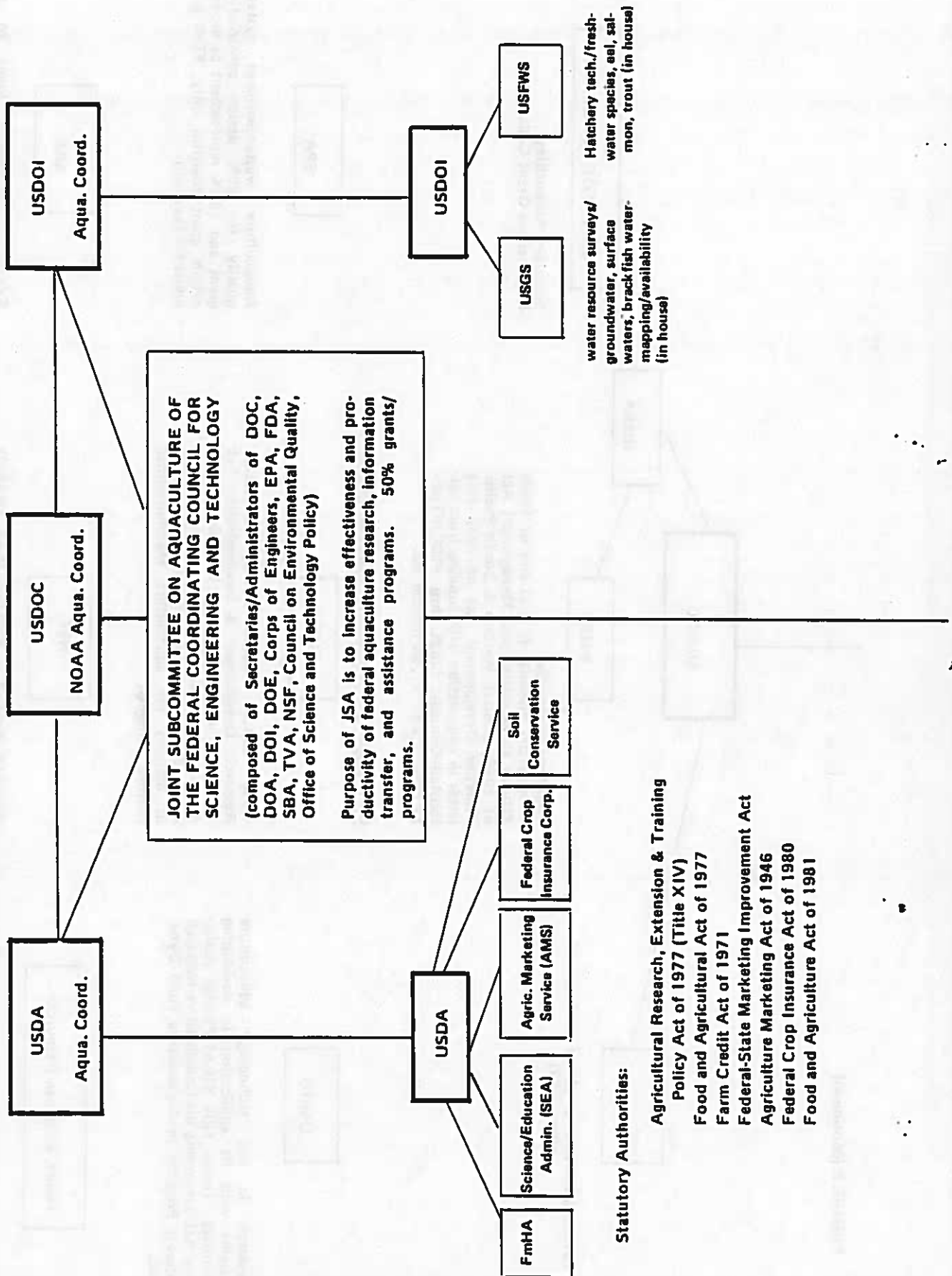
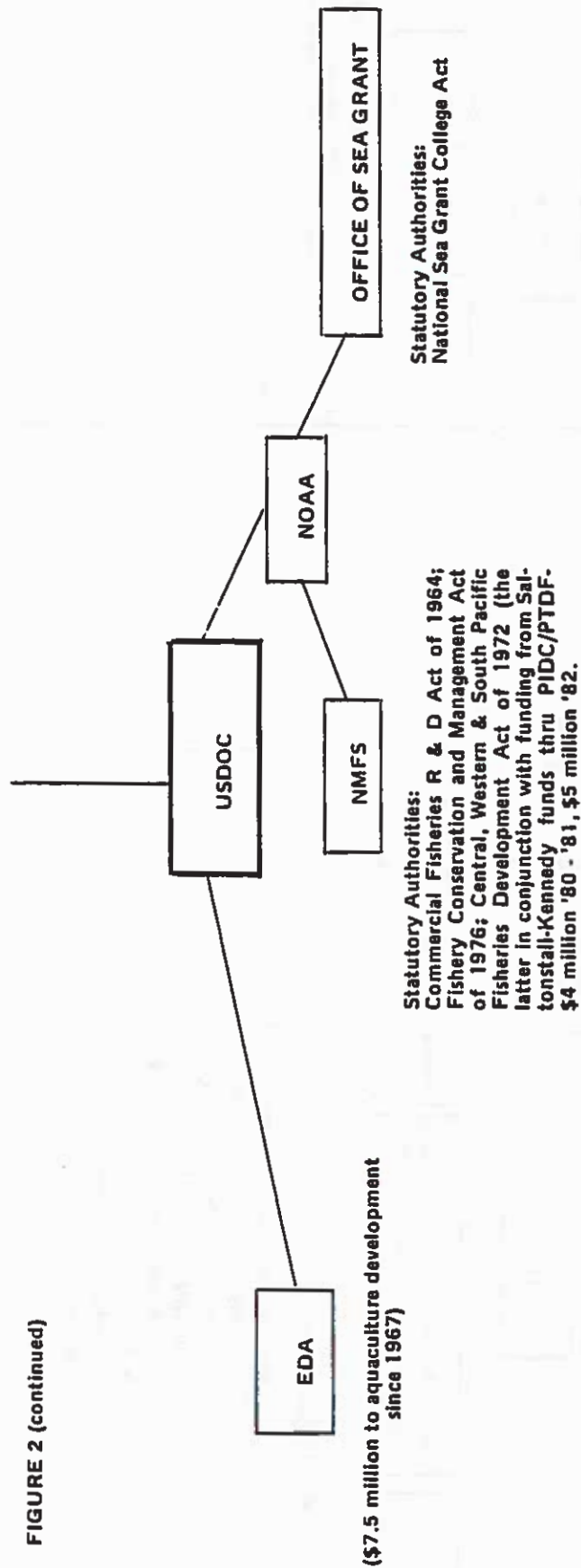


FIGURE 2 (continued)



OTHER FEDERAL GOVERNMENT SUPPORT

USAID	Research in low technology aquaculture systems with its application to developing countries. Under Title XII of Foreign Assistance Act developing the Collaborative Research Support Program in Aquaculture Pond Dynamics.
Health & Human Resources	Qualify each island group under National Shellfish Sanitation.
USDOE	Under Ocean Thermal Energy Conversion Research, Development & Demonstration Act of 1980. Funds available for FY '82 for pilot/demonstration of OTEC/Aquaculture systems in islands and territories. Other DOE support in biomass for aquaculture feed/nutrients/thermal effluents.
EPA	Aquaculture waste-treatment systems qualify for 85% design construction grant and 100% replacement or modification grant (baitfish only, FDA prohibits for foodfish).
NSF	Research Applied to National Needs (RANN) program for small scale appropriate technology.
SBA	Expansion/development loans to expand commercial demonstration.

AQUACULTURE SUPPORT PROGRAMS OF FEDERAL AGENCIES

The main agencies within the federal government that have activities directly or indirectly related to aquaculture are the Department of Agriculture, Department of Commerce and the Department of the Interior. Communications between these agencies regarding aquaculture programs and research has been poor in the past. The President's Joint Subcommittee on Aquaculture of the Federal Coordinating Council on Science, Engineering, and Technology established in 1978 within the Office of Science and Technology Policy has brought these agencies together regarding efforts in aquaculture development and has defined each agency's role. The Joint Subcommittee on Aquaculture will be the principal mechanism for coordinating, planning, implementing, and evaluating Federal aquaculture programs among the three (3) departments as well as among all the Federal agencies active in aquaculture.

Federal programs are in a state of flux. The review and revision of Federal programs by the Reagan administration with the intended reduction of federal governmental expenditures and the possible elimination of some of these programs will affect a number of the following agencies. However, the actual extent and degree of this austerity program is not known at this time. Therefore the appropriation of funds that have been authorized in legislation may in actuality not be appropriated to the extent originally authorized. This would subsequently limit the capability of the agencies responsible for carrying out the program as originally proposed and implementing programs proposed through the National Aquaculture Development Plan. Programs that have provided or can provide the greatest assistance to Guam must be actively lobbied for.

Of the proposed reductions in governmental expenditure that would affect aquaculture development to varying degrees, the following agencies and programs are mentioned. Of the proposed USDA cuts, this would include a reduction in direct lending by the Farmers Home Administration by 5 percent in the last half of 1981 and by 25 percent in 1982. This will reduce capital available to the aquaculture industry, since it is the direct loans that provide the low interest rates needed by the industry. The Economic Development Administration and the Regional Development Commissions of the Commerce Department are scheduled for elimination by the end of FY 82. The Coastal Zone Management program would be phased out at the end of FY 82. The administration wants to phase out by the end of the fiscal year 1981 the Comprehensive Employment and Training Act (CETA) that provided money for subsidized employment in the public sector. A deferment of some water development projects by the Army Corps of Engineers, the Soil Conservation Service and other Federal agencies is proposed. Support of Sea Grant colleges designed to enhance marine research efforts would be cut by about half.

DEPARTMENT OF AGRICULTURE

USDA Agencies and Activities

The Science and Education Administration-Extension and the Soil Conservation Service are responsible for aquaculture technology transfer in U. S. Department of Agriculture (USDA).

The basic authority exist under the Smith-Lever Act, as amended (7 U. S. C. 341-349). The responsibility of basic and applied research lies with the Science and Education Administration's Agriculture Research and Cooperative Research sections.

The Science and Education Administration-Extension (SEA-E) conducts cooperative agriculture extension work through land-grant colleges. This consists of the practical application of technology in aquaculture, home economics, and related subjects through instruction and demonstration. The emphasis of the program is to identify and solve farm, home, and community problems as they are identified by the local community. The University of Guam, College of Agriculture and Life Sciences is administering this program for Guam.

SEA-E carries out a Marine Advisory (Extension) Program from funds provided by Sea Grant (National Oceanic and Atmosphere Administration, Department of Commerce). The program includes aquaculture activities in pond or raceway design, construction and management, water quality management, fish nutrition, disease control, harvesting, transportation, processing, marketing, storage, by-product utilization, and hatchery management. This program on Guam has an office at the Marine Laboratory.

The Science and Education Administration-Agricultural Research (SEA-AR) is another unit under SEA. It provides basic, applied, and developmental research services, in the areas of animal production and protection; plant production and protection; use and improvement of soil, water, and air resources; and processing, storage, distribution, and consumer services. This program has, in the past, not been available on Guam.

Section 406 of the Agricultural Trade Assistance Act of 1966 (U. S. P. L. 89-808) provides for the Tropical Agricultural Research Program. Tropical agriculture research under Section 406 is administered by the Science and Education Administration, Agricultural Research (SEA-AR), U. S. Department of Agriculture. Other agencies and cooperative universities, both in the United States and abroad, are eligible to participate in this program if they have qualified staff and facilities. The University of Guam recently became eligible to participate in this program.

There are two research centers that coordinate the administration of the regional programs. The Caribbean Basin center operates out of the Universities of Florida, Puerto Rico, and Virgin Islands and the SEA-AR which serve the Caribbean, South and Central America and West Africa. The Pacific Basin center serves the Pacific islands and Asia and is based at the University of Hawaii.

The major objectives of the Section 406 Program are:

- 1) To give emphasis to projects which have definite implications toward improving tropical and subtropical agriculture and which, at the same time, will substantially contribute to solving important agricultural needs for the United States.
- 2) Improve domestic food and feed production in tropical areas so that food imports may be reduced and the tropics may become more self-dependent.

- 3) Improve the protein content and other nutritional components of tropical crops for man and animals.
- 4) Reduce the need for petroleum energy inputs in tropical agriculture through:
 - (a) the use of solar energy for crop drying,
 - (b) reduced need for fertilizer and other chemical imports through the development of synergistic, biotic systems,
 - (c) more intensive land management through multiple cropping,
 - (d) more effective use of plant and animal wastes, and
 - (e) improved water use efficiency.
- 5) Reduce food and feed losses in production, distribution, storage and processing of tropical agricultural commodities.
- 6) Improve the marketing of agricultural commodities in tropics.
- 7) Enhance the use and conservation of natural resources of the tropics.

Aquaculture as an integrated activity of agriculture should be eligible for funding under this program. An aquaculture research project funded under this program is being carried out by the University of Hawaii. This project is entitled "Manure-enriched Food Chains in Marine Pond Ecosystems."

The Science and Education Administration-Cooperative Research (SEA-CR) is another unit of SEA. SEA-CR participates in the planning and coordination of research programs between the States and the U. S. Department of Agriculture, and encourages and assists in the establishment and maintenance of cooperation within and between the States. The primary function of SEA-CR is to administer acts of Congress that authorize Federal Appropriations for agricultural research carried on by the State Agricultural Experiment Stations, 1890 land grant institutions, and other eligible institutions such as under the Hatch Act of 1887 as amended. This program is available to Guam.

Research nationwide in this program is being conducted on several major aspects of fresh-water aquaculture, including the breeding of aquaculture species for more efficient growth and more uniformity of product at harvesting; nutritional studies to define requirements for more efficient production of the various species; culture methods for optimum production, such as water treatment and quality, stocking rates, harvesting methodology, raceway culture, and other practices for optimum production. Methods of disease and parasite control to reduce losses are being studied. Processing and marketing studies are in progress to improve product quality and nutritional value, product acceptability, and greater efficiency in processing and marketing aquaculture products.

Two current aquaculture projects being conducted on Guam that are funded under the Hatch Act are:

Nitrogen Metabolism of Freshwater Prawns in Relationship to Diet. Marine Lab., UOG, Nelson

Genetic Assessment of *Macrobrachium* on Guam. Biology Department, UOG, Matlock.

The Soil Conservation Service (SCS) gains its authority for activities in aquaculture from the Soil Conservation Domestic Allotment Act (U. S. P. L. 74-76) which did 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 is now possible under the Territorial Omnibus Act (U. S. P. L. 96-597) along with other Department of Agriculture programs that could be extended to Guam that were previously excluded. USDA is planning to place a resource conservationist as part of the Soil Conservation Service and the Forest Service in a field office on Guam in the near future. This resource conservationist will coordinate work on natural resource inventories and condition assessments. Following completion of these assessments, SCS would plan to work with the territorial government in the development of 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 (PBDC correspondence).

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 system, 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 soils information;
- 6) site limitations (physical); and
- 7) facility design and layout.

The Agriculture Stabilization Conservation Service (ASCS) has a program that makes grants available to farmers for up to \$3,500 per year to install soil and water conservation plans. However, this is not extended to aquaculture farms at present. This may be changed with the new emphasis on aquaculture by the USDA.

The Animal and Plant Health Inspection Service (APHIS) has two (2) basic units: Plant Protection and Quarantine Programs and Veterinary Services. These are mainly concerned with the inspection of incoming goods. It is the Veterinary service that is of interest to aquaculturists. Efforts in disease control and eradication programs are carried out through close cooperation with State governments. Currently this program is not available on Guam for either livestock or fish, but should become available in the near future. The Plant Protection and Quarantine Program has recently (1980) been initiated on Guam.

The Farmers Home Administration (FmHA) has loan programs both direct and insured that are available to aquaculture enterprises. FmHA has an office on Guam and has processed loans for aquaculture farm developments. For further information on FmHA, see section on Financial Assistance.

The Agricultural Marketing Service (AMS) is the USDA agency responsible for all aspects of marketing including processing, packaging, distribution and marketing of aquacultural products. The AMS is responsible for administering the Federal-State Marketing Improvement Program (FSMIP), which is a matching fund program carried out in conjunction with State Departments of Agriculture. The program is authorized under Section 207 of the Agricultural Marketing Act of 1946. States where aquaculture is an important farm enterprise are encouraged to work with their industry to develop projects in the marketing field. Particularly encouraged are projects which are designed to provide producers better information on the needs of the current market and the size of the potential market.

The Economic, Statistics, and Cooperative Service (ESCS) is responsible for all activities associated with acquiring, interpreting, and disseminating crop and market information. The three (3) major duties of ESCS are:

- 1) To formulate, develop, and administer programs of economic research, analysis and information related to food, agriculture, and rural resources and communities;
- 2) To formulate, develop, and administer programs of collecting and publishing statistics, related to food, agriculture, rural resources and community areas; and

- 3) To formulate, develop, and administer research and technical assistance programs on financial, organization, management, legal, social, and economic aspects of cooperatives.

The information generated through ESCS assists farmers, processors, and handlers in production and marketing decisions. It also assists legislators and other public officials in developing and administering agricultural programs.

Some of the services of ESCS are performed for other Federal and State agencies on a reimbursable or advance payment basis. Such services would include conducting surveys, performing related statistical data collection activities and economic analyses.

USDA AQUACULTURE PLAN

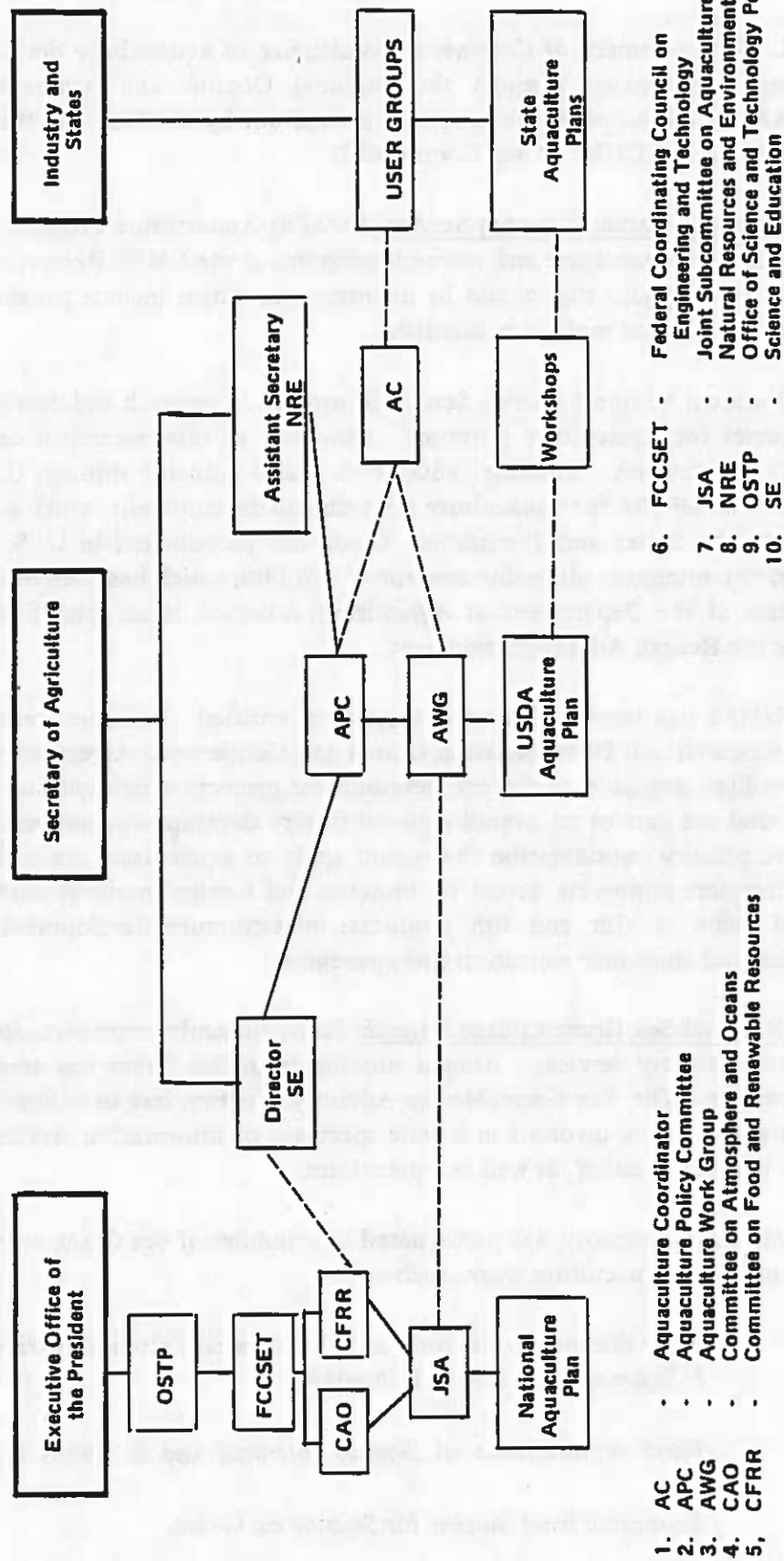
The U. S. Department of Agriculture has recently (1980) completed their Aquaculture Plan which is a component of the overall National Aquaculture Plan. The proposed special grants program in the USDA Aquaculture Plan indicates:

- 1) support will go to states with ongoing aquaculture programs and state aquaculture plans;
- 2) states must provide a planned aquaculture program within 2 years to be eligible for USDA aquaculture programs.
- 3) state agricultural experiment stations at land grant institutions and stations that demonstrate continual and direct industry participation in developing comprehensive research plans are eligible; and
- 4) matching of federal monies will be required for research and extension programs on a 50:50 basis.

The USDA's major aquaculture funding will be directed towards species that have been shown to be commercially viable with research in the area of production, processing, marketing practices, and environmental pollution abatement resulting from aquaculture. Other areas of support will be in providing technical assistance along with the dissemination of information that will contribute to the development and expansion of economically viable aquaculture. To a lesser extent funding will go to statistical and marketing surveys, and product safety and consumer acceptance research.

The interplay of the State Aquaculture Plan with the USDA is shown in Figure 3, which presents the USDA's structural organization for aquaculture. This also shows the relationship the State Aquaculture Plan has with that of the USDA's Aquaculture Plan and the National Aquaculture Plan.

FIGURE 3. AQUACULTURE COORDINATION U. S. DEPARTMENT OF AGRICULTURE
(AQUACULTURE A PROGRAM FOR THE EIGHTIES, USDA)



DEPARTMENT OF COMMERCE

The U. S. Department of Commerce's Assistance to aquaculture development and research is mainly channeled through the National Oceanic and Atmospheric Administration (NOAA) which supports the programs carried out by the National Marine Fisheries Service (NMFS) and the Office of Sea Grant (OSG).

The National Marine Fisheries Services (NMFS) Aquaculture Program consists of technical assistance in aquaculture and research programs at the NMFS Research Laboratories around the U. S. Programs that would be of interest to Guam include penaeid shrimp, sea turtles, marine finfish, and molluscan shellfish.

The National Marine Fisheries Service is involved in research and development for a number of species for aquaculture purposes. However, all this research is carried out in-house at NMFS laboratories. Funding (\$600,000) is also available through U. S. P. L. 88-309 and U. S. P. L. 89-304 for aquaculture research and development, which is appropriated nationwide to the States and Territories. Guam has participated in U. S. P. L. 88-309 and received the minimum allowable amount of \$25,000, which has been used for the aquaculture program at the Department of Agriculture; however, these grant funds will be eliminated under the Reagan Administration cuts.

The NMFS has recently initiated a program entitled "Fisheries Development and Utilization Research and Demonstration Grants and Cooperative Agreements." This program has \$10 million available to fishery development projects which will include aquaculture projects that are part of an overall regional fishery development program. Specific areas that receive priority consideration that could apply to aquaculture are technology development and transfer; improving access to domestic and foreign markets; safety quality, and nutritional value of fish and fish products; infrastructure development; industry economic studies; and consumer education and awareness.

The National Sea Grant College Program funds aquaculture projects and is involved in training and advisory services. Annual funding from Sea Grant has amounted to \$4 million nationwide. The Sea Grant Marine Advisory Program has an office located at the Marine Laboratory. It is involved in a wide spectrum of information services in the area of fisheries, boating, weather, as well as aquaculture.

The Marine Laboratory has participated in a number of Sea Grant supported projects which have included aquaculture work, such as:

Early life history of commercially important tropical marine organisms.

I. *Siganus*, *Tridacna*, and *Charonia*.

Food requirements of *Siganus rostratus* and *S. spinus* (Rabbitfish) on Guam.

Economic food sources for *Siganus* on Guam.

Early life history study of giant clams.

Biological studies on the coconut crab, *Birgus latro*.

Studies on the deep-water Shrimp, *Heterocarpus ensifer*.

Biological studies on the mangrove crab, *Scylla serrata* (Forsk.).

Mullet and *Gracilaria* culture.

The Economic Development Administration (EDA) has provided grants for a limited number of aquaculture projects such as hatchery construction. The provision of funds are primarily as a means toward job creation or preservation and income generation. Funds can be used for capital improvement or technical assistance projects. EDA has provided funds for two technical assistance projects in aquaculture on Guam. These projects are:

Multiple-Use Options For A Prawn Hatchery on Guam. Aquatic Farms, Ltd., 1979. Department of Commerce, Government of Guam. EDA Project No. 07-6-02028.

Recommendations For An Aquaculture Financing Program For the Territory of Guam. Warner, D. C. 1980. Department of Commerce, Government of Guam. EDA Project No. 07-25-01669-02.

In addition, funds are provided to assist the State Planning Program, which has funded this plan. Also, an annual Overall Economic Development Plan (OEDP) is part of this planning program and is a prerequisite to be eligible for funds from EDA. The OEDP provides a listing of projects in the various economic sectors. These projects are prioritized and submitted to EDA for consideration of funding. The proposed prawn hatchery has received a high priority ranking in the past couple years and received the top priority for the 1980 OEDP. However, EDA is scheduled to be eliminated at the end of 1982 as part of President Reagan's budget revision and therefore further funding for aquaculture projects from EDA is doubtful.

The U. S. Department of Commerce has a program for the collaboration between U. S. and Chinese (People's Republic of China) scientists in a number of areas of fisheries which includes aquaculture. Since China has been practicing aquaculture for nearly 4000 years, the utilization of this extensive practical knowledge in the U. S. may be helpful to the industry.

DEPARTMENT OF THE INTERIOR

The Department of the Interior has recently (Fall, 1980) extended an assistance program to Guam. The Seattle National Fishery Research Center has opened a substation located at the University of Guam Marine Laboratory. This is part of an 'Intergovernmental

Mobility Program" in which the Department of the Interior and the University of Guam have a cooperative agreement. The University's contribution to this program will be in the form of in-kind funds. The base funding is for a 2-year period and is renewable.

This program is mainly concerned with environmental problems and as such can be of indirect benefit to aquaculturists, since it will be providing biological technology resource data that can be called upon for information on water quality and flora and fauna of the streams and estuaries as it may affect aquaculture. The program will concentrate on the survey of inland waters, streams, estuaries and wetlands. From this information, the total resource and species present can be estimated with recommendations on areas needed for protection and potential refuges. At a later date investigation may be expanded to terrestrial and inshore marine areas as to its ecology, support of subsistence harvesting, and public use. The primary emphasis of this program is to protect intrinsic resources within the framework of growth and development.

The Department of the Interior to facilitate technology dissemination has training programs through the Fisheries Academy (U. S. Fish and Wildlife Service) in hatchery management, fish health monitoring, warm water fish culture, cold water fish culture, and fish nutrition that are available to qualified individuals and organizations with interest in these fields. The USFWS is instrumental in obtaining FDA clearance of various chemicals and drugs for use in fish culture. Much of the fish culture work of the USFWS is published in their journal *Progressive Fish Culturist*. Technical information regarding hatchery design, recycling, disease diagnosis can be provided for through the USFWS's Seattle and Longview, Washington stations as well as some of the other major research centers. However, the majority of expertise at these labs in fish culture, biology and aquaculture systems is relevant to cold water and warm water species. The assistance with tropical species is limited. The Stuttgart, Arkansas Lab works with the culture of warm water species and is a leading diagnostic and research center for fish diseases. International and national organizations working in the tropical regions would be more knowledgeable sources of information on tropical species, that are or may be cultured on Guam.

The U. S. Geological Service has an office on Guam. The Geological Service monitors the major rivers and streams on Guam for water flow plus provides other pertinent data such as distribution and amount of rainfall and temperature and publishes this information annually in the *Water Resources Data for Hawaii and Other Pacific Areas*.

The Geological Service is very familiar with the distribution and nature of subterranean water sources on Guam, which can be of assistance in the preliminary evaluation of sites suitable for the drilling of a well as the water source for an aquaculture facility.

U. S. AGENCY FOR INTERNATIONAL DEVELOPMENT

Aquaculture activities of the United States Agency for International Development (USAID) are directed towards developing countries to assist small-scale enterprises in the production

of low-priced species (e. g., carp and tilapia) for local consumption. The program's major goal is to establish self-sustaining aquaculture production systems overseas to supplement protein intake as well as providing an income to rural residents. Technical assistance, education and training, capital for public facilities such as hatcheries and specialized equipment are provided by USAID. Extension service plays a central role in the Agency's assistance in developing countries. The Agency works closely with the Peace Corps in implementing USAID's aquaculture program in these countries.

Under Title XII of the Foreign Assistance Act, USAID is presently developing a Collaborative Research Support Program in Aquaculture Pond Dynamics. This research will develop and refine pond production technology for transfer to developing countries, with the goal of increasing the availability of edible fish, creating new jobs and raising incomes. The majority of the Agency's support to research in the U. S. is through the University of Auburn's International Center for Aquaculture and the Oceanic Institute in Hawaii. Present funding for centrally funded aquaculture development is about \$800,000 per year. The University of Guam's Marine Laboratory is presently attempting to participate in these aquaculture research program's of the USAID. The USAID is also a major financial supporter of the nonprofit International Center for Living Aquatic Resources Management (ICLARM) in the Philippines whose research efforts are mainly directed toward aquaculture. The results from these research centers can contribute to the production technology for those species cultured on Guam.

OTHER FEDERAL AGENCIES

Other federal departments have minor or indirect programs which affect aquaculture. They include the Department of Energy which does not have programs which support aquaculture; however, they have conducted studies with aquaculture utilizing thermal waste waters from power plant facilities and they have a program in innovative alternative energy methods in which aquaculture projects could benefit (e. g., windmills).

National Science Foundation (NSF) does not have a program specifically for aquaculture; however, they do fund aquaculture research projects. The Marine Laboratory (UOG) has a two-year joint cooperative research program with scientists in Taiwan on the cultivation of *Gracilaria* that is funded by NSF. The National Science Foundation also has a special funding program for small business firms doing innovative research. This includes firms doing research in aquaculture. The program provides funds to high-technology, high risk research that can have a significant public benefit. The grant awards are given in phases. Phase I, which is up to \$30,000, is for a six month period to determine the feasibility of the project and the ability of the firm to do high-quality research. Phase II awards are given to those projects that have proven themselves to be the most promising in Phase I. The Phase II award can go up to \$200,000 for a 1 to 2 year period. Phase III is a follow-up phase that encourages further funding from the private sector.

U. S. Environmental Protection Agency has recently become involved in aquaculture to a limited extent. A research program in the use of natural systems (including aquaculture)

for the treatment of wastewater receives approximately \$300,000 per year. The Federal Environmental Protection Agency (EPA) through the Clean Water Act (U. S. P. L. 95-217) can provide funds to a local EPA for "innovative and alternative technology" for the construction or adaptation of wastewater treatment facilities or the utilization of by-products in an innovative manner. The program is to implement the reclaiming and reuse of water, productively recycle wastewater constituents or otherwise eliminate the discharge of pollutants, or recover energy through alternative processes and techniques. Aquaculture is considered a process and technique that is eligible for such funding. The effluent from a wastewater treatment facility could be used as a water and nutrient source for the cultivation of a harvestable species (e. g., tilapia, carp) and its natural food (e. g., phytoplankton zooplankton, benthic algae), while providing for the removal of the nutrient. Since under current Federal Food and Drug Administration regulations the use of fish produced in wastewater systems for human consumption is restricted, the fish produced could be utilized as animal feed or as a baitfish (e. g., *Poecilia* sp., *Chanos chanos*). The harvest in this case would be a valuable by-product to the treatment of the effluent.

The Small Business Administration (SBA) is authorized by U. S. Public Law 94-305 to assist farmers under its physical disaster and economic injury loan programs. This legislation did not diminish in any way FmHA's responsibility to meet the financial and other needs of farmers. It is the policy of USDA and FmHA to cooperate with SBA in the use of the respective loan making authorities to compliment the activities of each, and to the extent possible, to improve and expand the delivery of financial assistance to the agricultural segment of the country. These loan programs are made available only under a major disaster declaration by the president or declaration by the SBA administrator.

The Small Business Innovation Research Act of 1981, which is pending passage, is designed to help small, high technology firms tap federal research funds. It is modeled after the NSF program for innovative research. It is divided into three phases. Phase I will provide grants up to \$50,000, Phase II up to \$500,000 and Phase III will be financed by the private sector.

The Small Business Administration (SBA) through its Office of Advocacy has conducted an aquaculture marketing study entitled *A Feasibility Study to Identify Economic/Market Barriers to the Commercialization of Aquaculture Technology* (1981). This study consists of:

- 1) identifying the important operating parameters that influence existing regional distribution and market systems for three high potential aquaculture products;
- 2) identifying the barriers and constraints of the current regional distribution and marketing systems as a conduit for these aquaculture produced products; and

- 3) establishing the feasibility of extending this regionally focused study for a few select species to a national market assessment of a broad cross section of aquaculture products.

Since this study is confined to the States of Washington, Oregon, and California, the study will not be specifically applicable to Guam; however, common problems identified with recommended solutions could prove useful to Guam.

The Small Business Administration's Office of Advocacy was established to voice the needs and opinions in both Congress and the Administration of the small business sector. The Office of Advocacy has two (2) objectives:

- 1) to reduce the burdens that Federal policies impose on small firms; and
- 2) to maximize the benefits that small firms get from the government. The regional office for Guam is located at:

450 Golden Gate Avenue
San Francisco, California 94102

The Advocate for Agri-business and Ocean Industries (includes aquaculture) is:

Assistant Advocate (Mr. Robert F. Clairmont)
U. S. Government Small Business Administration
Washington, D. C. 20416

FEDERAL LEGISLATION

OMNIBUS TERRITORIES ACT OF 1980

The Omnibus Territories Act (U. S. Public Law 96-597) Section 601 authorizes the Secretary of Agriculture and the Secretary of the Interior to extend, at their discretion, programs administered by their Departments to Guam, the Northern Mariana Islands, the Virgin Islands, the Trust Territory of the Pacific Islands, and American Samoa. The Secretaries are authorized to waive or modify any statutory requirements relating to the provision of assistance, in order to adapt the program to the needs of each respective territory. This Public Law benefits Guam in a number of immediate ways and has the potential of being of significant benefit to Guam with specific benefits to agriculture and aquaculture development.

In regards to aquaculture, Section 601(a) and 601(c) provides for the expansion of assistance in the form of research, planning, studies, and demonstration projects. As an example, one USDA program that now can be extended to Guam is the Soil Conservation Service (SCS). SCS can provide technical assistance to aquaculturist and farmers. The extent to which the option to waive or modify any statutory requirements of these new programs

available to Guam or the existing ones is unknown. Nevertheless, such waivers of requirements could be of assistance in numerous ways, such as the loan requirements of FmHA. The majority of Guam's agricultural land (private or government owned) is leased and this prevents Guam's farmers from participating in low interest Farmers Ownership Loans (FOL). The FOL program currently requires farmers to own their respective agriculture land to be eligible for loan assistance.

A review of all the USDA and DOI programs is needed to determine which programs would be of assistance and what qualifying restrictions would need to be modified or waived to have these programs be of benefit to the development of the aquaculture industry on Guam.

NATIONAL AQUACULTURE ACT OF 1980

The National Aquaculture Act of 1980 became U. S. Public Law 96-362 on September 26, 1980. This Act has a history of bills that were introduced before the final passage of this version. This Public Law was introduced to the Federal legislature (96th Congress) in the form of three bills (H. R. 20, S. 1408 and S. 1650). S. 1408 was the most comprehensive and desirable of the three (3) bills in that it would provide for the greatest immediate benefits to Guam (or any State), while H. R. 20 and S. 1650 both represent a simplified version of S. 1408, and are very similar to each other. H. R. 20 had undergone major revision to show this simplified nature. Both bills (H. R. 20 and S. 1680) work more within the structural organization already organized by the executive branch for the investigation into aquaculture namely the Joint Subcommittee on Aquaculture, therefore, they were not redundant in formation of committees as was S. 1408. These were bills to replace the National Aquaculture Act of 1978 (H. R. 9370) which was pocket vetoed by President Carter. There have been a number of precursor bills (e.g., H.R. 370, H. R. 14695, H. R. 4739 National Aquaculture Organic Act of 1977, of the 94th Congress; H. R. 1833 of the 95th Congress) none of which were passed out of the House.

The National Aquaculture Act of 1980 is intended to promote the development of aquaculture in the United States and declares aquaculture to be in the national interest and adopts the national policy to encourage the development of aquaculture in the U. S. This Act is applicable to Guam. The three (3) major purposes of this Act are:

1. declaring a national aquaculture development policy;
2. establishing and implementing a national aquaculture development plan; and
3. encouraging aquaculture activities and programs in both the public and private sectors of the economy.

That will result in increased aquacultural production, the coordination of domestic aquaculture efforts, the conservation and enhancement of aquatic resources, the creation of new industries and job opportunities, and other national benefits.

The *National Aquaculture Development Plan* must be completed within 18 months after passage of the Act. The completion and implementation of the Plan is the responsibility of the Secretaries of Commerce, Agriculture, and Interior. The Plan will:

1. identify aquatic species that the Secretaries determine have significant potential for culturing on a commercial or other basis;
2. recommend actions to be taken by the public and private sectors (which may include, but are not limited to, research and development, technical assistance, demonstration, extension education, and training activities) that are necessary to achieve such potential;
3. address, after taking into account the status of aquaculture regarding the aquatic species concerned,
 - A. aquaculture facility design and operation,
 - B. water quality management,
 - C. use of waste products (including thermal effluents),
 - D. nutrition and the development of economical feeds, including natural food sources,
 - E. life history, genetics, physiology, pathology, and disease control (including research regarding organisms that may not be harmful to fish and shellfish, but are injurious to humans),
 - F. processing and market development,
 - G. production management and quality control, and
 - H. the development of adequate supplies of seed stock;
4. include, where appropriate, research programs on the effect of aquaculture on estuarine and other water areas and on the management of such areas for aquaculture;
5. include, where appropriate, programs to analyze, and formulate proposed resolutions of, the legal or regulatory constraints that may affect aquaculture; and
6. include such other research and development, technical assistance, demonstration, extension education, and training programs as the Secretaries deem necessary or appropriate to carry out this Act.

The Act provides for a continuing periodic revision of the Plan upon the evaluation of the operation and effectiveness of the Plan. This along with a continuing assessment of aquaculture in the United States will keep the Plan functional and relevant to the current needs and status of the industry.

The Act establishes the Joint Subcommittee on Aquaculture of the Federal Coordinating Council on Science, Engineering, and Technology within the Office of Science and Technology Policy. This will function as an interagency aquaculture coordinating group following the format of the previously established Presidential appointed Joint Subcommittee on Aquaculture. Its function is to increase the overall effectiveness and productivity of Federal aquaculture research, transfer, and assistance programs.

The Secretaries of Commerce, Agriculture and Interior have equal input in the Federal Aquaculture Program and their duties would be designed on past involvement and experience in aquaculture. The Secretaries, in carrying out their responsibilities as designated under the Plan, may award grants or contracts to implement these actions. The grants are limited to a maximum 50% of the total project cost.

The Plan also provides for a *Capital Requirements for Aquaculture Study* and a *Regulatory Constraints on Aquaculture Study* to be completed within 12 months of the enactment of this act followed by the development of a Plan for these two studies.

The Act authorizes to be appropriated the following funds:

- 1) Department of Agriculture
 - A. \$7,000,000 for fiscal year 1981
 - B. \$10,000,000 for fiscal year 1982
 - C. \$12,000,000 for fiscal year 1983
- 2) Department of Commerce
 - A. \$7,000,000 for fiscal year 1981
 - B. \$10,000,000 for fiscal year 1982
 - C. \$12,000,000 for fiscal year 1983
- 3) Department of the Interior
 - A. \$3,000,000 for fiscal year 1981
 - B. \$4,000,000 for fiscal year 1982
 - C. \$5,000,000 for fiscal year 1983

This Act even though not providing immediate and direct assistance to the aquaculture industry does provide for the establishment of programs and policies that should eventually stimulate and assist aquaculture development in the U. S. This provides for the needed organization and coordination between the public and private interest in aquaculture and the groundwork to the expansion of aquaculture production as a national goal.

FEDERAL CROP INSURANCE ACT OF 1980

The Federal Crop Insurance Act of 1980 (U. S. Public Law 96-365) was enacted on September 26, 1980. This act is intended to improve and expand the Federal crop insurance program which is administered by the Federal Crop Insurance Corporation under the International Affairs and Community Programs of the USDA. The program would form a public-private partnership for the issuance of crop insurance. It would permit a nationwide all-risk crop insurance program which will become the primary form of Federal disaster protection for farmers. The Act replaces beginning in the 1982 crop year the disaster payment program which was authorized by the Congress in 1973. Rather than providing disaster protection to the producers of only six crops (wheat, cotton, rice, corn, grain sorghum, and barley), this program will be available to all crops in all of the U. S., its territories and possessions. The Board of Directors consists of the Manager of the Corporation and Under-Secretary or Assistant Secretary of Agriculture responsible for the Federal Crop Insurance Program and the farm credit programs of the Department of Agriculture, one person experienced in the crop insurance business who is not otherwise employed by the Federal Government and three active farmers who are not otherwise employed by the Federal government.

The expansion and improvement of the Federal Crop Insurance Program includes the extension of the programs to Guam and the inclusion of aquacultural species as part of the "agricultural commodities" that are eligible for insurance.

The program will function as a form of subsidy to the cost of the insurance premium to the farmers. The Federal Crop Insurance Corporation will pay 30% of the premium on that portion of the policy issuing insurance coverage on 65% of the average yield. The insurance policies will be sold through a USDA agency and by private insurance agents and brokers.

The insurance offered against loss is based on the recorded or appraised average yield of the commodity on the insured farm for a representative period or the average yields for farms in the same area which are subjected to the same conditions. The maximum coverage available is 75% of the recorded or appraised average yield. Lesser levels of coverage are available down to a coverage of 50% of the recorded or appraised average yield. A worthwhile note is that this insurance is based upon the potential yield and not just the planting or stocking expense as has been the case with the crop insurance offered through the Guam Department of Agriculture.

The means for assessing the recorded or appraised average yield for a crop would normally be through the resources and data of the Soil Conservation and the Agricultural Stabilization and Conservation Service. However, since neither of these USDA offices are presently located on Guam, a possible alternative would be the use of Hawaii's data until such information is available on Guam.

FOOD AND AGRICULTURE ACT OF 1981

The recently passed Food and Agriculture Act of 1981 (U. S. Public Law 97-98) contains a section on aquaculture to be administered by the Secretary of Agriculture. It provides for the following:

- 1) Aquaculture assistance programs in research and extension work in accordance with the *National Aquaculture Plan*;
- 2) Land-grant colleges and universities, State agricultural experiment stations and colleges, universities and Federal laboratories having a demonstrable capacity to conduct aquaculture research are eligible for grants on an equal matching basis. The research must be in accordance with the implementation of the *National Aquaculture Plan*.
- 3) States are eligible for grants up to \$50,000 on a matching basis for the preparation of aquaculture development plans.
- 4) The establishment of four aquaculture research, development and demonstration centers for the performance of aquaculture research, extension work or demonstration projects having a national or regional application. These centers would be at existing Federal facilities or in cooperation with State agencies.
- 5) The establishment of an Aquaculture Advisory Board within the USDA with representation from the Federal, State and private industry. The Board will recommend priorities for research and extension programs to the Secretary.
- 6) This Act authorizes \$7,500,000 for each fiscal year beginning after the effective date of this subtitle and ending September 30, 1985.

Guam is eligible to participate in these programs and should pursue funding assistance available under the first three programs. Guam should also support the establishment of an aquaculture research, development and demonstration center (No. 4) in Hawaii to serve as a regional center for the tropical Pacific.

OCEAN THERMAL ENERGY CONVERSION RESEARCH, DEVELOPMENT AND DEMONSTRATION ACT. PUBLIC LAW 96-310

This act (U. S. P. L. 96-310) (July, 1980) encourages the development of ocean thermal energy through research and demonstration projects that would be funded under this act

through the Department of Energy. It appropriates \$20,000,000 for FY 81 and \$60,000,000 for FY 82. Guam is an eligible participant. Since the purpose of the act is to accelerate ocean thermal energy production, it sets energy production goals up to the end of the 20th century. The main form of energy produced is electricity; however, it may also take the form of an "energy product equivalent" which is defined as "an energy carrier including, but not limited to, ammonia, hydrogen, or molten salts or an energy-intensive commodity, including but not limited to, electrometals, freshwater, or nutrients for aquaculture." Therefore, such additional products, namely nutrients and this also could include temperature as an "energy carrier" are considered part of the energy production from an ocean thermal energy conversion operation. The production and utilization of these products and others should be considered as an integral part in the design of any OTEC power plant. In addition, the product of aquaculture namely the cultivated marine or freshwater organism can be considered a form of "an energy product equivalent" since the aquaculture product is an "energy-intensive commodity." Therefore aquaculture, namely mariculture, should play an important and integral part of the development of an OTEC electrical power plant facility; since it can be a significant contributor to the "energy product equivalent" and thereby further utilize the potential energy resource, and contribute to the economic viability of an OTEC operation.

AMENDMENT TO THE CONSOLIDATED FARM AND RURAL DEVELOPMENT ACT. PUBLIC LAW 94-68.

U. S. Public Law 94-68 (August, 1975) which amends the Consolidated Farm and Rural Development Act provides for the Secretary of Agriculture to designate an area as an emergency area if he finds that a natural disaster has occurred in that area which substantially affected farming, ranching or aquaculture operations. The addition of aquaculture as to the eligibility of receiving such disaster relief programs is a significant factor in encouraging aquaculture development by relieving some of the risk factor. The Secretary of Agriculture may delegate authority to any State director of the Farmers Home Administration (FmHA) to make emergency loans within that State without making any formal area designation and provided that the State director finds that a natural disaster has substantially affected twenty-five or less farming, ranching, or aquaculture operations in the area. The individual farms must have suffered losses of 20% or more of the normal production during a natural disaster to be eligible.

This act does not specifically include Guam. However, the recent passage of the "Territorial Omnibus" bill (U. S. P. L. 96-597) does provide the Secretary of Agriculture the authority to extend such a program to Guam. The Guam Office of the Farmers Home Administration will be the responsible Federal agency for its implementation on Guam.

TITLE XII AMENDMENT TO THE FOREIGN ASSISTANCE ACT OF 1961

Title XII Amendment to the Foreign Assistance Act of 1961 was enacted December 1975. This mandates a primary role of the Land Grant and Sea Grant Institutions to find solu-

tions to the world food and poverty problems. This program is intended to benefit domestic and worldwide agricultural research and training. Appropriations are made on a competitive grant basis to Land Grant and Sea Grant Institutions. Since the University of Guam is a Land Grant Institution it would be capable of participating under this program.

WATER RESEARCH AND DEVELOPMENT ACT OF 1978 (U. S. P. L. 95-467)

U. S. Public Law 95-467, enacted October 17, 1978, authorized funding through the Department of the Interior for Water Resources Research and Technology Institutes at land grant colleges. This includes Guam. The Water and Energy Research Institute of the Western Pacific (WERIWP) at the University of Guam is funded through this program. However, the extent of funding in the future is questionable as it is for other federal programs under the present budget review and reevaluation. Three research projects on aquaculture have been funded at the University of Guam's Marine Laboratory through WERIWP, which include:

- 1) Nitrogen uptake by tropical freshwater macrophytes. Nelson, S. G., B. D. Smith and B. R. Best.
- 2) Role of *Macrobrachium lar* in processing nitrogen in tropical freshwater ecosystems. Nelson, S. G.
- 3) Utilization of marine macrophytes for nutrient stripping. Nelson, S. G.

Under Title II, Water Research and Development for Saline and Other Impaired Waters, funding is authorized (e. g., \$14,000,000 for FY 80) to conduct, design, construct, and test processes, systems, and pilot plants for the conversion of impaired water into water suitable for beneficial use. This is mainly directed towards demonstration and construction of desalination facilities. However, funding from these programs can be utilized to reduce nutrient levels and other elements in the water. This could include work in aquaculture that utilizes an aquaculture system to reduce nutrient loads in the water.

Technology transfer and information dissemination for research conducted on water resources is funded under Title III. This is mainly through publications, seminars, conferences, or training sessions.

REGIONAL COMMISSIONS AND FOUNDATIONS

PACIFIC BASIN DEVELOPMENT COUNCIL

An additional source of funding exclusively for the Pacific Basin region is from the Pacific Basin Development Council, which is co-sponsored by the U. S. Department of Commerce, Interior, and Energy. They have a listing of proposed aquaculture projects which include the following:

Specifically for Guam

1. Prawn Hatchery
2. Addition to Hatchery for Penaeid Shrimp Production
3. Addition to Hatchery for Chinese Carp Production
4. Maturation of Chinese Carp
5. Evaluation of Mariculture Systems for Red Algae *Gracilaria* (Rhodophyta)
6. Aquaculture Handbook
7. Production of Mollies for Pole and Line Bait
8. Proposed Aquaculture Loan Program
9. Japanese Market Analysis

Regional (including Guam)

1. Regional Development of Aquaculture Industry Plan

Commonwealth of the Northern Marianas

1. Comprehensive Aquaculture Development Plan
2. To expand the Feasibility Study of Seaweed Culture
3. Feasibility Study of Mariculture

PACIFIC TUNA DEVELOPMENT FOUNDATION

The Pacific Tuna Development Foundation (PTDF) which serves Hawaii, Guam, American Samoa, Commonwealth of the Northern Marianas, and the Trust Territories was created by the Pacific Island Development Commission (PIDC) in 1974 for promoting the development of the tuna industry in the Pacific. Funding for research grants come from Saltonstall-Kennedy funds through the National Marine Fisheries Service. PTDF's sole interest in aquaculture has been in the funding of projects for the development of tuna bait-fish culture which have included the following:

SUMMARY - BAITFISH PROJECTS, PTDF

AREA	PROJECT TITLE/DESCRIPTION	YEARS FUNDED/ COMPLETED	TOTAL PTDF FUNDS
American Samoa	1. <u>Bait Culture and Test Fishing</u> - To produce 14,000 pounds of topminnows <i>Poecilia mexicana</i> and to evaluate their effectiveness as tuna live bait on board a commercial U.S. tuna live bait boat.	1977/1978	\$ 102,500
	2. <u>Bait Culture and Test Fishing</u> - To test the effectiveness of topminnows <i>Poecilia mexicana</i> as live bait while trolling for tunas in American Samoa.	1978/1979	19,100
Hawaii	1. <u>Bait Culture and Test Fishing</u> - To raise and test the suitability of the topminnow <i>Poecilia vittata</i> as a commercial baitfish in the pole-and-line skipjack fishery and to determine the cost-effectiveness of utilizing this species as baitfish in Hawaii.	1979/1979	70,000
	2. <u>Bait Culture</u> - To develop pilot procedures to produce as large a quantity as possible of cultured baitfish (mullet & milkfish) and continue research in improving production quantities.	1980/1980	94,950
	3. <u>Bait Culture and Test Fishing</u> - To raise and test the suitability of topminnow <i>Poecilia mexicana</i> as a commercial baitfish in the pole-and-line skipjack fishery and to determine the cost-effectiveness of utilizing this species as baitfish in Hawaii.	1980/1981	30,000
Palau	1. <u>Baitfishing/Conditioning and Resources Assessment</u> - To develop and demonstrate techniques necessary to secure adequate and effective live bait for skipjack fishing in the Palau District throughout the year.	1980/Ongoing	36,140

However, in recent years the expanding interest of the member islands into other areas of fisheries besides tuna has promoted the reevaluation of priorities and the organization of PTDF and may be incorporated into the Pacific Basin Development Council. Thus, in the future, programs may be expanded to other areas of aquaculture.

SOUTH PACIFIC COMMISSION

The South Pacific Commission is a consultative and advisory body of the South Pacific Islands, which includes the Mariana Islands, Trust Territory of the Pacific and all Pacific Islands south of the equator from Papua New Guinea eastward to Pitcairn. The Commission was established in 1947 by the six Governments then responsible for the administration of island territories in the South Pacific region. This included Australia, France, the Netherlands, New Zealand, the United Kingdom, and the United States. The Netherlands ended their participation in 1962. Since then Western Samoa, Nauru, Fiji, Papua New Guinea, Solomon Islands, Kiribati, Vanuatu, Cook Islands, Niue and Tuvalu have become participating Governments.

The Commission's purpose is to advise the participating Governments on ways of improving the well-being of the people of the Pacific Island territories. This includes activities in the fields of food and materials, marine resources, rural management and technology, community service and information services and data analysis. All countries and territories within the Commission's area of action are eligible to participate in many of these programs. In addition, the Commission serves in the coordination and dissemination of relevant information as to the Commission's work throughout the region. This is done by numerous publications such as a quarterly bulletin, technical papers, handbooks, and books.

The South Pacific Commission (SPC) conducts regional technical meetings on a variety of subjects including fisheries and holds an annual technical meeting on fisheries in which Guam has participated in the past. SPC also sponsors fisheries studies throughout the SPC membership islands' waters. Such studies as the *Skipjack Survey and Assessment Program*, *Sea Turtle Conservation Strategy*, *Deep Water Shrimp Trapping* and numerous other studies have been conducted, which benefit island membership as a whole. Island specific, as well as regional problems, in the islands are addressed, such as training of fishermen and assistance in areas of market development.

The Inter-Country Visit program of the SPC is another program that Guam benefits from. This program assist officials of member islands to visit other member islands on a variety of technical, social and economic subject matters. This includes fisheries and aquaculture. This program facilitates the exchange of expertise held in the various areas of the SPC that is often the most pertinent to the growth of the region and its individual islands.

UNITED NATIONS

Economic and Social Commission for Asia and the Pacific

The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) is the regional arm of the United Nations for Asia and the Pacific. Guam was admitted to ESCAP as an associate member in June 1981. ESCAP concentrates its assistance efforts in the following priority areas: food and agriculture, energy raw materials and commodities, transfer of technology, international trade, transnational corporations and external financial resources transfers, and integrated rural development.

The majority of ESCAP's assistance to aquaculture development for Guam would be indirect. One project that could be of technical assistance in supplying information regarding aquaculture is ESCAP's program for the Lower Mekong River Basin. The Mekong Committee, constituting the S. E. Asian countries that are part of the Mekong Basin, conducted an extensive aquaculture survey with the compilation of methods and statistics of the various species cultured along the Mekong River systems. This information would be relevant in most cases with possibly some modification to species and methods that could be utilized on Guam.

ESCAP's Trade Promotion Center (TPC) is for the development and expansion of trade within its member and associate member countries. Of the four main services of the TPC it is the Market/Product Development Service and the Trade Promotion Advisory Service that may be of assistance in developing Guam's export market for aquaculture products. Areas of assistance would include marketing techniques, market research, organization and strengthening of commercial representation abroad. They also could be of assistance in the planning, organization and operation of commodity control boards and marketing boards, and quality control and packaging.

ESCAP cooperates through regional institutions such as the South Pacific Commission (SPC). Such cooperation is exemplified by the South Pacific Regional Environmental Programme. This body promotes the environmentally sound development of the Pacific Islands while addressing both the terrestrial and marine ecosystems. The importance of the sea especially in the South Pacific countries is recognized by ESCAP, and ESCAP in cooperation with the United Nations Development Programme (UNDP) promotes fisheries development within the region. The Food and Agriculture Organization (FAO) of the United Nations, which coordinates its efforts with ESCAP and UNDP, has a number of aquaculture programmes in many of the developing countries that could be of service to Guam mainly as a source of technical information utilizing FAO's extensive experience in developing aquaculture and in coordinating intraregional cooperation and exchange. For example, it was through the FAO's Bangkok office that arrangements with the Thailand Department of Fisheries was made for the shipment of the catfish *Pangasius sutchi* for experimental culture on Guam.

The Asian Development Bank (ADB) was established as a result of ESCAP's effort to encourage economic growth and cooperation within the region. Membership in ADB is open to members and associate members of ESCAP, other countries within the region, and non-regional developed countries which are members of the United Nations. ADB's role is to promote economic and social progress of its developing member countries by lending funds and providing technical assistance.

Assistance has been mainly directed towards programs in agriculture and agro-industry, (i.e., agriculture, fisheries, aquaculture, forestry and livestock), industry, development banks, power, transport and communications, water supply, urban development, education and health.

The Bank makes two types of loans 1) the ordinary loan which is made to the more developed members at an interest rate of 7.4 percent (1979) for a maximum of 30 years, and 2) concessional loans which are made to the poorest members at an interest rate of one percent for a maximum of 40 years.

Since Guam would be considered advanced in its development as compared to other member or associate member countries of the region, a loan if available would be at the higher interest rate with a maximum of 15 years for repayment. In addition, the amount of ADB lending funds are restricted; thus, their availability to Guam will be limited. However, if financing for a project on Guam is eligible through ADB, the lower interest rate as compared to commercial banks would make it a preferable alternative.

PACIFIC INTER-REGIONAL COOPERATION

There should be a cooperative effort among the Pacific Islands in the development of aquaculture, since many of the problems and solutions are common to all. A common goal is to obtain a higher degree of self-reliance and aquaculture may assist in obtaining this goal. As one of the proposed projects on aquaculture at the Pacific Basin Development Conference (February 17-20, 1980), a proposal to do a comprehensive regional plan for aquaculture research and development for the Pacific Basin Islands entitled *Regional Development of Aquaculture Industry* was presented. This plan should also emphasize regional coordination and cooperation and provide the implementing mechanism.

The South Pacific Commission (SPC, 1979) made the following recommendations for cooperation between Pacific countries on aquaculture matters.

- 1) Arranging for the training of personnel.
- 2) Distribution of desirable species.
- 3) Supply of fry larvae and spat by existing hatcheries on preliminary or experimental scale and in the future on commercial scale and basis.
- 4) Providing for free flow of information and knowledge and cooperation with the organizations involved in tropical island aquaculture like FAO, UNDP, CNEXO, etc.

The South Pacific Commission should take the lead role of coordinating efforts to develop aquaculture in this region and establish a common information reference service. Each country should have a single agency responsible to report progress and needs regarding aquaculture to the South Pacific Commission. Hawaii, through a body such as the Pacific Basin Development Council, can also play a key role.

Regional cooperation in the development phase of aquaculture with the neighboring Commonwealth of the Northern Mariana Islands and islands of Micronesia can be provided from Guam as technical assistance and possibly as a cooperative regional hatchery supplying both Guam, the Northern Marianas and other islands of the Western Pacific.

SECTION III

Development Strategy

FACILITIES FOR AQUACULTURE

The two (2) major river valleys on Guam, the Inarajan and Talofofo Rivers, should be the main areas of a concerted aquaculture development program as identified in previous studies (Aquatic Farms, Ltd., 1978). These areas afford the greatest year round water flows (thus potentially support the largest acreage of ponds), suitable terrain, preferred soil characteristics and are free of urban or industrial pollutant sources.

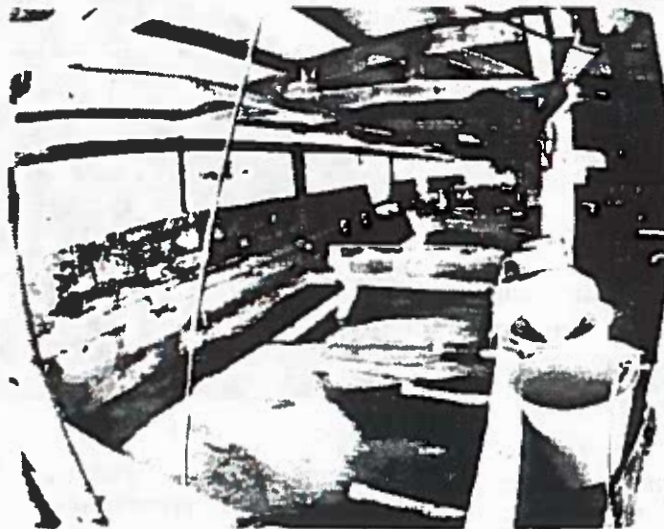
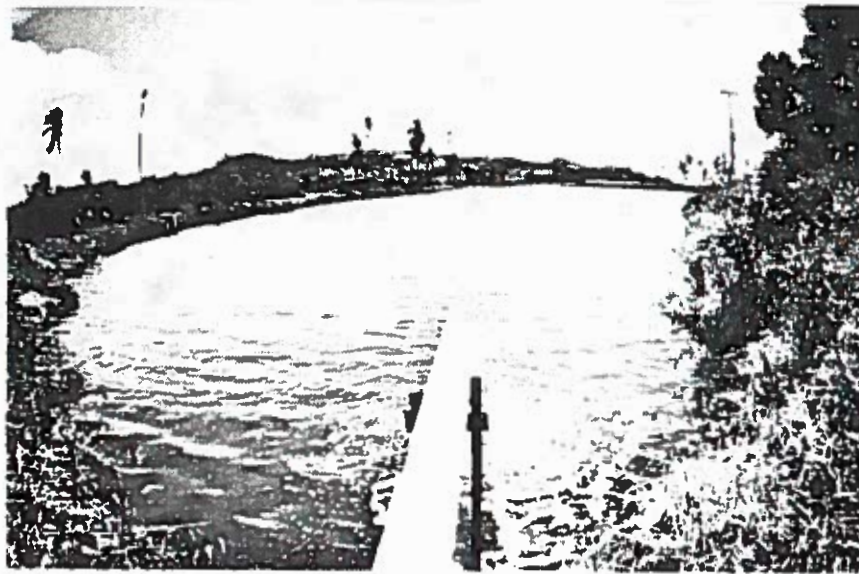
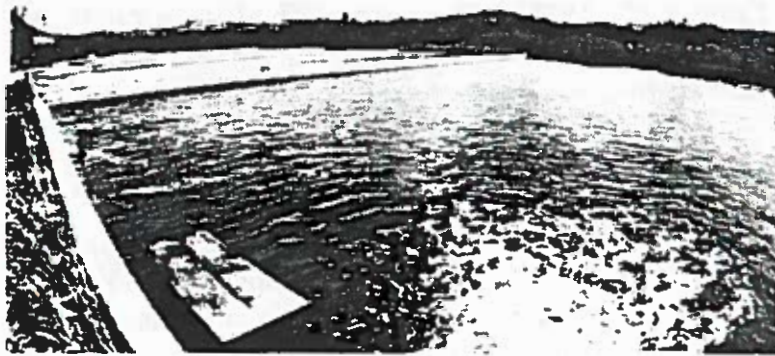
INFRASTRUCTURE

The first and most critical step in the development of supportive infrastructure to these areas is the construction of year round access roads. This is required to open the area up for survey and transport of construction equipment, and subsequently the daily operation of the farm. The second most important infrastructure would be the installation of power lines to operate water pumps and ancillary equipment associated with the farm. Potable water will be required if permanent residence is to be constructed. Potable water can be obtained by drilling a well if located in a suitable site, extension of main water line into the farm, or by rain water catchments.

The Department of Agriculture's heavy equipment division can be utilized for the clearing of access roadways. This should be topped and compacted with coral rock to assure access even during heavy rains. Subsequent development steps can include the clearing of proposed pond sites. This can be carried out under the existing heavy equipment programs at the Department of Agriculture. A priority assignment should be made to these areas for utilization of the heavy equipment. Public Law 15-107 provides for a Government of Guam subsidy of 50% of the cost of heavy equipment used in agricultural activities. The Department of Agriculture is the



Macrobrachium ponds located at Talofofo Bay. The larger river valleys are prime areas for the development of aquaculture.



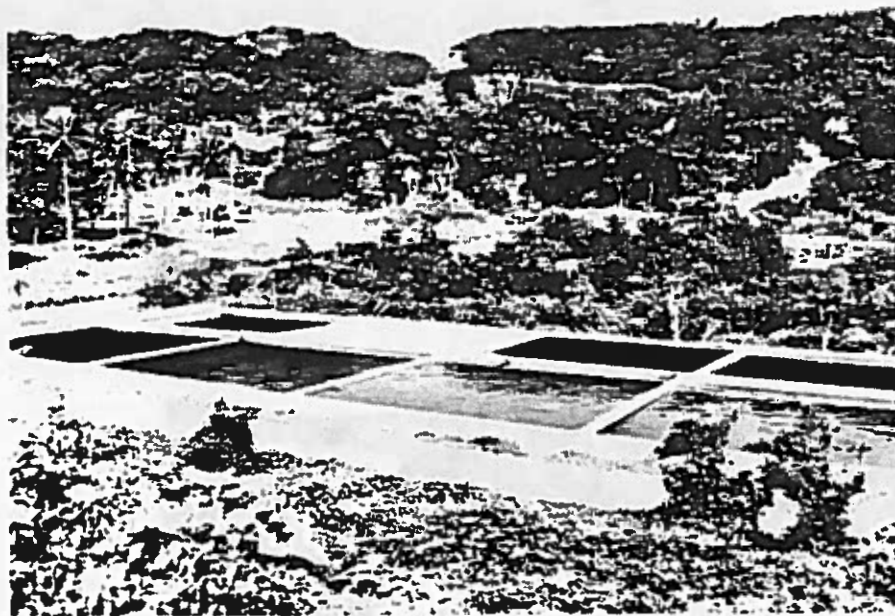
Guam Marine Products is mainly involved in eel (*Anguilla japonica*) and tilapia culture. Located on the Agfayan River.

administering agency for this program. DOA is in the process of drawing up the rules and regulations which once finalized will be followed by the implementation of this program. Aquaculture is considered to be eligible for such assistance.

AQUACULTURE GROW-OUT FACILITIES

PONDS

Earthen pond culture is the oldest and most widespread means of containing cultured species. Concrete ponds are utilized for various species (e. g., eels) or in intensive culture systems. Grow-out ponds vary greatly in size from less than 0.1 ha to over 40 ha depending on the species being cultured, the intensity of the culture, and the terrain. The present general trend is towards smaller ponds (e. g., 0.1 - 1.0 ha ponds), since they afford closer management practices. Nursery ponds are often utilized for the initial culture (i. e., one to three months depending on the species) of fry or juveniles prior to the stocking into grow-out ponds. These smaller ponds allow for the application of a more intensive managerial program (e. g., feed quantity and quality, water quantity and quality, disease management, environmental parameter control and predation control). This generally results in a much better survival rate during this sensitive portion of the life history as compared to the direct stocking of a species into grow-out ponds.



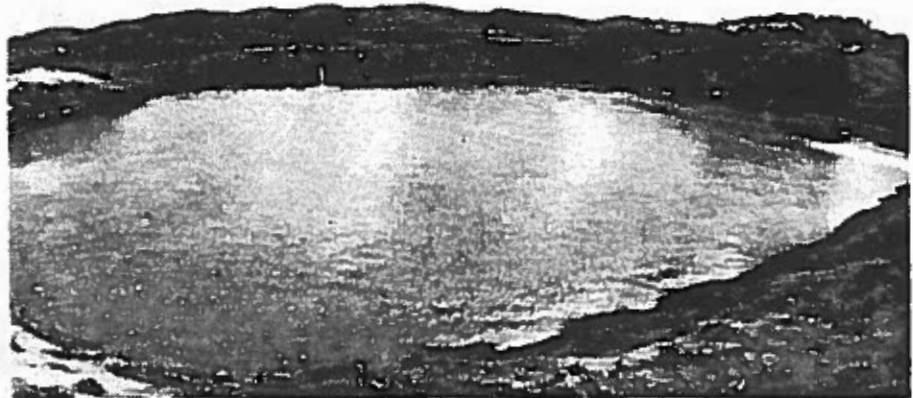
Concrete ponds utilized for the culture of tilapia at Perez farm.

Earthen ponds are constructed by the excavation of the soil from the pond area to form dikes. Heavy equipment (bulldozers and backhoes) should be equipped with LGP tracks (low ground pressure), since most ponds are constructed in areas consisting of soft soils.

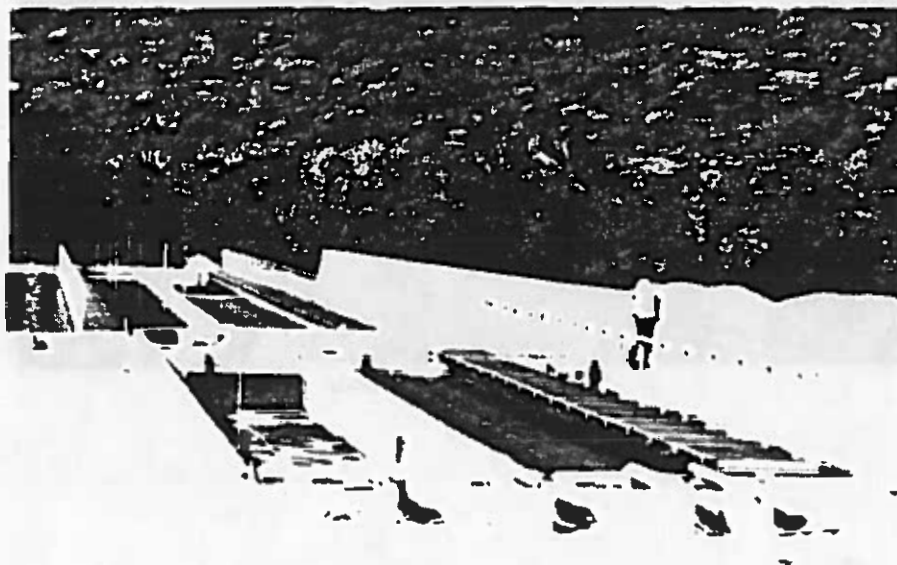
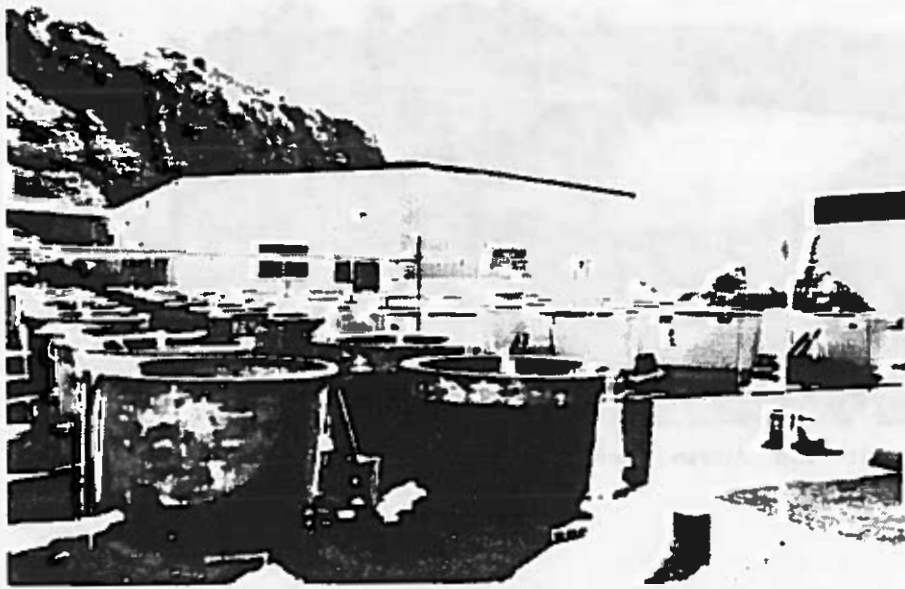


Roberto's Farm, Dan Dan, original site.

Reservoir



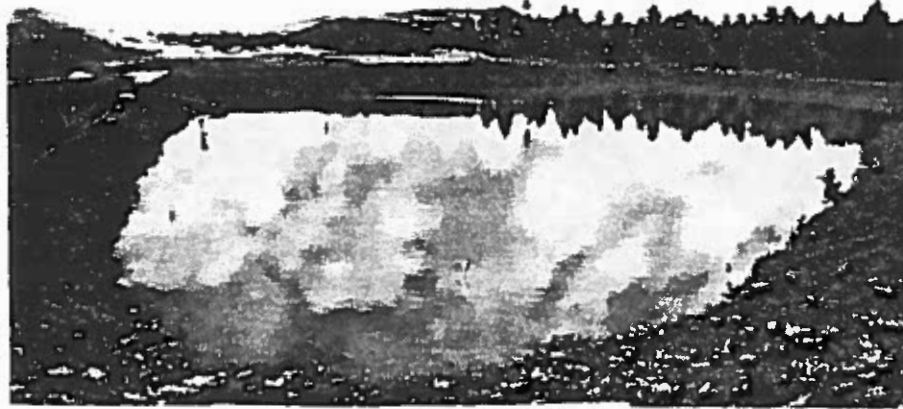
Macrobrachium rosenbergii and mullet polyculture.



Guam Aqua Research facility in Mangilao. Experimental work is conducted at this facility to develop technology and train personnel for export to farm sites throughout the world.



Giusti Farm, Ajayan River. *Macrobrachium rosenbergii* and tilapia culture.



Newly constructed ponds.



Conventionally equipped machinery would frequently become stuck or inoperative. As the soil is excavated and placed along the dikes it is firmly packed so that the bank does not allow leakage or possible breakage due to insufficient compaction. The soil should be free of vegetation, roots, and large rocks. It is preferable to minimize alteration as much as possible of the bottom and banks that are formed naturally by the terrain, since this soil is already compacted and less likely to allow seepage or breakage.

The actual lay-out of the ponds depends on the terrain. In V-shaped slightly oblique truncated valleys, small diversion ponds can be constructed. In rounded off V-shaped valleys, barrage ponds or a series of linked diversion ponds are constructed. In V-shaped valleys that are slightly horizontally truncated, strongly truncated or totally truncated the use of linked or parallel diversion ponds is recommended (Huet, 1970).



Roberto's Farm, Dan Dan. Ponds under construction at second site.

The type of soil the pond is constructed of is crucial. The soil must have the characteristic of water retention. This usually requires a minimum clay content of 25%. Fertile soils are naturally preferred, but marginal soils that are unsuitable for agricultural use can be utilized by the addition of fertilizers and lime (acidic soils). Mineral content of the soil should be examined. A high salt content can be deleterious to the culture of some species. Previous use of the land should be known. If pesticides were used the area may be unsuitable or require considerable leaching to remove the pesticide residue.

The width of the dikes depends on their use other than retaining the water. If vehicle access is required the width should be at least 6 m at the base and 3 m at the berm. Dikes separating ponds running parallel to each other can be of a reduced width if they are not intended for vehicle passage. The dikes should be seeded with a grass to prevent erosion;

a low growing Bermuda-type grass is preferred. The banks at the water line should be planted with a dense mat forming grass such as *Paspalum* to prevent erosion of the banks by waves. The planting of vegetation with large wood root systems is discouraged, since this weakens the dikes and facilitates leakage.

The slope of the banks varies according to the size of the pond. For ponds of the 0.1-1.0 ha size, an inside slope of 1:2 and an outside slope of 1:1 is recommended. Larger ponds require a 1:3-1:4 inside slope. The main purpose of sloping the banks is to reduce erosion of the banks by water movement. The dike height should be at least 30 cm above the surface of the pond water. Water level inside the pond should be 0.7 to 1.2 m deep. Historic review of maximum flood water height should be made, with the subsequent construction of the appropriate dike height to prevent entrance of flood waters into the pond. The soil Conservation Service of the USDA can conduct studies that provide such information and can make technical recommendations on the construction of ponds to prevent erosion and flooding (refer to section on Federal Assistance).



Culling of prawns

The pond bottom should have a slope of 0.2 to 0.5% towards the drain. It should be uniform in construction with no pot holes or roots remaining. It should also be compacted if possible while being bulldozed. A collection basin may be constructed at the drainage site. This basin should not exceed 10% of the pond area. The collection basin is of assistance in semi-automated harvesting where a fish pump is utilized to remove the harvest from the pond to containers on the bank for rapid sorting and sizing. The pond should also be capable of complete drainage to facilitate eradication of undesired species, control of disease problems, and mineralization of the bottom soil.



Harvested eels being sorted and held off feed for 24 hours prior to

icking of live eels for shipping. Iced water is used to
 over the metabolism of the eels for shipping.



Feeding of eels on a high protein diet especially formulated for eels. (Photo D. Crisostomo)

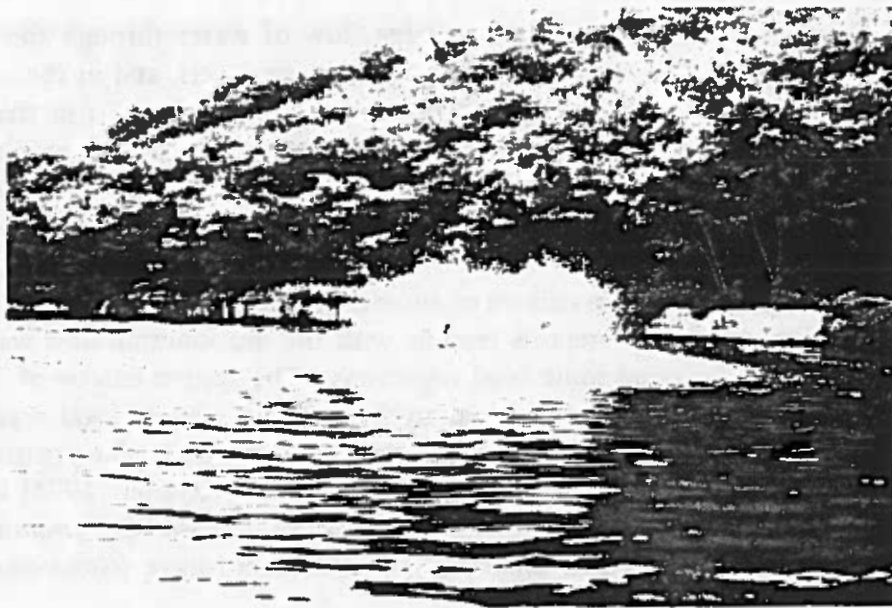
Water addition to the pond is usually done at the end opposite to the drain. Dispersion of water is in a manner to prevent erosion to the bank and bottom. Aeration is accomplished by splashing or spraying the water as it enters the pond. Various types of aerators to maintain the pond's oxygen level are available. The water source should be screened sufficiently to prevent introduction of unwanted species. It should also be free of pollution (e.g., pesticides, petroleum products, sewage or other waste products).



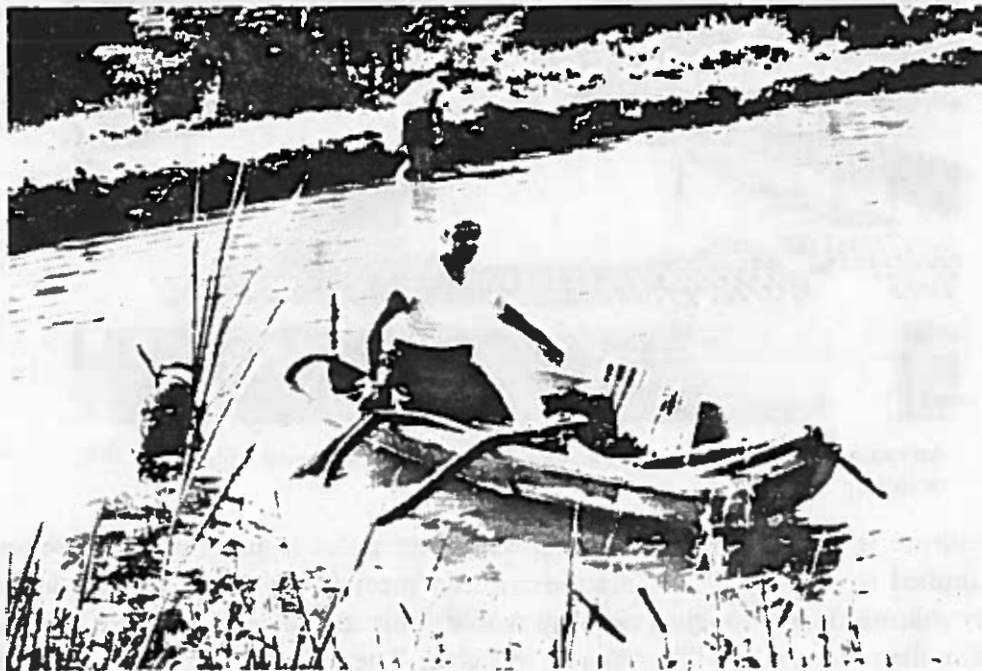
A portion of *Macrobrachium rosenbergii* harvest (photo by D. Crisostomo)

Drains (e.g., sluice gate, monk, or stand pipe) also vary in design and construction. However, the basic functions are to control water level (overflow), prevent escape of cultured fish (also introduction of undesired species from drainage canals), and to allow complete drainage to the pond. The preferred flow of water out of the pond is in such a manner that the bottom water is drained. Each pond should have its own drainage system that empties into a drainage canal. It is ill-advised to link ponds through the drainage, since this decreases management efficiency, and also increases the possibility of spreading disease through all the ponds.

Culture of species in impoundments where a stagnant water flow method is used would impose the least direct burden on the environment due to its limited discharge (except during complete harvest). In addition, it requires the least amount of water resources to maintain the system. Flow-through systems for species requiring a very high water quality or so intensely stocked that a continual flow is necessary to maintain basic water quality requirements would be a means of culture that discharges a continual and often substantial quantity of waste water.



An electric powered paddle wheel used for aeration and water circulation at the eel farm, Inarajan

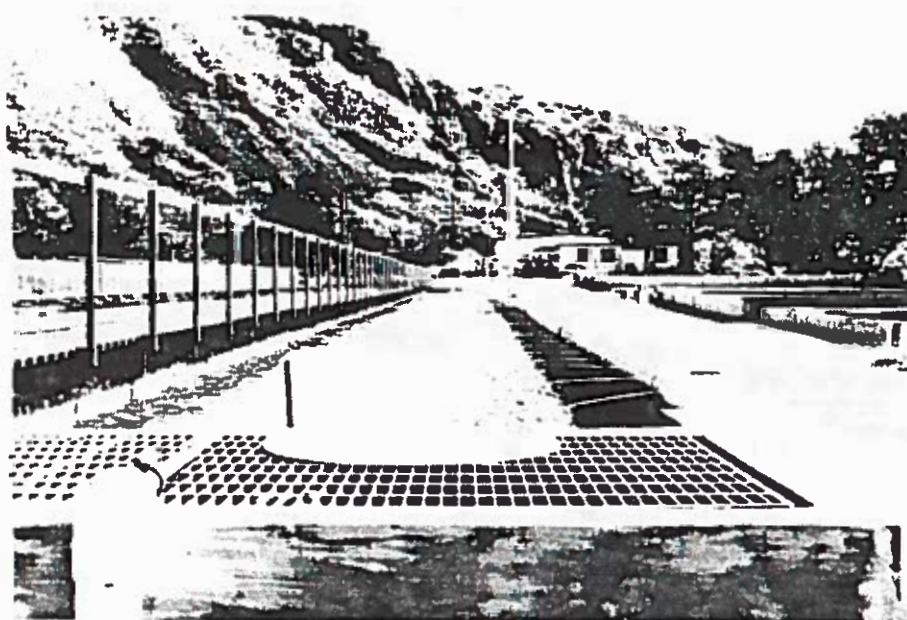


An unconventional method of aeration applied during an oxygen depletion at the 4-H pond. (Photo D. Crisostomo).

RACEWAY CULTURE

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 designed raceways the movement with the current of species of fish that tend to continually swim. Raceways are commonly used in trout and channel catfish *Ictalurus punctatus* culture. Due to the high water quality maintained in raceways, the stocking density is greater than that used in ponds, thus giving a higher production per unit area.

The application of a raceway to the culture of aquatic organisms can be diverse. Culture of filter feeding organisms (e. g., oysters) is feasible with the introduction of a water source containing a high density of planktonic food organisms. The system can be of an open or closed circulation type with flow rates suited to optimize delivery of food organisms, removal of waste products, and maintenance of a desired oxygen level. The practice of polyculture is feasible within a raceway system as demonstrated by Ryther (1975) in the production of fish (*Pseudopleuronectes americanus*), shellfish (*Crassostrea virginica*, *Mercuraria mercenaria*), lobster (*Homarus americanus*), and macroalgae (*Gracilaria foliifera*, *Agardhiella tenera*) within a raceway system.



An example of raceway culture (Guam Aqua Research) can be utilized for fish or shrimp culture.

Raceway culture is a sophisticated capital intensive means of aquaculture. Its use on Guam could be applied to both fresh and marine-cultured species. However, the requirements of large water volume flow through a raceway would limit its use in most cases especially for freshwater, unless the water is filtered and recycled. The major restricting factor in the use of saltwater for marine species in such a system would be the cost of pumping, not the supply.

FLOATING CAGE CULTURE

This method of culture originated in Cambodia and has spread throughout the Mekong River System. Modified versions are used in the culture of numerous species both in fresh and marine waters throughout the world.

Cage culture allows the utilization of an existing body of water (lake, river, ocean) for the culture of species that will tolerate intense stocking in a confined space. This method of culture has the advantage over pond culture of usually requiring less initial capital investment. Operational expense can also be less (e. g., no water pumping expense); however, the life expectancy is less than that of a pond. Frequent cleaning of algae growth and fouling organisms from the cage is necessary to prevent obstruction of water circulation, which is necessary to flush wastes and renew oxygen levels.



Experimental cage culture of siganids conducted by the Marine Laboratory.
Located at the Cabras Island power plant water intake channel.

Greater stocking densities are usually practiced in cages than ponds. Thus a species to be suitable to this type of culture must tolerate crowding. Examples of species that are used in cage culture are *Pangasius sutchi*, carp, sea bass, grouper, and red snapper.

The sizes of cages vary from a cubic meter to 625 cubic meters, which are essentially floating cages upon which the entrepreneur lives in a hut. A practical size range for use on Guam would be 10 m³ to 200 m³. A cage can be constructed of a number of materials, but the type that would be suitable to Guam would basically consist of a framework forming the structural shape of the cage, around which a netting material is attached to form the enclosure. This structure is attached to floating devices, or fastened to poles secured into the substratum where a tidal fluctuation does not occur. The net must extend beyond the water surface sufficiently to prevent the escape of the fish or introduction of undesired species. In cases where species tend to jump (e.g., *Pangasius sutchi*) netting must be extended over the top.

On Guam, the utilization of cage culture can contribute very substantially to the total aquaculture production. For example, obtaining the use of a portion of Fena Lake for the purpose of fish cage culture would be a productive means of utilizing an existing asset. Possibly, a cooperative venture could be arranged with the Navy, who controls the lake. In addition, it could be used to augment production within dammed areas adjacent to large fish culture operations. This culture method would be very applicable to marine species also. In most cases this is the preferred method, since it does afford a higher degree of management as compared to penning in an area of a reef flat. However, the use of cages in the marine waters would require that they do not obstruct passage of vessels. Areas where this might be practiced would be in Apra Harbor (i. e., Sassa Bay, Piti Channel).

The application of cage culture within aquaculture ponds can be utilized in cases where the culture of two or more species within the same body of water would be disadvantageous. This method of culture would allow the utilization of the portion of the three dimensional space that is afforded in a pond to its maximum and would be a means of increasing total production from an area while maintaining a high degree of manageability. Such an application in prawn ponds would be practical. The prawns utilize the bottom and sides of the pond while the open water space of the pond is not inhabited by the prawns and can be utilized by species of fish. This utilization of the total pond area is carried out in the currently practiced polyculture of prawns with carp on Guam. However, species such as tilapia or carp that do present different management problems when unconfined within a prawn pond (e. g., with carp in the harvesting procedure, and with tilapia in the direct competition for the prawn supplemental feed) could be cultured in cages within the prawn pond under controlled management with fuller utilization of the three dimensional space and increased total production per pond area. Additional substratum would also be provided by the cages which could be utilized by the prawns. Such culture methods are under investigation by Aquatic Farms Ltd., Hawaii.

RAFT AND STICK CULTURE

Raft and stick culture methods are used for oysters and mussels. Stick culture being limited to shallow water. Oyster spat that have settled on collector shells are attached to a stick

which is anchored into the substratum. This method of shellfish culture is susceptible to predation by benthic organisms and aerial exposure due to tidal fluctuation.

The raft culture method is more productive per area and a more manageable means of culture than stick culture. This consists of a raft constructed of cross-members (usually wood) which are floated (e. g., attachment of 55 gallon oil cans). From the crossmembers are hung the culture lines. The materials used for construction and design vary.



Raft culture of the oyster *Crassostrea gigas* at the mouth of the Talofoto River.

SUPPORT SERVICES

Aquaculture as an industry must compete with numerous other industries that have the advantage of being well established in the financial world. Aquaculture is still a new industry in the United States and does involve a higher risk factor than most established industries. To encourage investment in aquaculture there must be a well defined governmental policy of supporting aquaculture. This has been accomplished in Hawaii's growing aquaculture industry by a number of legislative laws to support the industry (e.g., Act 195, Act 226, Act 111, Act 27). This governmental policy of support to the industry has recently been implemented in the California Aquaculture Development Act of 1979. Since aquaculture is a means of developing Guam's natural resources in a conducive manner while expanding the economic base, it should be subsidized by low interest loans, grants, the removal of excessive legal and permit restrictions, a vigorous supportive governmental policy and the development of necessary infrastructure to assure the expansion of this new industry to its full potential.

The socio-economic climate in which the aquafarming business is to be conducted can be a major determinant in the success of the venture (Webber and Riordan, 1976). The attitude of government regarding industrial versus agribusiness development can also be a significant influence on the success of an aquaculture venture. Policy regarding incentive programs, such as the abatement of import duties on essential equipment and supplies, income tax abatement, or deferment, the legal structure regulating the use of the coastal zone or wetlands, land use and water resource patterns of development, and the availability of concessions for public lands and water are all important contributors of the technical and economic management decision regarding the choice of a site for aquaculture development.

FINANCIAL SUPPORT

Financial support and incentives to the development of aquaculture are essential. This should come in a variety of forms. The Government of Guam should be supportive in supplying needed infrastructure to the grow-out farms and establishing marketing avenues (local and foreign) for the products produced. This should be accompanied with technical support in the form of extension service to the farms and development of new and innovative techniques to assist the farmers with technical problems encountered in the culture of the various species. The research portion of the industry will be mainly the responsibility of government rather than private businesses in the early phases of development on Guam, since the low expected immediate return from research as compared to other investments makes such financial endeavors uninviting to small businesses with limited capital reserves.

A recent study completed entitled *Recommendations for an Aquaculture Financing Program for the Territory of Guam* (Warner, 1980) examines the financial needs of aquaculture on Guam and provides possible avenues of supplying the required financial assistance. The recommended avenue is through a government development loan with low interest and an extended repayment period. A general principle that applies to government credit is that it should be extended only if other credit facilities are not in a position to meet the financial need, or the extent required, and as rapidly as desired. Government credit and other

financial assistance, therefore, has a main role in helping to develop pioneer ventures such as aquaculture, operations which the private banking system will shun because it lacks a gauge for assessing the risks. Such a program of financial assistance to the development of aquaculture has been established in Hawaii. The Hawaii State Aquaculture Loan program can lend up to \$175,000 to an individual.

The current alternative means of obtaining a loan for aquaculture are very limited. Guam Economic Development Authority (GEDA) under Public Law 9-257 created the Agricultural Development Fund in 1969. The funds were limited to \$100,000 with loans granted to be charged an annual interest rate of 3%. At present, the remaining funds amount to \$15,000. Warner's (1980) study points out the need for revamping this GEDA loan program with a minimum funding of \$500,000 to \$600,000 and a variable interest rate not to exceed one half of the prime rate. However, the remaining balance in the Agriculture Development Fund is intended to be used to replenish the Agriculture Expense Insurance Fund to which \$25,000 was appropriated by Public Law 15-65 Section 1. The General Development Fund Act (GDFA) is GEDA's main financing fund. This fund can provide loans to agriculture and fisheries ventures, including aquaculture. The interest rate on loans from the GDFA is based on the interest rate quoted monthly from the U. S. Treasury plus a 1% service charge (e. g., interest rate for June 1981 - 15 5/8%). The applicant must show that he was unable to obtain private financing to be eligible. This program even though usually with enough capital is beyond the financial means, with its high interest rate, for the average aquaculture farmer and will not serve the needs of the aquaculture industry.

The Department of Agriculture administers the Farmers Small Loan Revolving Fund which was established by Public Law 9-121 and later expanded by Public Law 11-119 (1972). The appropriation amounted to \$350,000. Loans were limited to a maximum of \$10,000 per borrower with an annual interest rate of 2% and a maximum repayment term of ten years. The fund currently has less than \$11,000 with several loan applications pending. This fund is expected to be exhausted shortly without new appropriations.

An aquaculture operation should be eligible under either of these programs, since the interpretation of farming and farm production can include aquaculture. Both agencies are very interested in encouraging aquaculture development. However, neither of these loan programs in their present status are capable of making loans of the needed amounts to develop even a minimum scale economically viable aquaculture farm.

Guam Growth Council has received funds amounting to \$300,000 from the U. S. Department of Commerce, Economic Development Administration (Title 9 grant). This is for a Small Business Revolving Loan Fund which is administered by the Guam Growth Council and coordinated with the Guam Economic Development Authority, the Department of Commerce and several island banks for the evaluation of loan applications. Government of Guam's economic development priorities which stress growth in tourism, manufacturing, agriculture and fisheries will guide the Council in evaluating applications. Aquaculture would be considered as a high priority. Interest rates are 2% below the prime lending rate. However, the majority of the funds have been committed so that this program will not have funds available until the current loans are recycled (tentatively 1983 to 1984).

The significant expansion and extensive amendment of these programs would be of assistance in making funds available to aquaculture development; however, the most appropriate and beneficial method would be the enactment of the recommended Aquaculture Loan Program (Warner, 1980). This proposed program involves the appropriation of \$800,000 to fund capital improvement loans and \$400,000 for operating loans. This is based on the financial requirements for the development of 100 acres of ponds. The qualifications, terms, equity required as well as a draft of the legislation to create the Aquaculture Loan Program is included in Warner's (1980) study. Figure 10 presents a four phase implementation of this recommended loan program in relation to the development of the aquaculture industry as a whole. Phase I through IV are based on the progressive distribution of funds according to the growth of the "Farm Development" Sector of the industry. That is, as the number of pond acreage increases, the fund is increased proportionately in advance of the next phase of development.

Federal sources of loans for aquaculture farms are limited and are full of bureaucratic inadequacies which makes the obtaining of these loans difficult and frustrating for the small aquaculture entrepreneur. These inadequacies usually become immediately evident by the lacking information provided by these federal agencies (located on Guam) on the prospects and requirements of obtaining a loan for an aquaculture enterprise. This was pointed out in the recently completed study entitled, *The Role of the U. S. Department of Agriculture in Aquaculture* by the National Research Council (1979) that states, in the granting of aquaculture loans "there may be problems in communicating to local personnel of the Farmers Home Administration that they have such authority. Further, local FmHA personnel are inexperienced in assessing individual aquaculture applicants...." This should change in time with the increasing awareness of the aquaculture industry's needs both on the national and local level.

The federal government at present does not have loan programs specifically designed for the needs of aquaculture; however, existing agricultural business and industrial loans have been extended to include aquaculture enterprises. The U. S. Department of Agriculture, Farmer's Home Administration does have programs that can be made available to an aquaculture project. FmHA has both insured loans (direct loans) in which FmHA is the actual loaning body, and they have guaranteed loans in which the loan is made through a private lender and FmHA guarantees up to 90% of the loan. With guaranteed loans the commercial bank sets the interest rate at or above the prime rate, while in the insured loan the interest rate is usually below the prime rate with the amount depending on the actual loan program applied for. These loan programs that are available to an aquaculture enterprise are:

- 1) Farm Ownership Loans,
- 2) Operating Loans,
- 3) Emergency Loans,

- 4) Economic Emergency
- 5) Soil and Water Loans,
- 6) Business and Industrial Loans,
- 7) Resource Conservation and Development Loans,
- 8) Recreational Loans; and
- 9) Farm Labor Housing Loans.

The various programs have requirements and limitations on their use. A special classification of a "limited resource applicant" allows an applicant that qualifies under the Farm Ownership and Operating Loan programs, that shows limited resources, and the need for a special low interest loan to obtain an Operating Loan below the interest rate normally charged by FmHA for this type of loan.

The Federal Small Business Administration (SBA) can make loans to an aquaculture enterprise, but in general these loans are not as commensurate to the needs of an aquaculture farm as the loans available through FmHA; however, they are of assistance especially to those entrepreneurs who have incorporated, or formed partnerships and may be leasing land instead of outright ownership. SBA has direct and guaranteed loan programs. However, since the local SBA must compete nationally for funds their funding source for direct loans is limited and as a consequence their direct loans are set at a maximum of \$25,000 per borrower. As with the FmHA the SBA guaranteed loans are made with the cooperation of commercial lenders at interest rates at or above the prime rate. These types of loans do not meet the needs of an aquaculture farm of low-interest rates and consequently will not assist in meeting the financial needs for the development of aquaculture.

The availability of risk capital from private investors and corporations has become scarce in recent years due to the economic trends in the U. S. The before-tax rate of return required by such investors has increased due to macroeconomic instability (e. g., inflation and recession). The actual rates of return have not risen proportionately with the rates of return expected on investments. The inflation spiral, increasing pressures and expenses in the areas of new environmental and safety requirements, uncertain supplies, and energy costs attribute to this shortfall.

The availability of credit that meets the needs of an aquaculture farm will be a key element in the implementation of future plans for aquaculture development. With the unlikelihood of receiving and the financially (high interest rates) unbearable nature of loans from commercial lending institutions, along with the limited sources of funds, difficulty of obtaining loans from federal agencies, and the current inadequacies and unavailability of local governmental development loans, there is needed a financial assistance program to meet the industry's capital requirements.

The Government of Guam through the Guam Economic Development Authority (GEDA) provides for a number of investment incentives to corporations whose activities will create vitally needed facilities, generate new employment, or aid in import substitution and/or reduction in consumer prices. A corporation engaged in agriculture activities which would include aquaculture is eligible for a Qualifying Certificate. The incentives available under this program include the following:

- 1) Rebate of up to 75% of all corporate income tax payable to GovGuam for up to 20 years.
- 2) Rebate of up to 75% of income tax on dividends for up to five years.
- 3) Abatement on taxes levied on income derived from lease of land, building, machinery and equipment for up to ten years.
- 4) Abatement of real property tax up to ten years.

There is an option to double the time authorized on the above incentives by electing to take 50% of the described rebates and abatements.

Recommendations (Financial Support):

- 1) Establish the Guam Aquaculture Loan Program
 - a) To insure the loans are productively used, they should be accompanied with technical service (e. g., construction, how to increase production, and disease control) supplied by either the Lead Agency or CALS.
- 2) As an alternative to the preferred establishment of the Guam Aquaculture Loan Program, the existing Farmers Small Loan Revolving Fund administered by the Department of Agriculture should be consolidated with the Agriculture Development Fund administered by the Guam Economic Development Authority (GEDA) with the revision of its rules and regulations and the inclusion of aquaculture. This combined loan fund should be adequately refinanced. GEDA and DOA should jointly administer the loan program. DOA (and/or the Lead Agency) should serve mainly in the evaluation of the technical feasibility, review the use of the requested loan and once the loan has been granted provide periodic on site review of progress and the additional technical support as needed. GEDA should review and maintain the loan from the financial aspect, which would include payment collection.
- 3) Provide an interest rate subsidy program for commercial loans that are guaranteed through GEDA.

AQUACULTURE INSURANCE

Aquaculture does involve a certain amount of risk. Even in the more established cultured species there is risk of loss from epidemic disease outbreaks, pollution, equipment failure, poaching/vandalism, and weather (e. g., flooding and typhoons). An insurance program should be made available to aquaculturists that will compensate for a portion of the loss. Since an insurance program that covers the total possible loss that a farmer may encounter under any of the previously mentioned catastrophies would place the premium cost out of the practical range, a medium should be sought to insure the farmer from a total loss and provide enough compensation for him to continue operation with proper management.

Insurance against stock loss should be set at a minimum loss required before the underwriter becomes liable. This is to the long-term advantage of the more efficient and well managed farms that normally will not sustain losses in excess of 10% in a single incident except in the mentioned cases of catastrophic losses. A suggested minimum loss level is 25%. This will discourage large premiums due to excessive small claims that could add up to a negative cash flow for the underwriter at rates that are reasonably accepted by the farmers.

The Guam Economic Development Authority does have a limited crop expenditure insurance program for agriculture, the Agricultural Expense Insurance Fund. This is limited to the actual expenditure accrued by the farmer during planting (seed, fertilizer, and labor) and does not include the actual value or potential value of the crop at the time of harvest if the damage did not occur. The premium is 3% of the crop value, with the maximum insurance issued per crop being \$5,000. This program does include aquaculture crops but should be expanded to reflect the high operating costs and the high value of the aquaculture product and therefore the maximum insurance level should be raised appropriately, and should be expanded to a full crop insurance program.

Aquaculture crops, even though they may sustain some damage during large tropical storms and typhoons due to Guam's exposure to such weather conditions, are less susceptible to losses as compared to field cash crops. This is an important fact, since frequently hundreds of thousands of dollars are lost annually in field crops from tropical storms alone. This is exemplified in recent years by tropical storm Tip (1979) with a loss of \$2,199,016 in agriculture and \$30,554 in aquaculture and fisheries and in 1980 tropical storm Orchid caused a loss of \$900,000 (Department of Agriculture) which together amounts to a very significant amount of the annual wholesale value of actual crops produced. This factor of resistance to storm damage should be taken into favorable consideration when determining insurance premiums for aquaculture.

The recently enacted Federal Crop Insurance Act of 1980 improves and expands the Federal Crop Insurance Program (see Federal Crop Insurance Act of 1980 under Federal Agencies' Aquaculture Support Programs). Since this program now includes Guam and provides

coverage for aquaculture crops, this will be of significant assistance in the development of an aquaculture industry on Guam once the program is implemented. However, since there is no established USDA office on Guam for the administration of this program and the current austerity program within the Federal government, the realization of the benefits from this new Public Law may be deferred for a number of years. The implementation of this Federal program on Guam should be actively pursued while in the meantime the local insurance program should be improved to meet the present needs of agriculturists and aquaculturists.

A private international firm based in England, Aquaculture Insurance Service, Ltd., has stated its willingness to insure aquaculture operations on Guam. However, the premium from private underwriters can be prohibitively expensive for the average farmer (Secretion, 1978).

A minimum level of competence and experience must be mandatory for the aquaculturists to be insured. This is to guard against the likelihood of poor management and misuse of an insurance program, and the continued existence of inefficient farms. Minimum standards should be formed regarding the physical design of the farm to assure its ability to withstand normal physical and environmental characteristics of the site (e. g., heavy rains, runoff, high winds).

Additional aspects of each individual aquaculture business should be considered by its management for insurance through commercial underwriters that normally handle business insurance. Such areas to be considered would include workmen's compensation and general liability. Products' liability should also be considered, since aquaculturists are primary producers and, as such, face the possibility of being found legally liable for injury, disease, loss or damage to a third party caused by their products. This applies to hatcheries producing stocking for farms as well as the grow-out farms that produce the product for market.

Recommendations (Aquaculture Insurance):

- 1) Evaluation of the insurance needs of the aquaculture farmers.
- 2) Collection of statistical data on production and evaluation of production methodology and site location in regard to determination of bases and guidelines for the premium and eligibility to an insurance program.
- 3) Revamp the existing Agricultural Expense Insurance Fund to a full coverage insurance program. This should be provided as an interim program until the establishment of the USDA program provided for in the Federal Crop Insurance Act of 1980.
- 4) The expedient establishment of the Federal Crop Insurance Act of 1980 on Guam with its full program and benefits available to farmers and the aquaculturists.

- a) Efforts to implement the program should come from the Governor's office and Guam's Congressional Representative and be directed to the Secretary of the U. S. Department of Agriculture and the Assistant Secretary of Territorial and International Affairs.

HATCHERY

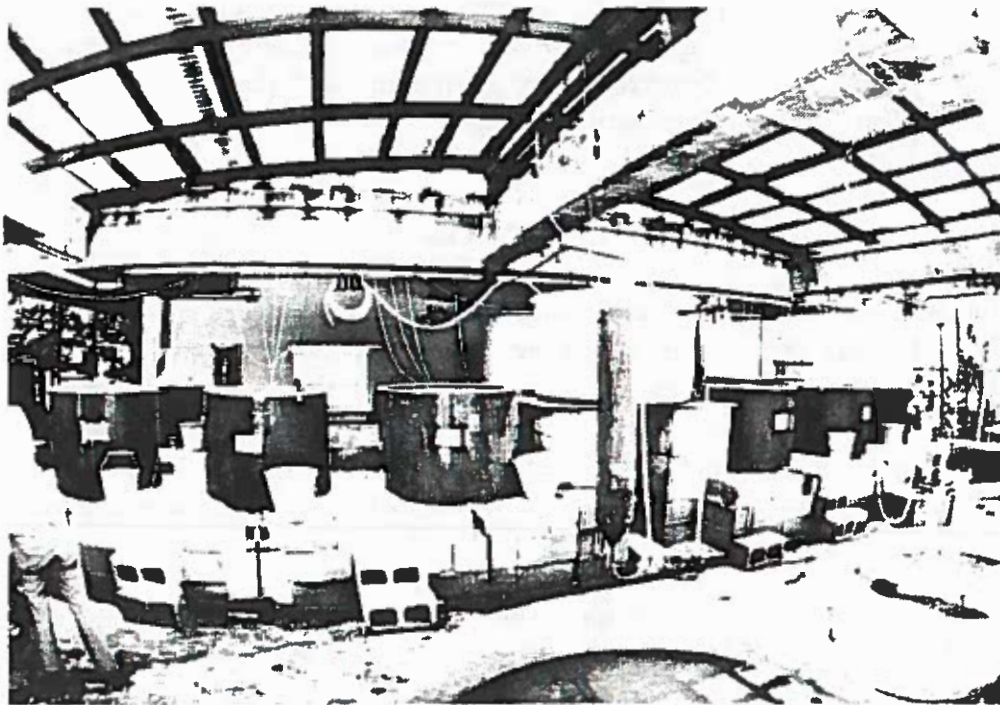
The lack of an on-island hatchery to provide the postlarval and fry stages of the various species cultured is the single major constraint to the development of the aquaculture industry on Guam. The Government of Guam has a great interest in establishing a viable prawn industry and is seeking funding at the federal level for the construction of a hatchery. The proposed government permanent hatchery estimated to cost \$620,000 (1981 estimate) has received a high priority rating in the 1979 and 1980 Overall Economic Development Plans.

With the realization of this constraint on the aquaculture industry placed by the absence of an on-island hatchery, the Government has passed an appropriation of \$25,000 to fund the construction and operation of a temporary hatchery located at the Marine Laboratory (P. L. 15-129 Section 30). The hatchery is intended to operate to meet the minimum needs of the existing farmers until a permanent hatchery is constructed and becomes operational.

The function of a government operated hatchery should not be limited to the production of postlarval and fry of cultured species even though this is its prime concern. It should play an integral part in the extension service program (CALS), which is necessary to coordinate hatchery production with the farmers' needs. It should also actively participate in a training and continued education program for the aquaculturist, prospective aquaculturists, and the interested general public. This training and continued education program as proposed (see Manpower) includes CALS and AHRD. The hatchery would also be involved in the research and development program (see Research and Development) and will be an important part of the gathering of data and disseminating that information to the public. Thus the hatchery will form the integral base to the aquaculture industry.

The hatchery could also assist regional development of aquaculture to the extent of providing postlarvae and technical assistance for nearby Pacific Islands (e. g., Northern Marianas) that develop a limited size aquaculture industry that would not justify the investment into a fullscale hatchery for each island.

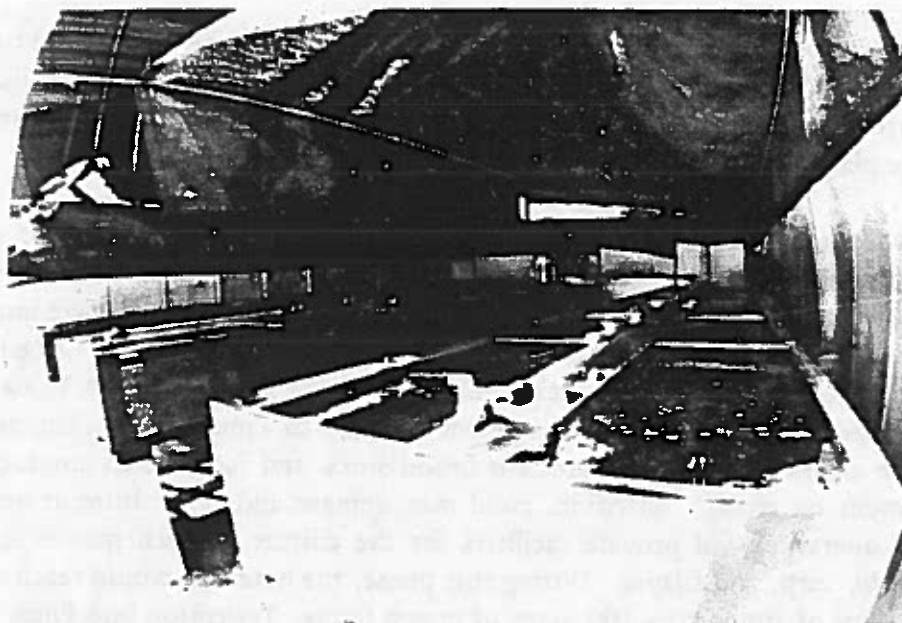
A private hatchery as part of the aquaculture industry should be considered as a viable part of the industry. The construction and operation of a hatchery by the private sector or a cooperative is an alternative to a government hatchery as the industry expands and presents an adequate market for the hatchery products to allow the operation to be economically



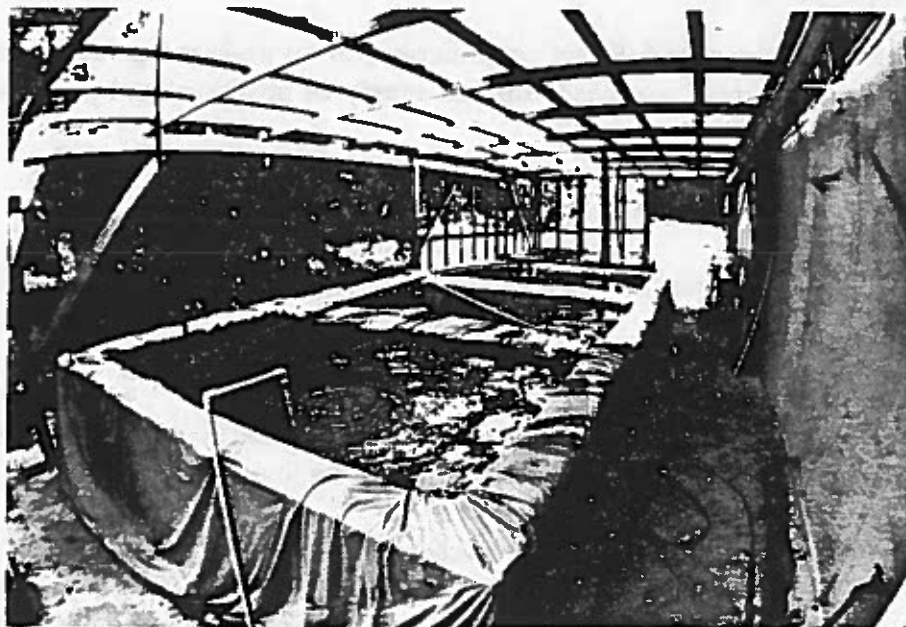
The temporary prawn hatchery located at UOG Marine Laboratory. Annual production capacity is 1.0 million *Macrobrachium rosenbergii* postlarvae.



Macrobrachium rosenbergii postlarvae (6 - 10 mm long).



Roberto's experimental pilot prawn hatchery, Piti.



viable. Experienced entrepreneurs in hatchery operations should be encouraged to establish such a facility with assistance of low interest loans and other incentives to establish a hatchery. To assure a minimum quantity of postlarvae and juveniles at a reasonable price conditions could be placed upon such a loan and incentive package.

The hatchery operation is proposed in a number of scenarios (see Section IV). The main emphasis of the hatchery in Phase I (Figure 10) is to produce *Macrobrachium rosenbergii* postlarvae; however, the production of secondary species (e. g., carp) that are important to the economic viability and pond management of prawn ponds should be placed into production on a limited basis as the facilities will allow in the initial stage. A Phase II for the hatchery is proposed so as to expand the prawn hatchery to a multi-species hatchery, which would include an earthen pondage area for brood stock and facilities to conduct research and development on growth, nutrition, pond management and the culture of new species. The Phase II operation will provide facilities for the culture of such species as penaeids, *Pangasius sutchi*, carp, and tilapia. During this phase, the hatchery would reach its original designed capacity of support to 100 acres of prawn farms. Transition into Phase III, which is an expansion of the hatchery's capacity, calls for a decision to continue as a government operated hatchery or to turn the hatchery's operation over to a qualified private group or cooperative.

As presented in Figure 10 there is an interplay between the hatchery, farm development, market development and financial assistance. This relationship in time among the integral parts of the industry is important to the timely implementation of the various phases.

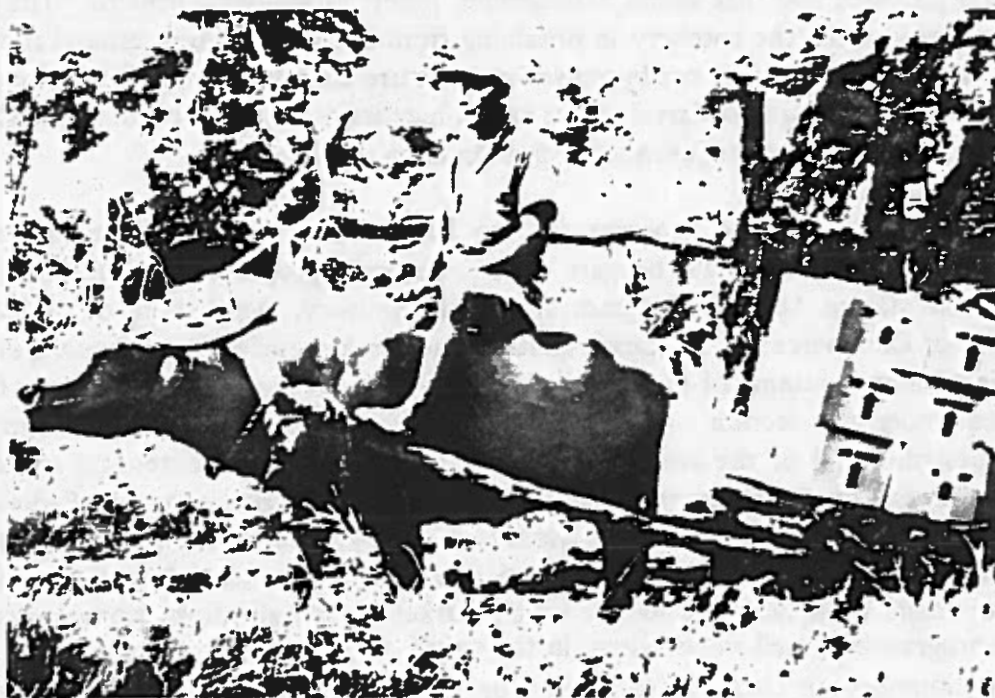
Recommendations (Hatchery):

- 1) The establishment (A/E and construction) of an on-island government operated hatchery to meet the needs for the supply of postlarval and juvenile stages of species cultured.
 - a) Secure funding from a federal agency in the form of a grant; or
 - b) Secure funding from a federal agency in the form of a loan; or
 - c) Appropriate funds from the local general fund.
- 2) The establishment of an on-island private operated hatchery with government assistance in the form of a grant or low interest loan.
 - a) Such a privately operated hatchery with funding from a government source should consist of a cooperative of the user group of the hatchery product. This will deter the establishment of a monopoly or the preferential treatment of one farmer at the expense of others.

- 3) The establishment of a privately operated and funded hatchery.
 - a) Such a hatchery would most likely be associated with its own grow-out facilities. The excess production of postlarvae or juveniles could be sold to other farmers.
 - b) Adequate incentives should be provided (e. g., low interest loan, lease of government land, GEDA Qualifying Certificate), but with covenants to insure a minimum quantity of postlarvae and juveniles at a reasonable price.

EXTENSION SERVICE

A strong extension program is essential no matter whether the industry consists of large scale corporate farms or small scale family oriented farms, even though in the latter case its importance is paramount. The aquaculture extension program should be through the College of Agriculture and Life Sciences (CALS). CALS has the internal structure for such a



Prawn postlarvae airfreighted from Hawaii for stocking of ponds in Inarajan are transported through muddy terrain by a more traditional means of transportation.

program which includes the training of farmers in the various skills necessary to operate an aquaculture farm. Currently, there is one aquaculture extension agent on the staff; however, additional staff with field experience and qualifications that covers the knowledge and skills required to fully service an aquaculture industry will be necessary.

Funding for such a technology transfer program could be obtained through the Science and Education Administration-Extension Service of the USDA. There is a program that provides instructions and practical demonstrations in agriculture, home economics, and related subjects (including aquaculture) to encourage the application of such information by means of demonstration and publication to persons not attending the college.

The extension service must be closely coordinated with the hatchery operation. Preferably the extension agents should be stationed at the hatchery. This is necessary to fully coordinate the hatchery production with the requirements of the farmers.

The on site assistance provided by the extension service should include recommendations on site suitability, pond design and construction, water quantity and quality, species to culture, stocking density, feeding rates, fertilization of ponds, disease problems, harvesting and general farm management. Aside from the periodically scheduled visits to the farm, the agent must be able to respond quickly to emergencies at the ponds (e. g., low oxygen). The services of the extension agent will be necessary in the follow-up of loans made from the proposed Aquaculture Loan Program. The agent will also assure that proper advice and assistance is provided and that sound management practices are being utilized. The extension agent should assist the hatchery in obtaining from the various farms around the island an adequate supply of gravid female prawns and mature animals of other species cultured that will be raised through the larval stages at the hatchery. The agent would then be responsible for the delivery of the juveniles or postlarvae to the farms.

The training and information program for the farmers and those interested in entering aquaculture as a business should be part of the extension program and coordinated with the Sea Grant Marine Advisory Program, Marine Laboratory, Department of Agriculture, Department of Commerce (or the Lead Agency), and other agencies that may contribute to the information and training of personnel. The training program should follow the format as outlined under the section on manpower. The extension program should provide a brochure describing all of the available assistance programs that the extension service and other Government of Guam agencies can provide in aquaculture along with Federal programs and activities that are available to assist or that may affect aquaculture development. The extension program should also publish an *Aquaculture Quarterly Newsletter* covering the developments in aquaculture locally (e. g., market statistical information, government assistance programs) as well as elsewhere in the world as they relate to and influence aquaculture development on Guam. This would be of valuable assistance to the industry by disseminating important scientific, technical, legal and economic information that could influence and assist management in the decision making process, such as adjusting production and harvest schedules to meet the demands of the market, application of new technology or possible investment in the expansion or improvement of facilities.

Recommendations (Extension Service):

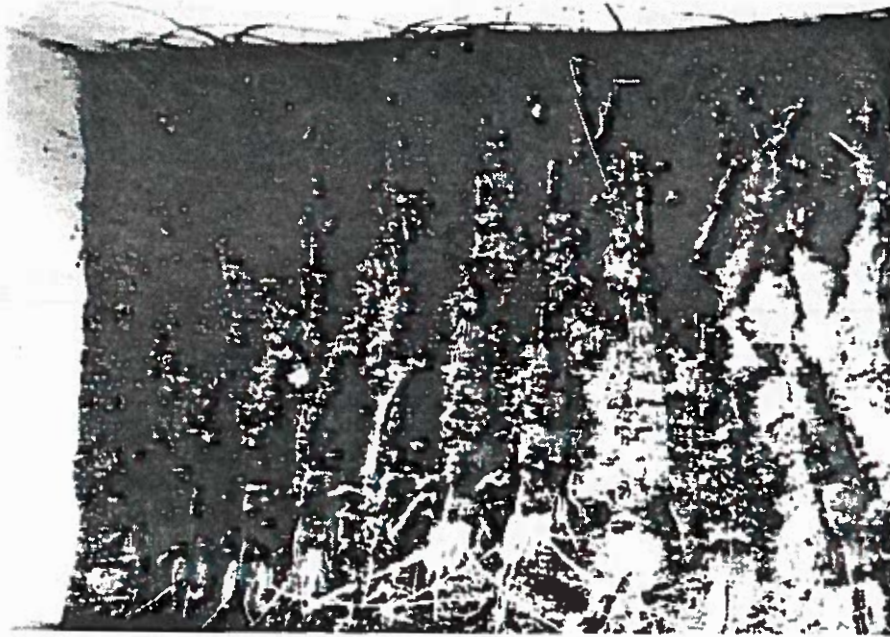
- 1) The strengthening of the extension program with coordination of services between the farms and the temporary hatchery or the permanent government hatchery when it is established.
 - a) Training program
 - b) On site assistance
 - c) Dissemination of technical information
 - d) Coordination of production and marketing
 - e) Coordinate and assist farmers in obtaining benefits and meeting requirements of various Government of Guam and federal programs and agencies.
 - f) Expand financial support to the program, through grants and federal assistance programs.
- 2) Publication of a quarterly newsletter on current relevant market and technical information on aquaculture.

RESEARCH AND DEVELOPMENT

Research and development is an important portion of the aquaculture industry. Continuous research will be needed in nutrition, biology, pond management, disease, behavior, and genetics as well as farm design and construction. Data collected in research efforts would be applied to actual operations to further develop efficiency in the use of the natural resources and increase production.

To maximize the benefits in Research and Development, a cooperative effort between the government and the private sector is necessary. Contrary to Research and Development programs established in other locations and countries that have very large tracts of undeveloped land suitable for aquaculture and bountiful water resources, Guam is limited in this respect as well as in the government's financial resources. Thus the financial burden of a Research and Development Program cannot be borne exclusively by the Government of Guam and will necessitate the obtainment of research grants. However, a pragmatic Re- other aquaculture research centers with similar physical and climatic conditions (e. g., Hawaii, SEAFDEC, ICLARM, CNEXO - COP, Taiwan, Philippines) and then adapting or modifying the most promising findings to Guam's situation would be of assistance in minimizing these fiscal responsibilities to the government. As the industry matures the private sector should become more directly involved in initiating and implementing research.

The major source of financial support to the Research and Development program should be sought through federal and private grant programs (e. g , Sea Grant, NSF, USDA, USDOC, USDO, USAID, Rockefeller Foundation).



Experiment for shipping live *Macrobrachium rosenbergii* in dry saw dust at a lowered temperature.

Research and development will be mainly a responsibility of the Marine Laboratory and the hatchery. The government hatchery as proposed will include in its Phase II development stage a number of earthen ponds which will be used to hold brood stock and conduct tests on the applicability of research results to a commercial pond situation on a limited scale. This provides the background and data for entrepreneurs to evaluate and determine if they wish to apply a new technique or species for commercial culture. In some cases further testing on a full scale commercial type operation or an expansion of the data base may be advisable to truly evaluate a new technique or species. In such a circumstance a cooperative agreement should be sought between a commercial operation, the hatchery and the extension service. Such an operation could be initiated by either group, for example if the hatchery wants to test a new species on a larger scale the assistance of a commercial farm should be sought, or if a commercial farm wishes to investigate a new species or technique that has been shown to have prospects elsewhere (outside of Guam) it may request the hatchery and extension service along with the Marine Laboratory to provide assistance. Such experimental work initiated by a government agency should be structured to minimize economic cost to the entrepreneur. The results from such studies would become public

information and will add further to the background data on the feasibility of various species cultured or the applicability of various techniques of culture on Guam. This should be the central function of Research and Development to collect preliminary data and make it available to prospective commercial aquaculture operations. This research and development information will also assist a loan agency (government or private) in evaluating a loan application by applying this information to the proposed commercial enterprise.

Recommendations (Research and Development):

- 1) Establishment of a cooperative government and private Research and Development program, with the mutual sharing of the information to the benefit of the industry as a whole.
- 2) Coordination of the government research efforts in aquaculture being centered at the Marine Laboratory and the hatchery.
- 3) Examine endemic marine fin fish for mariculture prospects e. g., *Trachuroops crumenophthalmus* (mackerel), *Coryphaena hippurus* (mahi-mahi), *Epinephelus* sp., (grouper) *Lutjanus* sp., (Snapper), *Mulloidichthys* sp., (mullet), and *Scarus* sp. (parrot fish).

FEED AND FERTILIZER

In intensive aquaculture systems the increasing costs of feed, which are attributed to the rising costs of raw materials and transportation, puts pressure on the development of economic solutions to this important problem. This rising cost applies to feed imported as a finished product or as an ingredient to be milled on Guam which will prove to be a major constraint to the development of an aquaculture industry beyond the local market. To be competitive in the potentially large foreign market for Guam's aquaculture products the cost of feed will have to be lowered. Since feed costs constitute a major operational expense, up to 30%, it will be necessary to implement studies that will lead to the reduction of this expense. Three (3) alternatives which should be considered to negate the problem of rising feed costs are:

- 1) the evaluation of nutritional needs of the various species cultured with the formulation of a specific diet that will give a better conversion rate than the previously incomplete diets;
- 2) the economical production on island of ingredients for commercial feeds to be manufactured in the local feed mill; or
- 3) the increased production of natural foods within the culture system.

deally a solution combining these three approaches to the problem of escalating feed costs would be the most desirable. This effort should be coordinated with work at other locations such as Hawaii.

The College of Agriculture and Life Sciences has a livestock feed nutrition program that is investigating the possibility of producing crops and utilizing by-products produced on Guam that could economically replace the imported ingredients that are used in the production of feed at the local feed mill. Crops that are under investigation are cassava and tangantangan (*Leucaena leucocephala*) along with the use of fish waste from the local fisheries. Utilization of by-products from such proposed projects (private enterprise) as the annelidic (earthworm) recycling of biodegradable waste products can be very useful. From this, two products useful to aquaculture would be obtained: 1) fertilizer from the waste excrement of the earthworms, and 2) protein food source from cropping off the excessive worm production. An additional food and fertilizer source for aquaculture is the utilization of sludge from the sewer treatment plant. This by-product is currently being given away to field farmers and utilized as fertilizer. This practice is not being advocated until a full analysis of the sludge is completed and its applicability to field crops as well as to aquaculture is determined. This investigation should be the responsibility of the CALS. Since this would be a recycling of a potentially useable by-product as opposed to the use of commercial inorganic fertilizers such as nitrogen, which requires high energy input to produce, the utilization of sludge could become a more prudent use of our resources as well as being an economical substitute. The full utilization of economically recyclable products should be programmed into all future projects that have the potential of producing such products. Such projects could possibly be funded under "Innovative and Alternative Programs" (IAP) from federal funding programs available to PUAG and GEPA (102 Clean Water Act see Federal Agencies).

The use of fish ponds in the purification of sewage water has been noted by numerous authors (Schuster et al., 1954; Schroeder, 1975; Schroeder and Helpher, 1976; Woynarovich, 1976). Light loads of either organic-rich raw sewage or nutrient-rich biologically treated (secondary) effluent can be channeled through an aquaculture system which would essentially be an extension of the waste treatment process. This would simultaneously derive an economic benefit in the form of fish or other aquaculture product from the system. The effluent from aquaculture utilizing waste water as part of a treatment process or the effluent from an aquaculture system not using waste water could be taken one more step in a multiple use system with this effluent and the remaining nutrients being used to irrigate agricultural field crops. The limiting factors to the use of aquaculture in waste treatment would be the presence of toxic chemicals, petroleum, metals, and pathogenic organisms above an acceptable level. Properly treated (filtered, settled, and diluted) sewage water that does not contain significant poisonous industrial pollutants is a suitable medium for fish culture.

Fish culture associated with duck, chicken, and pig rearing as the source of fertilization is common in countries throughout the world, and is an effective solution to domestic animal waste management problems. This is mainly an Asian fish culture practice, but is also a long practiced method in Europe (Bardach et al., 1972; Woynarovich, 1976) and Israel (Schroeder and Hephher, 1976); and is used on an experimental basis in the United States (Buck et al., 1976). Odum (1974) also cites a study in Israel; fish ponds serve as nutrient traps where most of the organic compounds are either precipitated, lost to the atmosphere, bound by the sediments, or tied up in fish flesh so that a minimum amount of nutrients leaves the ponds. The amount of sewage that can be put through a pond is determined by maintaining the BOD level at a safe point to prevent oxygen depletion. Daily rates of sewage addition can be in excess of 1.5 tons/ha. These sources of nutrients serve to enhance primary production along with a fauna associated with eutrophic conditions. The mineralized portion of the manure provides nutrients to the phytoplankton while the non-mineralized portion serves as a food base for zooplankton. This food source is in turn utilized by the stocked fish population (usually tilapia or carp). Utilization of carp in the treatment of nutrient enriched waste waters is practiced in Indonesia and Germany (Bardach et al., 1972). The carp feed on the natural productivity of the waters. Recent studies (Carpenter, 1974; Coleman et al., 1974; Goldschmidt, 1970; Schroeder, 1975) have indicated that fish improve the waste treatment capacity of pond systems. Utilization of fish ponds for this purpose is feasible on Guam. They also have been used in effluent wastes from dairies, sugar mills, slaughterhouse, and starch mills. Part of pond ecology and proper management is the use of species to utilize excess food thus affecting reduction of pollution, improvement of pond environment, and greater production. Yields of fish grown in such ponds, with no supplemental feeding, have been as high as 4000 kg/ha/year (Schuster et al., 1954; Schroeder and Hephher, 1976). Presently FDA regulations restrict the use of human and animal wastes in foods grown for direct human consumption. Even if the fish crop from such impoundments were not directly suitable for human consumption they could be utilized in a feed for fish or livestock that would be consumed by humans. This benefit along with the processing of sewage waste waters should stimulate investigation into the application of such systems on Guam.

Recommendations (Feed and Fertilizer):

- 1) Evaluate the nutritional needs of the various species cultured with the formulation of a specific diet that will give an optimum conversion rate.
- 2) The economic production of ingredients and utilization of existing by-products for the formulation of commercial feeds in the local feed mill.
- 3) The determination of methods to increase production of natural foods within the culture system.

- 4) The investigation into alternative fertilizers includes the use of agricultural and industrial by-products.
- 5) Investigation into the application of aquaculture in the treatment and utilization of sewage waste.

ESTABLISHMENT OF A FISH HEALTH MONITORING PROGRAM

The introduction of exotic species for the purpose of aquaculture is a necessity on Guam for establishing a viable aquaculture industry. Candidate species for introduction should be carefully evaluated with regard to their ecology, behavior, reproduction, and potential marketability prior to importation. An Animal Import Screening Committee has been established to review all intended importations of new exotic species to Guam. This includes aquatic species. This Committee is composed of representatives from the government and private interest groups as follows:

Aquatic and Wildlife Resources (DOA)
Forestry Division (DOA)
Animal Industries (DOA)
Marine Laboratory (UOG)
College of Agriculture and Life Sciences (UOG)
Guam Environmental Protection Agency (GEPA)
Guam Customs (DOC)
Public Health
Private Pet Store Owners

Indiscriminate introductions can be detrimental to endemic species. The problems associated with introduced aquatic species have been reviewed by Lachner, Robbins and Courtenay (1970). The potential for inadvertently introducing parasites and other pathogens represents a threat to established cultured species as well as to endemic organisms.

The oceanic location of Guam and its subsequent isolation from other geographical areas deters the spread of freshwater fish pathogens. However, rapid air transport of aquatic species has increased the probability of introducing infected fish (including asymptomatic carriers) and waterborne pathogens.

The importation of fish and animals requires an import permit from the Guam Department of Agriculture. In addition to this permit a certificate of health from the point of origin must accompany the imported fish. However, it is not desirable to depend on a foreign country to carry out the proper screening of fish for export to Guam. The validity of these health certificates is often questionable.

A program should be implemented to monitor the health of imported fish for culture along with a continual monitoring of existing stock. Introduction of infectious virulent pathogens (e. g., *Bothriocephalus*, Spring viremia of carp, or the interlamellar form of *Henneguya*) with imported fish stock can have a significant negative effect on a developing aquaculture industry. The cooperation of prospective importers could be enhanced through education in this area.

An outline of such a monitoring program would include the following:

- 1) Determine which fish pathogens are present in the natural waters and ponds of Guam (baseline data);
- 2) Know the area or origin of each species imported and the diseases prevalent in these areas for each of the species;
- 3) Define pathogens that are to be excluded. This must be done in order to limit the inspection process to pathogens with a high probability of having a negative impact on cultured species;
- 4) Set up an inspection program establishing standard diagnostic techniques or procedures for importations of aquatic animals. This would consist at a minimum of a spot check for the listed pathogens (minimum holding period 48 hours). Diagnostic facilities and isolated quarantine facilities would be required;
- 5) The responsible agency for the inspection should have the sole authority for the issuance of health certificates or clearances; and
- 6) Importations should be limited in the future by establishing facilities on Guam for rearing juveniles of the majority of cultured species (those with completed life cycles in captivity). This would greatly reduce the hazard of introducing pathogens.

During the early phase of establishing a screening program, step 1 could be eliminated so that the program could be implemented without delay. Baseline information could be gathered and applied appropriately in the future.

A disease management plan should be based at the government operated hatchery and should include a program for the prevention of disease outbreaks through the use of appropriate bacterins, vaccine, and improved diets and genetics that increase resistance in the animals cultured. This overall management plan should also include the reduction of environmental stress that the animal is subjected to by careful manipulation of the limiting environmental parameters. Predisposition by adverse environmental parameters is often encountered in the course of aquaculture and is a major contributor to disease problems. The use of pesticides in adjacent areas, and the entrance of it into the water supply of

aquaculture farms should be carefully monitored and regulated. Insecticides are especially detrimental to crustacean species due to their similar physiology to insects.

Recommendations (Establishment of a Fish Health Monitoring Program):

- 1) Establishment of a fish health monitoring program.
- 2) Provision of a disease management program for the aquaculture industry.
- 3) Restrictive use of pesticides adjacent to aquaculture facilities.

MANPOWER

The manpower required by the aquaculture industry covers the span from unskilled to highly trained technical and managerial personnel. As the industry grows a training program will be required to fill the need for skilled personnel. Persons with a college degree in the biological sciences would be most suitable for technical and managerial positions on large aquaculture farms. Since most interested farmers and entrepreneurs lack practical experience and specific knowledge in aquaculture practices, a technical training program should be provided to fill this manpower training need.

The manpower requirements for aquaculture can be divided into three levels of skill:

- 1) Unskilled labor will be needed to maintain the farm which would include the cutting of grass, pumping of water, draining of water, pond bank repair, minor mechanical repair and maintenance, carpentry, feeding, harvesting, sorting and delivery. This level of personnel will constitute the main labor force. On-the-job training would be sufficient to meet this demand; however, education at the secondary level stressing training and employment opportunities in aquaculture/agriculture should be encouraged to stimulate this manpower base;
- 2) Skilled/managerial personnel would be needed to oversee all operations on a farm. The degree of skill required will vary according to the size and complexity of the operation and species raised. Some species (e. g., eels) are more difficult to raise requiring a higher level of skill than others (e. g., tilapia). For this group of personnel there would be required a training program to assure an adequate number, so as not to restrict the growth of the industry. Skills required at this level include general biological knowledge of species cultured and of pond ecology, how to calculate stocking and feeding rates, calculation of biomass, population sampling, harvest scheduling, water quality measurements (e. g., O_2 , pH), basic business management skills necessary to maintain financial records, cash flow projection, procurement and sales, and preparation of financial statements. This level of skilled personnel would be needed at all of the

farms; however, one per farm should be sufficient. At the small family farm size operation (less than 5 acres) the person in charge would not have to be proficient in all of these skills even though it would be advisable; and

- 3) Highly skilled personnel are needed to form the core of technical and professional expertise in the field of aquaculture. This group would provide the instruction base in the proposed training program. Their background should include a formal education in aquaculture or a related biological field and extensive working experience in aquaculture.

This group, along with private consulting groups, will provide the information source in such matters as site selection, pond design and construction, appropriate species selection, biology, physiology, and behavior of the species cultured, pond ecology, disease prevention, diagnosis and treatment, and the economic analysis of a proposed farm (e.g., capital cost and operating cost). This group of personnel will be few in number, but will be vital in providing technical advice and training. These personnel will usually be associated with government programs in aquaculture (e. g., DOC, DOA, Marine Laboratory and CALS); however, large farms would require such personnel on their staff.

The proposed technical training program should be coordinated and managed jointly by the College of Agriculture and Life Sciences' education extension program and the Sea Grant Marine Advisory Service, since both these groups function in disseminating technical information to the public and are involved in aquaculture work. The mechanical aspect of establishing the program could be coordinated with AHRD and Guam Community College. AHRD through the CETA program can assist in the classroom training by providing funding for the instructors salary, supplies and materials, and equipment used in the course of the training program. The Guam Community College could provide the facilities.

This training program would bring together the island's aquaculture experts from the government, University and private sectors. This would involve qualified available staff from the Marine Laboratory, CALS, Department of Agriculture, Department of Commerce and private firms, along with staff from the College of Business to provide the business managerial training necessary. A permanent training program on a continual basis will most likely not be justified so an ad hoc training program will be adequate.

Recommended course outline for Basic Aquaculture Technology (40 hours of classroom work and 20 hours of field work would be sufficient to provide the minimum basic course):

A. Biological

- 1) Pond ecology
- 2) Basic biology, physiology, and behavior of species cultured

- 3) Water Quality management
- 4) Disease management
- 5) Determination of stocking rate
- 6) Estimation of stock density
- 7) Determination of feeding rate
- 8) Harvesting strategy and methods
- 9) Handling and processing of cultured product

B. Business

- 1) Basic accounting principles and practices
- 2) Cash flow projection
- 3) Procurement and sales (marketing)
- 4) Financial statement
- 5) Payroll

Upon completion of this course AHRD with the CETA program could further assist those graduates who are not self-employed or have positions secured, and that wish further on the job training by providing placement into the private aquaculture industry or a government operated hatchery. This approach would be advantageous, since it would provide a means to round out the training program with actual working experience, which is very important in the field of aquaculture. The private sector would provide the position so that these trainees could broaden their working skill and gain the confidence and proficiency necessary to eventually operate an aquaculture farm and become a valued employee. The private sector would jointly share the cost of employment of these trainees with CETA which will pay up to 50% of the wages during the training period. This on the job training program of CETA could also be extended to the unskilled level of personnel to provide them with hands on training and the opportunity for gainful employment in the private sector.

The training program (Basic Aquaculture Technology) would also fulfill the level of technical competence set as a qualifying factor for entrepreneurs applying for a loan from the government proposed "Aquaculture Loan Program" (see Financial Support).

Other training courses should be provided as needed including short courses (less than 10 hours) in net construction and repair, and business organization (sole proprietorship, limited partnership, and corporation).

The recruitment of personnel from Hawaii or the mainland may become necessary if the industry expands faster than the training program can provide qualified personnel. The importation of foreign labor has been addressed in the Guam Legislature's Resolution number 62 (adopted 3/8/79), which requested the U. S. Department of Labor to reinstate the H-2 Alien Labor Program for agricultural and aquacultural development activities on Guam. Since then a number of requests through the Guam Department of Agriculture to the U. S. Immigration office have been sent to request H-2 workers in these fields. However, the extension of the H-2 workers program for aquaculture would be contrary to the goal of establishing an industry which would provide employment and an alternative lifestyle to the residents of Guam. The importation of labor from foreign countries would not be necessary except in special circumstances and then for only limited term contracts (e. g., one year). This would occur where a specialized type of culture (e. g., eels) or one that has not been practiced on Guam is being used and there is a lack of qualified personnel to fill the manpower demand on Guam. Since the H-2 Alien Labor Program has often been abused in the past to the point where qualified local residents are by-passed for a position, the stipulation should be made that a resident of Guam will work as an apprentice during this limited term contract utilizing foreign expertise. This type of arrangement could possibly be coordinated with the Agency for Human Resources Development (AHRD). In addition, an adequate training program can be established to meet the industry's long-term needs. Therefore, it is not advocated except in the limited cases of specialized personnel that the H-2 Alien Labor Program be extended to aquaculture.

To meet the need of foreign investors who want to have experienced managerial personnel they are familiar with, especially in the initial stage of an operation where most problems are encountered, an alternative to the reinstatement of the H-2 program for aquaculture could be the utilization of the L-visa, which allows foreign investors to bring in managerial staff from their home based company once a farm is established on Guam. This would allow the foreign investors to bring in his skilled managerial level personnel for a limited period of time, while hiring local labor as farm workers and potential managerial replacements. Thus this would give the foreign investor the needed confidence in a known experienced manager to assure his capital investments during the important initial start-up stage. This manager can then train a replacement from locally hired staff. Again this type of training program could be coordinated with AHRD.

Recommendations (Manpower):

- 1) Periodic evaluation of the manpower needs of the aquaculture industry in relation to the labor force.
- 2) Establishment of a technical training program to meet the manpower requirements.
- 3) Coordination of governmental and private bodies in the training and employment of residents of Guam.

- 4) Promotion of aquaculture as a career.
- 5) Placement of stringent limitations upon the use of alien labor in aquaculture.

UTILITIES

An aquaculture facility other than a hatchery will not place a large demand on potable water; since the water supply for ponds will be from surface waters or a well. However, the agricultural water rate should be extended to aquaculture facilities since aquaculture is similar to agriculture in function.

In addition to the special water rates, which are preceded by the agricultural water rate, there needs to be a comparable electrical rate charged to certifiable agricultural and aquacultural operations. The need for a reduced electric power rate in aquaculture is more pronounced than for agriculture, since there is the dependence on pumping of water from wells or surface waters as well as supplying aeration as needed. A three phase electrical line should be installed to aquaculture facilities. The advantage of three phase electricity is initially to lower the cost of electrical equipment such as pumps as compared to single phase pumps of comparable horsepower. In addition, the operation of such equipment is more efficient with three phase electricity thus lowering the cost of operation.

Installation of power lines to aquaculture facilities should receive a priority as an industrial need. Along with roads constructed into areas of major potential aquaculture development a main power line should be extended so that the farms developing in the area can obtain electrical power at a bearable cost by extending a power line from the main power line.

Alternative energy programs should be investigated. Such programs as wind power for direct pumping of water, generating of electrical power, and for pond aeration, along with the possible use of solar power to generate electricity especially in areas not suited for wind power should be examined as to the replacement of fossil fuel generated power.

Recommendations (Utilities):

- 1) Establishment of special electrical power rates to aquaculture and agricultural users.
- 2) The extension of agriculture water rates to aquaculture.
- 3) High prioritization to aquaculture facilities for the installation of power lines and water lines.
- 4) Investigation into alternative energy sources to replace or supplement conventional energy sources (e. g., electricity, fossil fuels).

LAW ENFORCEMENT

Since poaching and vandalism can constitute a significant economic loss to aquaculture farms, such violators must be prosecuted to the full extent of the law. Such violations can have a very negative effect on the development of the aquaculture industry if poaching is condoned by limited law enforcement and prosecution of violators. This has been experienced on Guam on farms attempting to raise livestock (mainly cattle), where poaching became so rampant that most farmers discontinued livestock production or have reduced their stock to very low numbers. It is the responsibility of the farmer to take all practical measures to discourage such violators (e. g., fence, watch dogs) but also the strict enforcement of the law is necessary when violators are apprehended to deter further violations.

Recommendations (Law Enforcement):

- 1) Strict enforcement of laws for violations (poaching, vandalism) occurring on aquaculture facilities.
 - a) Some laws would have to be reevaluated as to the effectiveness of the penalties as a form of deterrent.
 - b) Provision in the law for the reimbursement by the violator to the victim for the damages or losses caused when the crime was committed.

MARKET

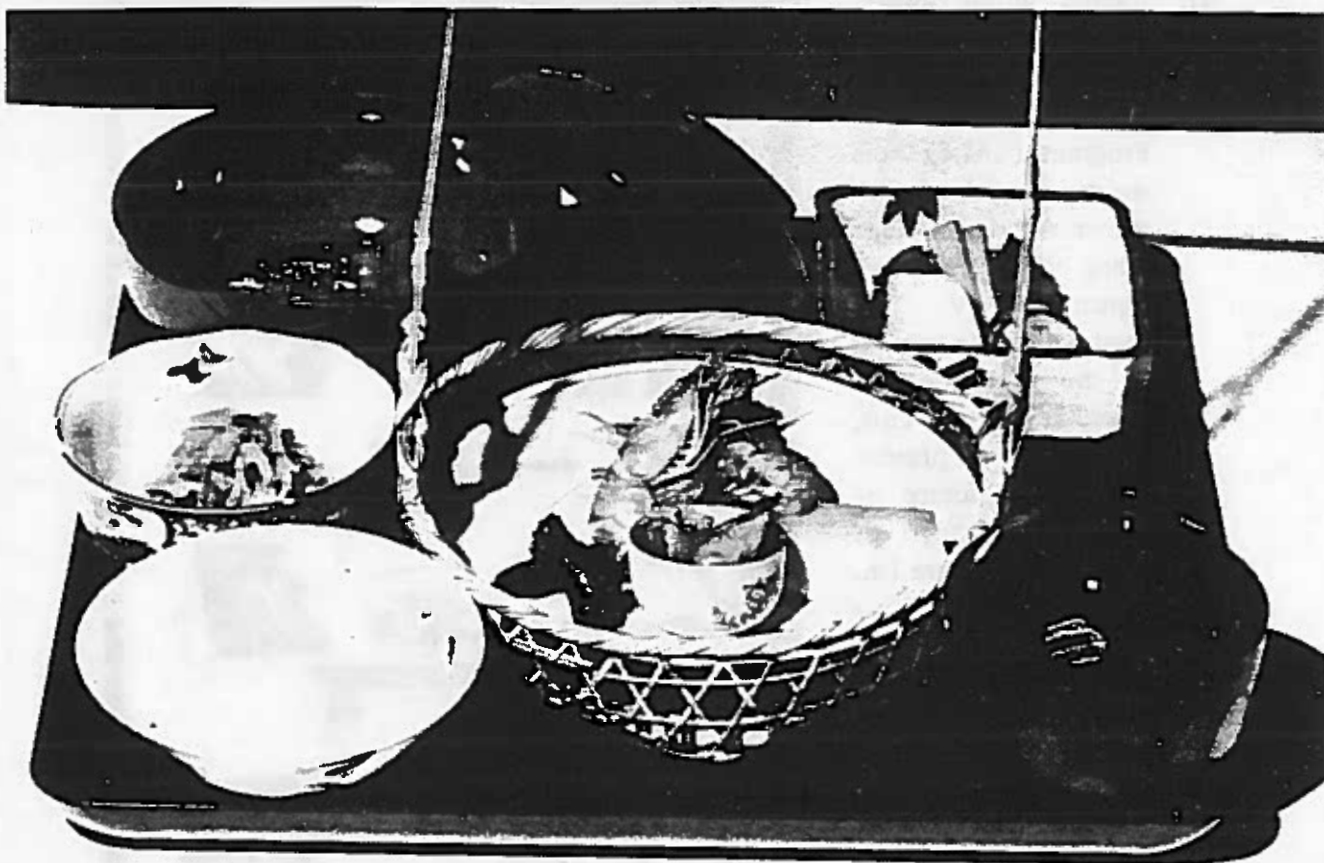
The market for aquaculture products produced on Guam will involve the securing of both local and foreign markets. Certain aquaculture products (e. g., eels, algae) due to their nature will have a very limited market on Guam and will have to seek foreign markets immediately, while other products (e. g., prawns/shrimp) can be absorbed in substantial quantities by the local market. Due to Guam's small population any large scale development of aquaculture regardless of the species will necessitate foreign market penetration. This will require a concerted effort by both government and private business to develop an appropriate, sophisticated and aggressive marketing program. The major foreign markets for Guam's aquaculture products will be Japan and possibly Hong Kong. This should be a consideration when choosing what species to be cultured as well as preferences by the Japanese market in size and how the product is processed.

MARKETING PROGRAM

A well organized and executed marketing program will be needed to maximize sales of locally produced aquaculture products. In the current initial phase of aquaculture development little marketing effort would be required and would be of little benefit, due to the limited and sporadic nature of production. No established markets can be set up under such a product supply. However, as farms develop and production increases and stabilizes a marketing program will play an important role in the future of aquaculture growth on Guam, since the industry's dependence on securing a sufficient proportion of the local and foreign market is self-evident. This marketing program should be directed towards the main aquaculture products in proportion to their importance so as to help expand and diversify the crops produced and to maximize exploitation of the market. Certain species may take a more intense marketing program (e.g., carp) due to their novelty and possible adverse connotations and cultural stigmatizations associated with them. Marketing efforts will have to become more sophisticated at the phase where an export market will be required for further expansion of the industry on Guam.

The marketing program should be implemented by the University of Guam's College of Agriculture and Life Sciences (CALS) home economics extension service and coordinated with the Guam Agriculture Marketing Board whose duties as established in its enabling legislation is charged with the advertisement and promotion of locally produced agricultural and food products. For example, the promotion of the Giant Malaysian Prawn (*Macrobrachium rosenbergii*), which is similar to the familiar marine shrimp but has different characteristics such as body shape along with a more delicate mild taste, should include:

- 1) a demonstration of methods for the cooking and serving of the prawns to purchasing agents and head chefs from the hotels and restaurants; present a display at the annual conference of the Guam Hotel and Restaurant Association;



Guam grown prawns served Japanese style at the Kurumaya Restaurant. Restaurants will be a major market for prawns.

- 2) the printing of a booklet with recipes and attractive serving methods for the prawn. A similar book of recipes was compiled in Hawaii (Takata, 1978). Local recipes should be included as a Guam exclusive specialty. These booklets should be distributed to the major commercial restaurants and be made available to the general public;
- 3) market promotion should also be done at some of the major supermarkets so as to make the public aware of the product. This would include taste sampling, small displays on the background of prawn culture on Guam and examples of the prepared products;

- 4) further public awareness should be pursued through the various media. The Extension Program (CALS) runs short education consumer awareness films along with the "farm report" on TV. This method can be applied to the promotion of aquaculture also. This, in essence, will present a broader picture of the whole process of the prawn culture i.e., larval rearing in a hatchery, grow-out on the farms, harvesting, and the cooking and serving of prawns. Newspaper articles and advertisements along with radio announcements would further serve the promotion of aquaculture products.



Aquaculture display provided by the College of Agriculture and Life Sciences to promote aquaculture (Photo by D. Crisostomo).

All these promotional means can be applied to all of the species being cultured. The extent of each promotional program will depend on the importance of the species and its promotional requirements.

Assistance in the area of marketing should be sought from the U. S. Department of Agriculture under the Research and Marketing Act of 1946 (U. S. P. L. 79-732). This program includes research to improve the quality of, and the development of new and improved methods of production, marketing, distribution processing, and utilization of plant and animal commodities at all stages from the original producers to the ultimate consumers. The Research and Marketing Act authorized the Secretary of Agriculture to enter into contracts with public or private organizations or individuals to research marketing programs.

To take advantage of the local market, the Giant Malaysian prawn (*Macrobrachium rosenbergii*) even though it is very similar in appearance to the endemic prawn (*M. lar*) which is a delicacy among the Guamanians, will require consumer education to maximize its portion of the local market. The main competitive product is the marine shrimp sugpo (*Penaeus monodon*). The two differ in appearance; however, both are of similar high quality flesh and taste.

Hotels and restaurants, which account for approximately 28% of the shrimp/prawn market (Aquatic Farms, Ltd., 1978) have expressed interest in the prawns, but are hesitant to try the new product. The major objections to the prawns are the large size of the head (cephalothorax), the lack of a stable supply, and how to prepare the prawn. A stable supply of a high quality consistent product is often a prerequisite for the purchase by the various restaurants and markets on Guam. This is especially true in the restaurant market where their demands are high, since they need a reliable item that can be incorporated into their menu without fluctuations in supply. The majority of restaurant sources contacted would not consider the purchase of the prawns without assurance of a consistent supply. Marketing efforts will have to be designed to meet these demands and penetrate and secure this substantial market.

LOCAL MARKET

Results from the *General Feasibility Analysis, Prawn Aquaculture on Guam* (Aquatic Farms, Ltd., 1978) provides an estimation of the local market consumption of prawns and shrimp to be between 16,000 - 25,000 pounds per month (2.3-3.6 pounds annual consumption per capita) with an additional estimated 4,000 pounds per month consumed by the military. Of the commercial outlets, restaurants accounted for 28%, large supermarkets 17%, and small retail markets 55% of the shrimp and prawns sold. Aquatic Farms, Ltd. (1978) estimated that the Giant Malaysian prawn should be able to capture approximately 35-45% (approximately 8,000 pounds per month) of the currently imported products. In addition, some increase in consumption would be expected by a new market (5,000 pounds per month) with the introduction of the high quality fresh locally produced product. Wholesale market prices for the near future are expected to be \$4.50 to \$6.50 per pound depending on the size and whether they are live, fresh, or frozen. The retail price for shrimp on Guam has undergone a dramatic increase of 226% between 1973 to 1980 (Quarterly Economic Review, 1980). Price elasticity of an aquaculture product is a problem that must be taken into consideration in the projection of your market and subsequent profit margin. Aquaculture products that are based on a current high demand-high price factor can be adversely affected by an increasing production and supply with its possible subsequent reduction in price for that particular product.

The price-elasticity of demand is a measure of the consumer's sensitivity to price changes; that is the percentage change in quantities consumers would be willing to purchase associated with a given percentage change in price. This can be expected to be an important factor in marketing especially for the local market due to its rather limited size. As production in prawn and other aquaculture products increases, a point will be reached where the market

will become saturated for that product at the given price; however, with a reduction in price an increase in consumer consumption would be expected, thus the total potential local market will be strongly influenced by the price of the product in relation to substitutable products. This influence by the availability and price of close substitutes such as imported products from the Philippines and the U. S. will act in an antagonistic manner upon sales of locally produced aquaculture products. This increase in price of the aquaculture product, in question would tend to increase the use of substitutes (price remaining constant) and consequently lower consumption of the aquaculture product, while the opposite would occur if the price of the aquaculture product is lowered. There is a balancing point where the total expenditure of the consumer does not increase in response to the price of the product being lowered and this would represent the true saturation point of the local market for that product. This depends on the elasticity of the market along with other factors controlling the capability to lower prices of the product and still allow an acceptable return to the producer and marketing agents. This is a simplified outlook of the relationship between a given aquaculture product and its close substitutes in regards to their influence and interaction upon each other in the market. As the production of the aquaculture industry increases a study of this interaction along with the effect of changes in real income of the consumer would be appropriate to obtain an optimum price and consumption ratio.

The substitution of foreign imports of shrimp and prawns with locally produced products as cited by Aquatic Farms, Ltd. (1978) may be overly optimistic. A recent 1980 analysis of the shrimp and prawn imports into Guam in which they were itemized according to the variety, size, and price showed the total shrimp and prawn imports (all varieties and sizes) amounted to an average of 8257 kgs per month (18,165 pounds per month). However, due to the size and the price requirements necessary to be viable and competitive the locally cultured Giant Malaysian Prawn will have to compete for the market with imports of the larger shrimp and prawns which only amounts to an average of 3,062 kgs per month (6,736 pounds per month). Of the total shrimp imports (Department of Commerce, 1980), 35-40% are of the large size class, which represents the portion of the market that *Macrobrachium* would be competing to capture. This market for 1980 amounted to 37,000 kgs (81,400 pounds) of shrimp. This figure is slightly less than that projected by Aquatic Farms, Ltd. (1978) which was 43,636 kgs for the existing market plus 27,273 kgs created by new demand for the product for a total local civilian market potential of 70,909 kg. The Department of Commerce does not include the addition of potential new demand. Initially only a portion of this market potential will be substituted by the local product; however, with the expansion to the culture of marine shrimp and with an appropriate and aggressive marketing program the majority of these imports should be replaced in time by the local products.

Awareness of the fluctuation pattern of the shrimp imports (Figure 4) is important to the development of a local marketing program. These fluctuations should be noted by the farmers so as to coordinate their stocking and harvesting appropriately to meet the demands of the market. As the local product becomes more readily available and stable these fluctuations in imports should be dampened with the shift to purchasing of the local product.

FIGURE 4

GUAM'S TOTAL SHRIMP IMPORTS: JANUARY 1979 THROUGH JUNE 1981
 LARGE CLASS IMPORTS: JANUARY 1980 THROUGH DECEMBER 1980

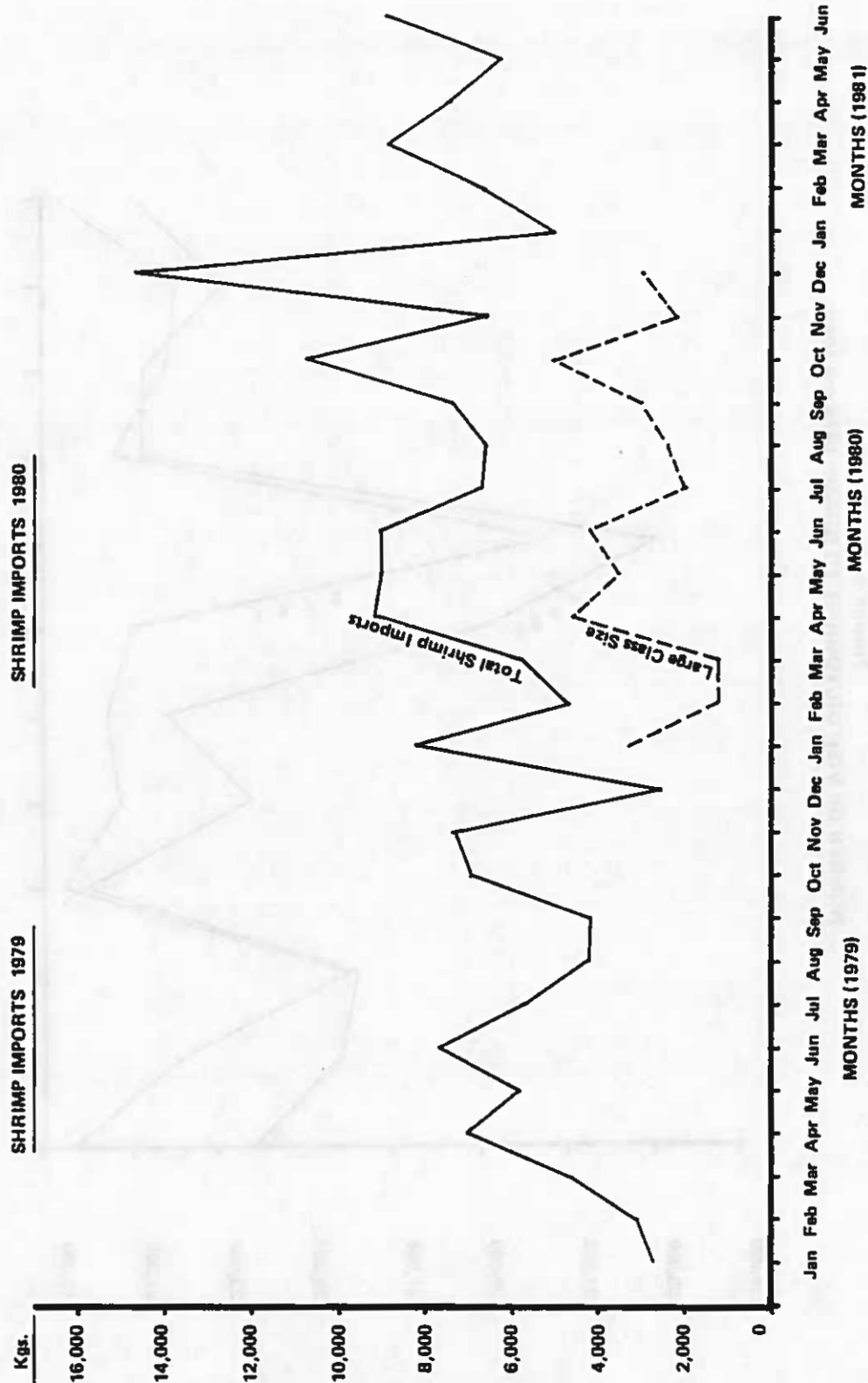


FIGURE 5
NUMBER OF VISITOR/TOURIST TO GUAM: 1979 and 1980

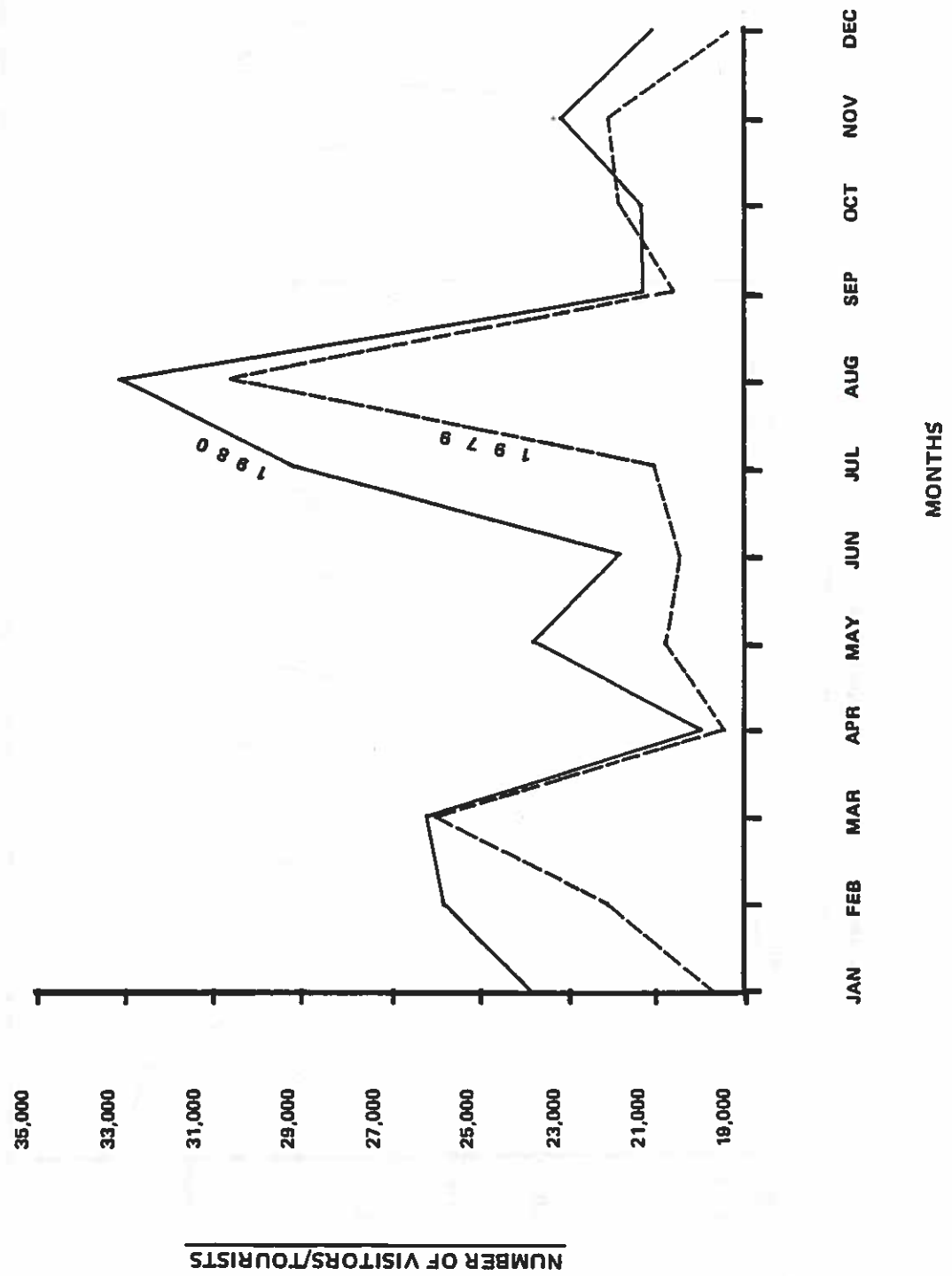


TABLE 5
TILAPIA IMPORTS SUMMARY 1980 - 1981*

MONTH	WEIGHT Kg.	AVERAGE PRICE/Kg. (F.O.B.)
July 1980	407	\$ 2.20
August	523	2.19
September	547	2.29
October	356	2.37
November	221	2.46
December	287	2.56
January 1981	228	2.42
February	275	2.49
March	426	2.48
April	275	2.58
May	324	2.50
June	337	2.02
TOTAL (average)	4,206	(\$ 2.36)

* Compiled from Custom's import invoices (Department of Commerce).

The fluctuations in monthly imports are mainly attributed to large purchases made by major wholesalers and fluctuations in the demand as it relates to the fluctuation in the monthly number of visitor/tourist (Figure 5). There is a tendency of the large wholesalers to make large purchases 1 to 2 months prior to peak periods in the tourist trade. There has been a tendency since the latter part of 1980 to change the means of importation of large individual purchases of shrimp from ship to air cargo. This shift in the means of transportation would affect the purchasing strategy of major wholesalers from buying substantial amounts well in advance of peak demands to assure adequate supply, to one which more closely follows the current market demand thus reducing the necessity of storage of large quantities of shrimp and allowing a more fluid market. This general trend is seen in the 1980 and 1979 data in which the peak imports proceed peak periods in the number of tourists. There is approximately a one (1) to two (2) month time lag.

The marketing of alternative species such as carp, tilapia, catfish will be mainly limited to a local market due to the lower price these species generally receive and the limited export markets which Guam would be able to compete for economically. Tilapia, especially the reddish-orange hybrid variety has a potential of developing into a viable alternative species for the local and possibly the export market depending upon the technology developed involving intensive culture and the potential export market demand and price. This variety has been publicized in Japan as a substitute for the popular sea bream. It is even used for sashimi at some places in Japan and commands a relatively high price. The importation to Guam of tilapia from July 1980 through June 1981 showed that it was not a large quantity (Table 5). The projected total annual importation estimate for 1980 was between 4,500 to 5,000 kg. Guam's aquaculture farms marketed approximately 15 m tons of tilapia in 1981. These production and market potentials will have to be researched to determine the maximum extent to which these species can be economically cultured on Guam. Also, the investigation into the marketing of these species in a processed form, such as fish sticks, fish cake or kamoboko has potential if the production is high and production costs are relatively low.

ASSESSMENT OF CONSUMER PREFERENCE

The consumer preference for seafood products on Guam is heavily weighted towards fresh 81.4% over frozen, canned, dried, or smoked (Callaghan, 1978); however, of the minimum estimate of annual household retail purchases of seafood only 36% of the expenditure went for fresh seafood products. This would indicate that there is a definite potential market for the increased supply of fresh seafood, which is not being fulfilled currently. Aquaculture products could supply a large proportion of this demand for fresh high quality products.

With this information relating the preference to the actual purchases made and assuming its application to shrimp/prawn imports the estimate for the local market total shrimp consumption from Aquatic Farms, Ltd. (1978) would be expanded to 16,436 - 25,682 kgs per month (36,160 - 56,500 pounds per month or 5.2 to 8.2 pounds annual consumption per capita) and the estimate by the Department of Commerce would be expanded to 18,660 kgs per month (41,052 pounds per month or 5.9 pounds annual consumption per capita). Caution would have to be observed in using these figures for the calculation of the potential local market, since there may be other limiting factors (e. g., price, income, and substitute goods) for this large expanse between what is preferred and that which is purchased (a factor of 2.26).

OUTLET STRUCTURE OF THE LOCAL MARKET

Aquaculture products can be marketed locally through a number of existing "wholesale dealers." This includes the Guam Fisherman's Cooperative Association, which was established in 1977 and now has an effective marketing procedure for fishery products. The



Prawns grown on Guam being marketed through the Fishermen's Cooperative.

majority of their sales are retail (approximately 65%) with the remaining (35%) being wholesale to restaurants and markets. This will probably shift to mainly a wholesale outlet as their volume increases. In the past some aquaculture products have been marketed through the Guam Farmers Cooperative Association which deals mainly with agricultural products that are sold exclusively wholesale. However, due to their limited

facilities for refrigeration and freezing a more appropriate marketing organization for larger quantities of aquaculture products would be the Guam Fisherman's Cooperative Association, especially due to the similarity in products handled. The Fisherman's Cooperative Association has recently started marketing the cultured prawn. Both cooperatives add a nominal fee onto the purchase price from the farmers, fishermen, and aquaculturists to cover processing and marketing expenses. There are a number of additional private corporate wholesale market outlets that would be capable of handling aquaculture products.

At present, the majority of aquaculturists market their products directly to the consumers or to retail outlets thus avoiding the wholesale distributor and allowing for up to \$7.00 per pound to the farmer. This is mainly due to the current low production and high demand. As farm production increases, the need for a permanent market structure will become apparent. This is when the existing cooperatives will begin to play an important role in the marketing structure for aquaculture products. The coops will provide a service which will allow the aquaculturist to market his product with minimum expense and time, and add a stabilizing effect on the supply, since purchasers (e. g., restaurants, retail stores, consumers) will not be dependent upon an individual source for their supply. Such a centralization of the market outlet will continue to grow in importance as the production increases and the saturation of the local market is reached and the exportation phase of products become a necessity for the further growth of aquaculture.

The marketing system will be divided between the small to medium size farms and the large farms. The small to medium size farms will be the ones to mainly utilize the centralized marketing system, while large farms would have a consistent enough supply that they would be able to market directly to local retailers and export markets. This is currently being done by Guam Marine Products, Inc. which markets eels directly to a Japan distributor. However, once the centralized marketing system is firmly established it may prove advantageous to the larger farms to market their product through this system.

Executive Order 79-24 (1979) established the Agriculture Marketing Facility Act of Guam. This created the Guam Agriculture Marketing Board which consists of seven (7) members representing the College of Agriculture and Life Sciences, Department of Commerce, Department of Agriculture, Guam Farmers Union Association, Malojloj Green Farm Association, Guam Hog Producers, and the Guam Fisherman's Cooperative Association. The purpose of the Marketing Board is to promote the development and expansion of direct marketing of local agricultural commodities for the mutual benefit of farmers and consumers. The Board is capable of making a limited amount of funds available such as low interest loans to coops for the purpose of improving their marketing capability.

MILITARY MARKET

The Guam military market constitutes a potential major outlet for aquaculture products. The military portion of the island's population consists of military personnel, their dependents and off-island hired Department of Defense employees and their dependents which amounts to 22,800 (Department of Commerce, 1980). However, this potential market through the commissaries and mess halls is significantly larger than what would be expected based on the personnel stationed on Guam, since Guam serves as a supply center to a number of ships in the Western Pacific. In addition, an unknown amount of purchases are made by the civilian population who have access to the commissaries either directly or through friends and relatives.

The military population constitutes 22% of the total island population. However, a conservative estimate of the military's proportion of the total island imports for food is a disproportionate 30-40% (Department of Commerce). Utilizing this estimate and assuming that this proportion would apply to shrimp imports the military importation of shrimp would amount to approximately 2475 - 3300 kg per month (5445 - 7260 pounds per month). This is based on the documented amount imported into the civilian community which averaged 8257 kg per month (1980).

FOREIGN MARKET

The growth of aquaculture on Guam beyond filling the local market demand will depend on securing foreign markets for export. Guam will be competing on a world market that is highly competitive. National and international trade laws regarding export and import of aquaculture products will have to be thoroughly examined and evaluated as to their relevance and effect on Guam. A worldwide awareness of developments in aquaculture production such as species and product form (e. g., live, fresh, frozen; round or gutted or filleted; or processed into a convenience food); packaging; price levels; control of portion size; transportation requirements; quality requirements in terms of wholesomeness as well as in terms of taste, color, texture; delivery schedules and numerous handling requirements; and appropriate gross shipping weights for institutional markets and other such factors will be a necessity for the continued evaluation of Guam's role in this market. For example, a number of large international corporations are becoming involved in aquaculture production on very large scales. Numerous companies are involved in shrimp culture and are producing or will be producing large quantities of shrimp which will definitely influence the world market; however, the extent is yet to be seen. Even though the present market for shrimp is still heavily weighted on the demand side, a continual awareness of the worldwide market structure, size and price elasticity for the product will be required. With the projected increase in worldwide production, this supply may increase to the point where the competition for markets become intense. Further, a high-cost product today may cease to be so with improved technology and the expansion of mass production as occurred in the poultry industry.

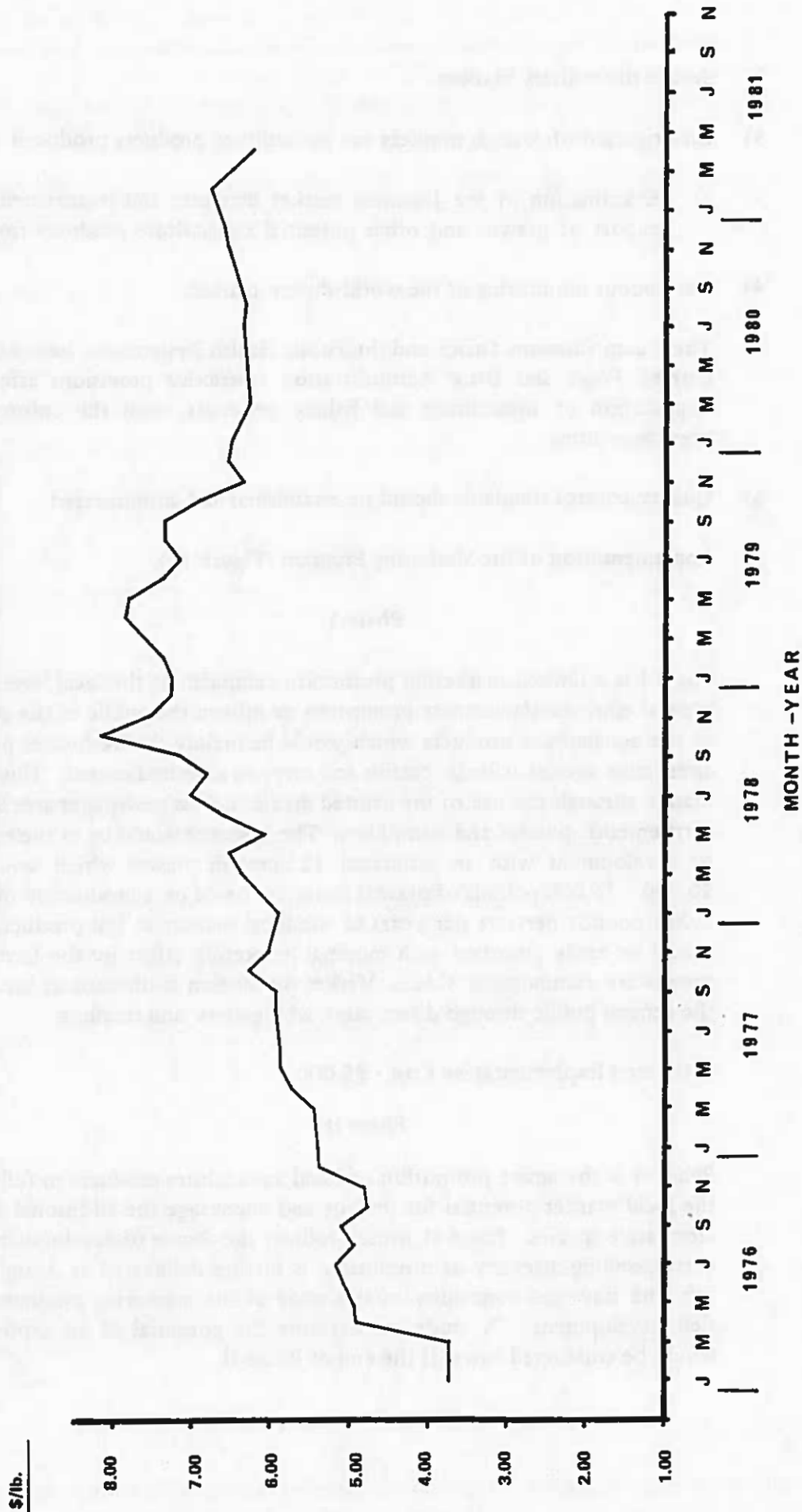
Of the three major shrimp markets in the world (constituting approximately 50% of the world market for tropical species of shrimp) Western Europe shows a preference for cold water shrimp (*Crangon* and *Pandalus*) importing only a small percentage of the tropical shrimp (penaeids) catch. The United States along with Japan are the major importers of the tropical shrimp; however, it is projected (South China Sea Fisheries Development and Coordinating Program, 1977) that an increasingly larger portion of the U. S. market will go to the cheaper northern water shrimp (*Pandalus*) during the current ten year period (1975 - 1985). Japan will continue to prefer the tropical species and become the major importer of these shrimp. There is expected to be an increase of 20% by the year 1985 in total usage of tropical shrimp over the 1975 consumption by these three markets.

The rapid growth of the Japanese shrimp market during 1965 to 1975 was based on two factors: 1) increasing population; and 2) rising per capita usage. The current period (1975 - 1985) as opposed to 1965 - 1975 is expected to have a lower rate of increase in the shrimp market due to significant social and economic changes that are affected by the higher rates of inflation and slower economic growth thus having a negative impact on consumer incomes, along with the peaking of the urbanization in Japan. An estimate of the 1985 shrimp import market in Japan is 256,000 to 300,000 tons. This represents a projected increase in imports of 58% to 85%, while during 1965 to 1974 there was an increase of nearly 400% in shrimp imports (SCSFDCP, 1977).

As mentioned, trends in the world prawn/shrimp aquaculture industry as well as shrimp fisheries will influence the extent and success of prawn/shrimp aquaculture on Guam. For example, landings of shrimp for the U. S. commercial fisheries in 1979 are 336 million pounds worth \$471.6 million, which is down 31% by volume but up 22% in value from the 1978 harvest (Fisheries Statistics of the United States, NMFS). This rise in price is also reflected in the international purchase of shrimp by Japan up through 1979 (Foreign Fishery Information Release, NMFS, 1980). However, a more current look at the world production and price is somewhat less optimistic as far as a profitable return to potential aquaculture farms. A specific case in the commercial shrimp fisheries is a 31% decrease in the price per pound of shrimp in the Georgia shrimping industry for the period of April through June 1980 as compared to the same period for 1979. Even though the shrimp landed increased by 72%, which is mainly attributed to the 39% increase in trawlers shrimping in the Georgia waters, the gross income per boat has been severely reduced with the decreased value per pound and greatly increased fuel costs (The Marine Newsletter, 1980, Vol. 11(5)). This current (1980) trend in the reduction of the price per pound of shrimp is also reflected in the international purchases by Japan (Figure 6).

FIGURE 6

WHOLESALE PRICES OF FROZEN SHRIMP IMPORTS
TOKYO CENTRAL WHOLESALE MARKET, FOR INDONESIAN WHITE SHRIMP (*PENAEUS* SP.), 16-20 PER POUND
(HEAD-OFF, SHELL-ON)
(FOREIGN FISHERY INFORMATION RELEASE, NMFS)



- 2) Secure the military market
- 3) Investigation of foreign markets for aquaculture products produced on Guam.
 - a) Examination of the Japanese market structure and requirements for the export of prawns and other potential aquaculture products from Guam.
- 4) Continuous monitoring of the world shrimp market.
- 5) The Guam Customs Office and the Public Health Department become aware of current Food and Drug Administration restrictive provisions affecting the importation of aquaculture and fishery products, with the enforcement of these provisions.
- 6) Quality control standards should be established and administered.
- 7) Implementation of the Marketing Program (Figure 10).

Phase 1

Phase I is a limited marketing promotion campaign at the local level. This is a general education/awareness promotion to inform the public of the availability of the aquaculture products which would be mainly the freshwater prawn, and alternative species (tilapia, catfish and carp) to a limited extent. This would be mainly through the use of the printed media such as newspaper articles and advertisements, posters and pamphlets. The industry would be in the early phase of development with an estimated 12 acres in prawns which would supply 20,000 - 36,000 pounds of prawns (estimate based on a production of 2,000 to 3,000 pounds per acre per year) to the local market at full production. This would be easily absorbed with minimal marketing effort by the farmers and a promotion campaign by CALS. Market promotion is directed at local sales to the general public through direct sales, wholesalers, and retailers.

Estimated Implementation Cost - \$5,000

Phase II

Phase II is the active promotion of local aquaculture products to fully develop the local market potential for prawns and encourage the additional growth of alternative species. Phase II, which follows the degree of development and the corresponding intensity of promotion, is further delineated as A and B to signify the flow and continuity of this stage of the marketing program as a unified development. A study to examine the potential of an export market would be conducted towards the end of Phase II.

Phase IIA

At Phase IIA the local market will be at approximately half the expected saturation point for prawns. This will involve marketing a maximum of 50,000 to 75,000 pounds of prawns per year. This will require the active promotion of the products to the general public and the initiation of the promotion to restaurants.

A survey should be done to determine and identify the potential local market outlets (e. g., hotels, restaurants, wholesaler, retailers and military) and the level of interest in purchasing the aquaculture products. From this, marketing strategies can be built upon to develop the market. A recipe booklet for the prawns and alternative cultured species should be prepared.

Active promotion to the restaurants and hotels should be initiated during this phase. A means of promotion would be by way of cooking and preparation demonstrations for the various aquaculture products to the chefs and purchasing agents.

Estimated Implementation Cost - \$10,000

Phase IIB

Phase IIB is a continuation of Phase IIA with an expansion to promoting aquaculture products to the military market. At Phase IIB the maximum annual production to be marketed through local outlets would be 75,000 to 110,000 pounds per year.

Additional means of product promotion should include displays at supermarkets and taste sampling of the prepared product. Other media such as radio and television could be employed.

If the utilization of an existing Cooperative (e. g., the Guam Fisherman's Cooperative Association) is not proven practical the organization of an Aquaculture Marketing Cooperative should follow.

At this phase marketing controls should be emphasized. This would include quality control, size, grading and fresh, frozen or alive categorization. This should be coordinated through CALS and Public Health.

Estimated Implementation Cost - \$6,000

Export Market Study and Analysis

An export market potential study should be conducted towards the end of the development of Phase IIB's marketing program which would include as a minimum the following:

- 1) Identification of potential export markets;
- 2) How to enter these markets;
- 3) Requirement of the markets;
- 4) Size and potential of the markets;
- 5) Price; and
- 6) Transportation methods.

The findings from this study will indicate the potential for developing beyond the local market and provide recommendations to establish the potential export markets.

Estimated Cost - \$15,000.

Phase III

Phase III is mainly concerned with the development of an export market. In Phase IIIA the local market reaches saturation and exportation is initiated. Phase IIIB involves the concerted efforts to develop the export market.

Phase IIIA

This is the point in the development of the aquaculture industry where the local market for prawns is expected to be essentially saturated with an annual production of 100,000 to 150,000 pounds of prawns.

Emphasis on marketing efforts in Phase IIIA for the prawns will be transferred from the development of the local market to the establishment of an export market. Japan should be the major export market and efforts to develop this market should be the priority. The results and recommendations of the Export Market Study initiated under Phase IIB should be utilized to establish the procedure and strategy to develop the potential export markets and to commence the implementation of these programs.

Estimated Implementation Cost - \$20,000

Phase IIIB

This is the further development of the export market for prawns/shrimps as well as other high value species. Additional potential markets other than Japan should be investigated at this point. The annual prawn production would approach 200,000 to 300,000 pounds. The expansion of the industry beyond the original support of the proposed hatchery for 100 acres would depend upon the findings of the marketing studies and the potential for the further development of the export market.

Efforts in marketing both at the local and export levels for various alternative species and the prawn should continue during this phase.

Estimated Implementation Cost - \$15,000

RIPARIAN RIGHTS AND SUBMERGED LANDS OWNERSHIP

There are both Federal and Government of Guam rules and regulations that apply to the use of the surface waters of Guam. Riparian rights and the ownership of submerged lands are broadly covered in two Government of Guam Civil Code Sections 670 and 830. Civil Code Section 670 states: "The Government of Guam is the owner of all land below tide-water within Guam; of all land below the water of a navigable lake or stream; of all property lawfully appropriated by it to its own use; of all property dedicated to the government; and of all property of which there is no other owner." Civil Code Section 830 states in regards to boundaries by water "Except where the grant under which the land is held indicates a different intent, the owner of the upland, when it borders on tidewater, takes to ordinary high-water mark; when it borders upon a navigable stream, where there is no tide, the owner takes to the edge of the stream, at low-water mark; when it borders upon any other water, the owner takes to the middle of the stream."

"Navigable waters" are not defined in the Civil Code; however, an opinion (No. CV 80-2-1212) from the Attorney General's office cites legal cases which have set a precedent. *McGilvera v. Ross*, 30 S. Ct. 27, 31 (1909) refers to the term "navigable waters", as applies to the dominion of the national and state governments over shore lands and the rights which they have or can convey, means waters which are navigable in fact and not simply tidal waters. In *Daniel Ball v. United States*, 10 Wall. 557-556, 77 U. S. 99 (1871) found that those rivers must be regarded as public navigable rivers in law which are navigable in fact. And they are navigable in fact when they are used, or are susceptible of being used, in their ordinary condition, as highways for commerce, over which trade and travel are or may be conducted in the customary modes of trade and travel on water. The Army Corps of Engineers defines navigable waters (Part 329.4) as: "Navigable waters of the United States are those that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce."

In the cases where the stream bed is owned by a private party this does not allow him to alter or manipulate the flow of water as he sees fit, since the water-course is subject to the Federal Water Pollution Control Act and other federal and Territory of Guam statutes dealing with water use and purity that have authority over the use of such waters. 33 Code of Federal Regulations 329.8 (a) (3) states:

"Private ownership of the lands underlying the waterbody, or of the lands through which it runs, does not preclude a finding of navigability. Ownership does become a controlling factor if a privately constructed and operated canal is not used to transport interstate commerce nor used by the public; it is then not considered to be a navigable water of the United States. However, a private waterbody, even though not itself navigable, may so affect the navigable capacity of nearby waters as to nevertheless be subject to certain regulatory authorities." (emphasis added).

Such a regulatory authority that a private waterbody would be subject to is the United States Code Annotated, Title 33, Section 403:

"The creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States is prohibited and it shall not be lawful to build or commence the building of any.... structures in any.... navigable river, or other water of the United States....and it shall not be lawful to alter or modify the course, location, condition, or capacity of.... any channel of any navigable water of the United States, unless the work has been recommended by the Chief Engineers and authorized by the Secretary of the Army prior to beginning the same." (emphasis added)

Thus the construction of a dam or the diversion of water in a stream, even one which is considered privately owned under the guidelines set forth in the above statutes may still be subject to certain regulatory authorities. Private landowners may not regulate or affect water flowing through their property, if it obstructs or impedes the capacity of a navigable waterbody. In addition, a permit (DA) would be required for the placements of dredged or fill material into all waters (tidal or nontidal) and their adjacent wetlands.

Guam Law controls waters flowing over private property that do not connect with navigable waters of the United States, which under Government of Guam Civil Code Section 829 states:

"The owner of land in fee has the right to the surface and to everything permanently situated beneath or above it, subject to restrictions as are provided by law." (emphasis added)

Civil Code Section 3479 sets forth several applicable restrictions:

"Anything which is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property, or unlawfully obstructs the free passage or use, in the customary manner, of any river, bay, stream, canal, or basin, or any public park, square, street, or highway, is a nuisance." (emphasis added)

Therefore a private landowner who causes "an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of property" by obstructing "the free passage or use, in the customary manner, of any river, bay, stream, canal, or basin" is guilty of causing a nuisance which is subject to abatement pursuant to Civil Code Sections 3479-3503 (Guam's Attorney General Opinion COM 80-928).

There is a potential problem regarding the development of aquaculture ponds along rivers with a limited flow on Guam. This involves the water use needs and rights of one aquaculture site vs. another aquaculture site or user along the same river with one site being upstream to the other. For example, an established downstream aquaculture farm site is adversely affected by a new development of a site upstream, which utilizes a large percentage of the limited water flow in a stream resulting in the downstream site no longer having an adequate water supply to operate its ponds.

The Attorney General's opinion (COM 81-0570) on the above subject is summarized as each riparian owner is entitled to his "fair share" of the water. The use of the stream by its riparian owner is only limited to "reasonable use", having due regard for the rights of owners above, below or on the opposite bank. A number of tests have been used to determine reasonableness of use. One is the "purpose" test. The purpose for taking the water must be suitable to the river, lawful and beneficial to the user. Thus, an owner who acts without benefit to himself, in a harmful manner to other owners because of spite, or in violation of law, does not meet this test. The same "reasonable use" rule also applies to percolating waters (ground waters).

There are no definite rules or regulations that apply to the fair share of a limited water supply of a stream. The determination of what is a fair share is made, taking into account the number of owners, amount and nature of their needs, size of the stream, and the proportionate stream frontages of the owners. This is usually done voluntarily by the riparian landowners. The avoidance of such a situation by careful planning and analysis of water needs and supply prior to developing a site is preferred.

According to Attorney General's Opinion COM 80-786, the Government of Guam does have jurisdiction over fish culture cages suspended in navigable waters as well as for fish pens which are extended to the bottom of a navigable stream, bay, or tide water (as defined above). Currently there is no law which requires a lease for the use of this submerged land. A study recently completed entitled *Ocean Leasing for Hawaii* (Clay et al., 1981) addresses Hawaii's laws regarding the use of submerged lands and the use of those lands (and water) for aquaculture with its potential legal implications. A similar study regarding leasing of submerged lands around Guam should be implemented as a prerequisite to the establishment of the legal basis for leasing submerged lands for aquaculture. Government Code Title XIII, Ch. IV 12310 requires the issuance of a license from the Department of Agriculture for the placement or maintenance of a fish weir; however, this does not provide for coverage of fish cages or other means of culturing fish in open natural bodies of water. This needs to be clarified.

To allow for and encourage the practice of aquaculture in appropriate public waters and submerged lands around Guam, provision for a lease program should be instigated. This could be established as an amendment to Public Law 15-18 which sets guidelines for the

lease of government owned lands for aquacultural use. Section 2 of P.L. 15-18 defines agriculture to include aquaculture. Section 1 states "The Department of Land Management subject to approval by the Governor, is authorized to declare available for lease under the provisions of this Act, government real property as may be suitable for agriculture and which is not required for public use or reserved for other purposes by any other provision of law." The Department of Agriculture administers the lease of government land designated under this public law by the Department of Land Management for agricultural lease. Since aquaculture practice utilizing fish cages, fish pens, raft culture (bivalves), or other means of culture of aquactic species in public waters or submerged lands it not expected to be extensive on Guam, it would not be prudent to designate all government owned submerged land that could be used for such aquaculture practices into the government land lease program (P. L. 15-18). Such sites should be identified by the prospective aquaculturists wishing to establish such a structure in government waters and submerged lands. Then such a proposed lease should be reviewed by the appropriate government agencies.

The point of providing a provision for the lease of public waters and submerged lands is for an entrepreneur to develop an aquaculture site in coastal waters he must have some assurances of the continued use of that site for a certain period of time so as to regain his initial investment and a reasonable return on the investment. The leasing of submerged shoreline and public waters for the practice of aquaculture involves a number of practical constraints that must be clarified regarding the leasee's rights. The regulation of poaching, vandalism, or trespassing within an area leased for aquaculture that has been open previously to public access are some of the potential problems. In addition, the means in which a lease is granted would have significant consequences upon its usefulness. An issuance of a license that has been reviewed by the appropriate government agencies carefully delineating its use, rights, and restrictions could eliminate the process of obtaining permits from various government agencies.

Recommendations (Riparian Rights and Submerged Lands Ownership):

- 1) Conduct a study of the laws and the legal implications in the leasing of submerged lands for aquaculture.
- 2) Provision of a lease program for public submerged lands and waters around Guam to allow for and encourage aquaculture practices.

PERMITS FOR AQUACULTURE

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 6 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 as to whether the application complies with the GCMP. Guam's "coastal zone" includes all non-Federal property within the Territory of Guam, including offshore islands and the submerged lands and waters extending seaward to a distance of three (3) nautical miles, so in essence 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 involving proposed facilities to be located within a unit of the Guam Territorial Park System or effecting a cultural or historic resource. An aquaculture facility within the Guam Territorial Park System would require a permit from DPR under Sections 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 virtue of Chapter XIII, Government Code of Guam. Section 13985.19 states the requirement for clearance by DPR prior to construction.

The construction of earthen ponds requires an excavation permit from the Department of Public Works. The construction of structures such as a storage shed, living quarters, water shortage tanks, and concrete walled ponds would require a building permit from Public Works. This requires the applicant to submit a detailed draftsman's drawing of the proposed facility. Land Management must also issue a permit denoting that the proposed

TABLE 6

RESPONSIBLE AGENCIES FOR ISSUANCE OF PERMITS FOR AQUACULTURE RELATED ACTIVITIES

	ARMY COE	PUBLIC WORKS	LAND MANAGEMENT AND SEASHORE PROTECTION COMM. & TERRITORIAL PLANNING COMMISSION	GEPA	BOP	DOA	PARK & REC.	REV. & TAX.	PUBLIC HEALTH	PUAG
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 ocean	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

TABLE 6
RESPONSIBLE AGENCIES FOR ISSUANCE OF PERMITS FOR AQUACULTURE RELATED ACTIVITIES (continued)

	ARMY COE	PUBLIC WORKS	LAND MANAGEMENT & SEASHORE PROTECTION COMM. & TERRITORIAL PLANNING COMMISSION	GEPA	BOP	DOA	PARK & REC.	REV. & TAX	PUBLIC HEALTH	PUAG
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 plants	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.

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 and 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 usage. To obtain potable water Public Utility Agency of Guam (PUAG) must inspect the premises. Reduced agricultural rates are available. An access road constructed within private property does not require a permit unless major excavation is involved, then an excavation permit is required from Public Works.

Department of Revenue and Taxation does not have the responsibility of issuing permits or reviewing permit applications for aquaculture type of operations. Department of Revenue and Taxation does require an aquaculture operation once it starts to market its product to obtain a retail or wholesale business license. However, since aquaculture is an agricultural activity Section - 16024(b), 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-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 note to this exemption is that it applies only to producers and the direct sales by that producer. 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 keeping for use of property by a bonafide farmer engaged in agriculture on Guam and used or held for use only for agricultural purposes.

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 verifying that the animals are free of disease by a certifying agent in the country of origin. 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 Commission are located serves as a review and approving agency for permits involving land use. They are not a permit issuing agency. The Territorial Seashore Protection Commission membership is composed of the same seven (7) members that 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 including 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 plan 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 it is 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 Commission must be cleared through Land Management as a procedural process before the U. S. Army Corps of Engineers will issue their permit.

All development of a site must comply with the zoning laws. For example Chapter 3 Title XVIII of the Government Code of Guam Section 17103 "A" rural zone: 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 aquaculture activities also.

The Guam Environmental Protection Agency (GEPA) must review various permits before they are issued by the issuing agency, for example all clearing and grading permits (Public Works) must be reviewed and approved by GEPA as to the 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 license, and also a well drilling and a well operating permit is required from GEPA and falls under the Rules for Protection, Development and Conservation of Water Resources in the Island Territory of Guam. Issuing permits for discharge of effluent through an injection well, which are 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 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 Consolidated Permit Program Regulations, which applies to States 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 jurisdictions of the U. S. Army Corps of Engineers is mainly with structures 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 for the purpose of dumping it into ocean waters.

The following is a clarification and elaboration on the actions above (numbering corresponds to actions in Table 6) and their requirement for a U. S. Army Corps of Engineers permit.

- 1-2. Construction of earth or concrete ponds requires a DA permit if the earth fill or concrete for the ponds themselves, 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 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 require a DA permit. Construction of influent lines or pump stations in other areas may require a DA permit if discharge or placement of dredged or fill 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 discharge structure.
9. Land zoning requirements are strictly a matter under local jurisdiction not the 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.

A proposed list of "Categorical Exclusions", which are "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" 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.

To obtain all of the legally required permits as presented here by an aquaculture entrepreneur, many being small farmers with limited financial resources and experience in pursuing bureaucratic formalities, would often be discouraging. This may be discouraging enough to have the potential entrepreneur discontinue the pursuit of establishing a farm or possibly to proceed without obtaining the proper permits in fear of rejection during the permit application phase or the potentially prohibitive additional cost in capital and time to the construction of the aquaculture facility. The latter has been the case in the majority of the presently established aquaculture facilities on Guam, with the additional justification under the guise of ignorance of such permits being required and the independent nature of farmers that are often indifferent to government regulations restricting the use of their privately owned land. This problem of non-compliance to all the permit requirements would have to be corrected over time and in such a manner as not to place all the burden on new farms while not requiring established farms from meeting neglected regulations. A grace period should be allowed so as to permit all farms to meet the necessary requirements equally.

There is an apparent lack of knowledge within and among the permit issuing agencies as to what permits are actually required for the various activities in the construction and operation of an aquaculture facility. This bureaucratic inadequacy became apparent in the compilation of this permit requirement summary. Often contradictory statements were made on the requirements for a permit for a given activity from a certain agency. This confusion and frustration to the potential entrepreneur would be avoided by the establishment of a Master Aquaculture Permit Application.

The Aquaculture Lead Agency should be responsible in screening potential aquaculture entrepreneurs and providing them with a detailed listing of permits required after carefully reviewing the particular site for the proposed facility. A master application form should be formulated so as to not burden the potential entrepreneur with repetitive application forms, and the provision of documents to the various permit issuing agencies. This Master Aquaculture Permit Application should then be circulated by the Lead Agency to the various departments and federal agencies that are responsible for the issuance of the required permits.

This procedure of consolidation and simplification would greatly assist the potential entrepreneur and assure the equal compliance of all aquaculture facilities to the permit requirements and minimize potential deleterious impact on the environment by providing the proper review of the project thus serving the private sector in its development while assuring the rights and the preservation of the general environment of the public as a whole.

Recommendations (Permits for Aquaculture):

- 1) Provision of a Master Aquaculture Permit Application.**
 - a) The Aquaculture Lead Agency would be responsible for informing potential entrepreneurs of the permits required and the distribution of the permit application to the appropriate agencies for issuance of the necessary permits.**
 - b) Develop a permit guide for aquaculturists.**

SECTION IV

Implementation Strategy

INDUSTRY ORGANIZATION

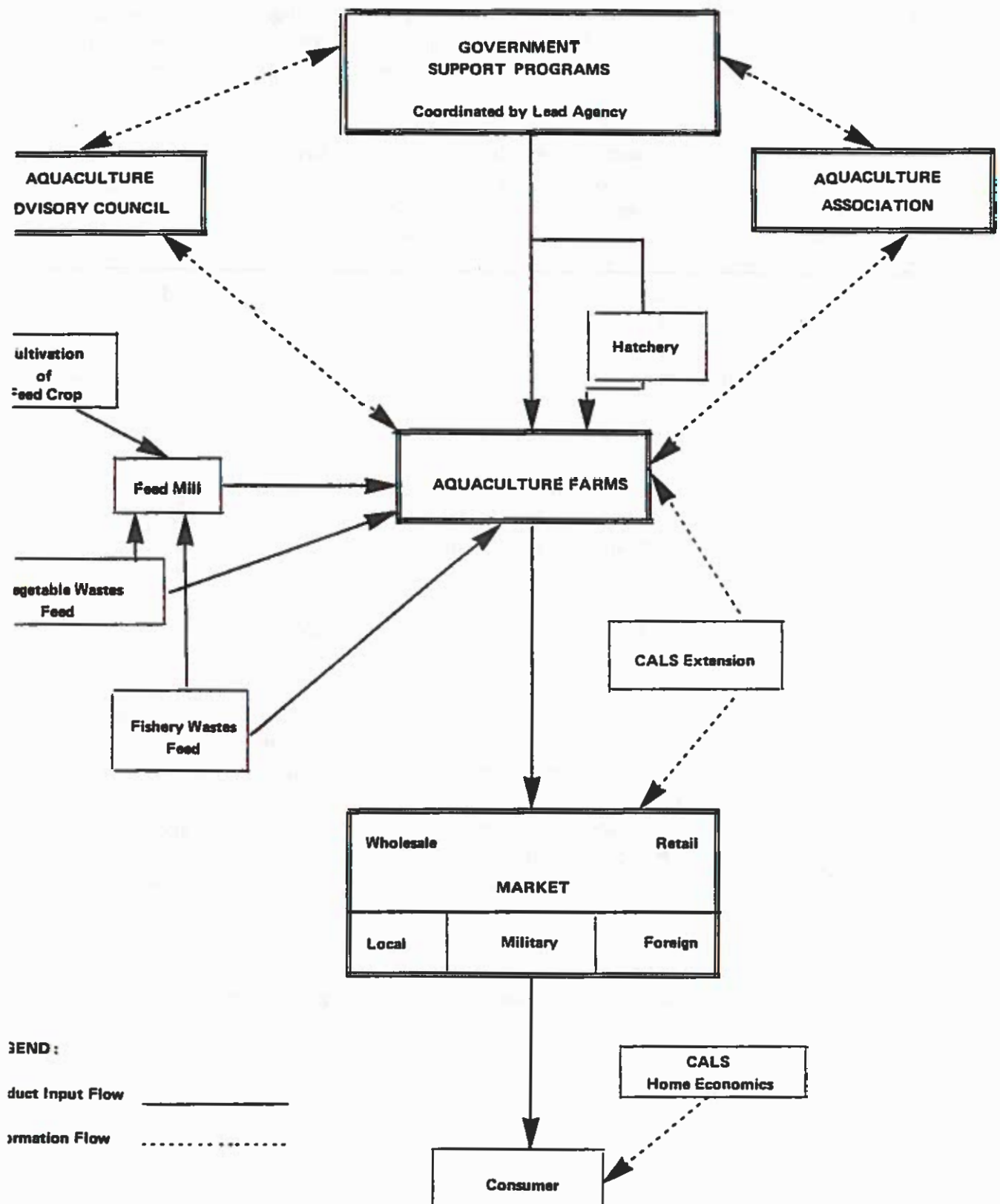
A horizontal and vertically integrated system (Figure 7) should be instigated on an island wide basis involving both private and government bodies to maximize efficiency and coordination among the various levels within an aquaculture industry. This should optimize production and profit to the firms involved and supply a high quality product at a reasonable cost to the consumer. A horizontally integrated organizational cooperative should be formed at the producer level. This has been established by the formation of the Guam Aquaculture Association.

The vertical integration in aquaculture should involve both existing agricultural and fisheries organizations as much as possible. Since there exists a well developed agricultural support base and the fisheries group is becoming organized, they can both be of assistance to aquaculture without the establishment of a completely new organization or infrastructure. This vertical integration would constitute the support system of aquaculture being associated with agricultural organizations such as infrastructure (roads, power, water) feed, fertilizer, loans, crop insurance, extension service, education and training. Aquaculture has many similarities to agriculture especially in the supply of input factors as well as the production process, while processing and distribution have much the same characteristics as commercial fisheries. The hatchery and grow-out farms would be the primary aquaculture component and the center of the system. This would then terminate forward into the fisheries sector where the marketing of the product would be handled. There would also be a feedback from the fisheries sector into the aquaculture components in the form of supplying fish and fish scraps as a feed supply. This would have a stabilizing effect on aquaculture and promote a unified industrial unit within the island economy.

GROWTH PATTERN OF THE INDUSTRY

Aquaculture development on Guam will most likely be based on an artisanal industry which will gradually expand into a mature full-scale commercial industry. Some medium to large scale commercial operations can be expected to develop as the industry matures. A sound basic approach to those entering aquaculture with limited experience and resources is to start with species that are relatively simple (e. g., tilapia) and with lower than maximum stocking densities to allow for a margin of error in management practices without producing economic catastrophic results. Once the management of an aquaculture farm is well experienced, a progressive change over to species requiring a more refined management plan can be accomplished if there is the market demand and if the economics of the situation are favorable. This type of approach would allow for the development of managerial skills without the possible frustration and economic loss that could end in the abandonment of the aquaculture farm with the culture of a more demanding species.

FIGURE 7. AN INTEGRATED SYSTEM FOR THE AQUACULTURE INDUSTRY



The growth of the industry is expected to be slow at first until infrastructure and the support base become established and functional. Caution mixed with keen interest in the potentials of this industry by entrepreneurs will be experienced in the early phase and followed by rapid growth as the pioneer aquaculturists show economic success. Thus, the industry is expected to show an early lag phase followed by rapid growth which then levels off as the local market approaches saturation. Foreign market investigation and attempts to secure a market for Guam's aquaculture products should be conducted prior to the saturation of the local market. With favorable prospect for an export market, the infrastructure to meet those markets' demands (e. g., quality, quantity, consistency and price) must be developed. Again there is expected to be only a slow growth in aquaculture during this period of stabilization between a local market and an export market. Once the channels and procedures are established for the foreign market, another period of rapid growth would be expected and this would then level off at a point where competition for available natural resources and possible limits on the foreign market are reached. This plateau will then signify Guam's maximum potential in aquaculture.

AQUACULTURE ADVISORY COUNCIL

The creation of an Aquaculture Advisory Council should be a high priority and is required to bring together leaders of the various government aquaculture programs and support services with the private sector that are actively involved in aquaculture or a support function to the industry. The Council should have a vertically integrated representation of the various sectors involved in the aquaculture industry (e. g., hatchery to consumer).

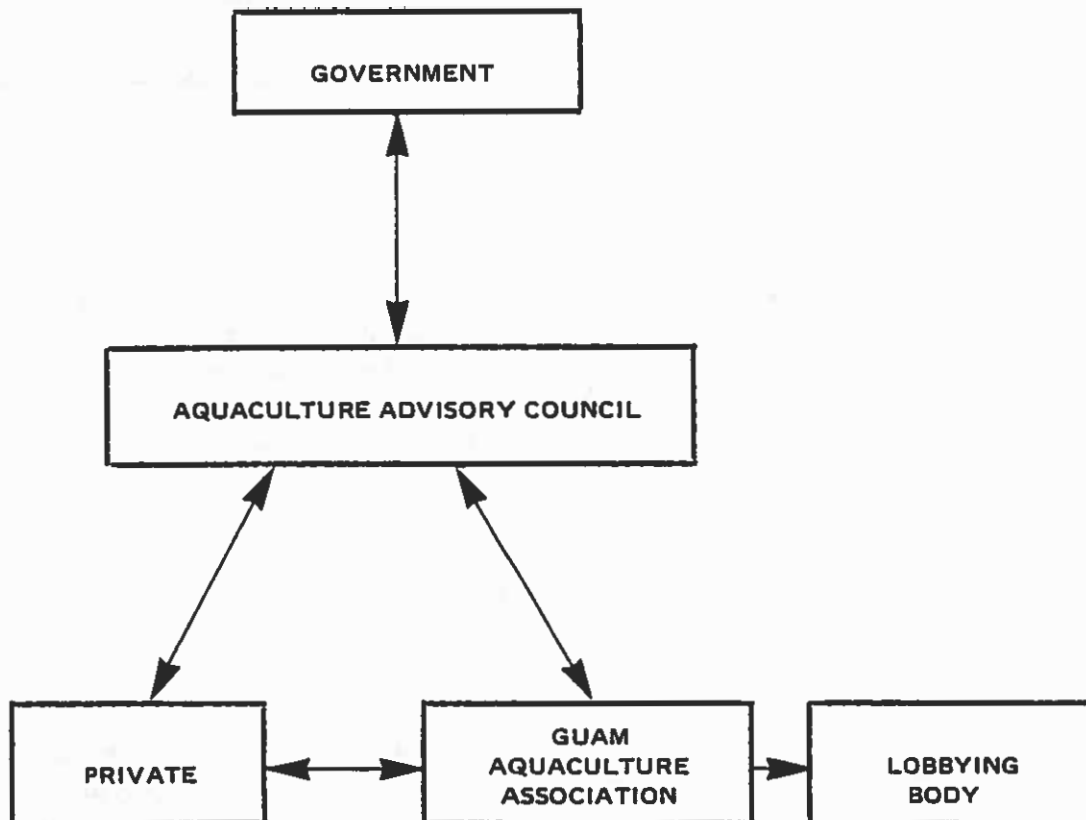
A recent study by the National Academy of Science (1978) points out that aquaculture in the U. S. will flourish best if there is strong support from the state governments. That support will be most effective if it is organized and guided by user groups (involved state agencies, producers, and consumers). It was recommended that the governors appoint an "Aquaculture Advisory Council" in their respective states.

The function of the Council would be to provide a forum in which interaction between the public and private sectors can occur to facilitate the growth of the aquaculture industry. This will allow the private sector to have direct input, to voice their needs and allow the government to coordinate their efforts to fill these needs. This interaction diagrammatically illustrated in Figure 8 should also identify areas of expertise and input that will be required from the private sector to aid the industry's development. The Council's interaction with the total industry should gain a holistic outlook and be able to provide a realistic overall guidance to the development of the industry and advice the Governor's office on policy and public laws affecting aquaculture.

The voting membership on the Council should be limited to agencies and people directly involved with some aspect of the aquaculture industry. Federal studies on the development of aquaculture in the United States recommended a 40% to 60% representation of

FIGURE 8

**INTERACTION BETWEEN GOVERNMENT AND PRIVATE INDUSTRY
FACILITATED BY THE AQUACULTURE ADVISORY COUNCIL**



the private/industry sector to be included in the voting membership of a state Aquaculture Advisory Council. The memberships should include the following:

VOTING MEMBERSHIP

GOVERNMENT

- Department of Agriculture
- Department of Commerce
- College of Agriculture and Life Sciences
- Marine Laboratory
- Guam Environmental Protection Agency
- Bureau of Planning (Coastal Zone Management)
- Guam Economic Development Authority

PRIVATE

- Guam Aquaculture Association
- 3 Commercial Aquaculture Producers at large (provide representation to all major species being cultured e. g., prawns/shrimp, eels, finfish).
- Guam Fishermen's Cooperative Association
- Consumer Group Representative

The following non-voting members should attend meetings only on special request, regarding support or information needed from that particular agency.

NON-VOTING SUPPORT MEMBERSHIP

- Guam Farmers Cooperative Association
- Public Health
- Guam Power Authority
- Public Utility Agency of Guam
- Department of Public Works
- Department of Land Management

Chairmanship of the Council should remain with the Lead Agency or if such an agency has not been formed, the chairmanship should rotate annually between DOC and DOA. The Lead Agency (Department of Commerce or Department of Agriculture if Lead Agency not established) should supply staff support to the Council as needed (e. g., preparation of minutes, correspondence, and position papers).

Recommendations (Aquaculture Advisory Council):

- 1) Establish the Aquaculture Advisory Council.

LEAD AGENCY

It is disadvantageous to have the aquaculture program divided up among a number of governmental agencies with no lead agency setting an overall direction and goal to the program. At present, the program is divided among four different government agencies. They are the Department of Commerce, Department of Agriculture, Marine Laboratory, and the College of Agriculture and Life Sciences. The importance of a unified program with the consolidation of resources (manpower and funding) cannot be overemphasized. There is a tendency within government to segment and divide various aspects of a program into a number of departments each striving for their own uniqueness and authority which results in the detriment of the program as a whole. The success and cost effectiveness of the program will be dependent upon the unification of the program (Figure 9).

The Lead Agency must be action oriented and dynamic in its ability to deal with all functions of the industry in order that it may efficiently coordinate the entire aquaculture program of the government.

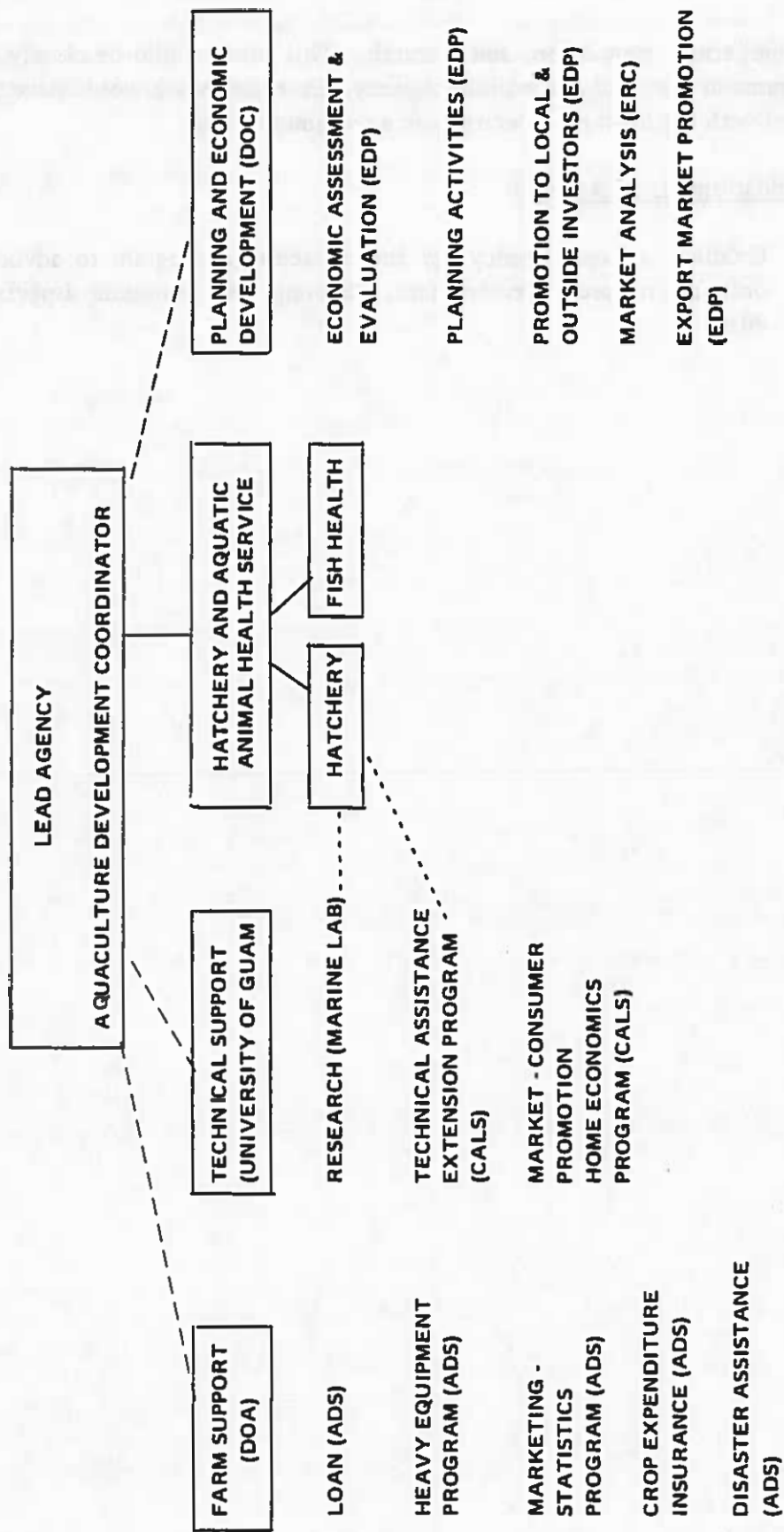
The most effective placement of the aquaculture program with its increasing importance in the island economy would be within the Governmental reorganizational scheme as proposed by the present administration. The creation of a consolidated Department of Natural Resources with the placement of the three major complementary bodies - - Agriculture, Fisheries (Marine Resources), and Aquaculture - - as separate divisions would be the most beneficial organization (additional agencies within this Department could include Forestry, Land Management, Parks and Recreation and the Energy Office). Each division would have their own unique problems to address and yet, these complementary activities would be best coordinated and enhanced through such a unified Department so that interaction of expertise, utilization of joint facilities, planning, and efficient decision making can be coordinated to utilize and manage the island's natural resources to the optimum benefit. This approach would also minimize the cost burden on the Government by elimination of duplication in complementary areas and the sharing of resources.

An alternative to the reorganization of government agencies is the establishment of a Lead Agency within one of the line agencies presently involved in the aquaculture industry, preferably one with an active background in attracting investment, both local and foreign or by assigning a Special Assistant within the Governor's office to coordinate research, development, planning and economic aspects of the industry.

The University of Guam will be of assistance to aquaculture through the Marine Laboratory and CALS. Since the University's policy is not to become directly involved in the economic aspects of the private sector, which are the responsibilities of various government line agencies, its participation in aquaculture will be in the form of services for extension.

FIGURE 9.

PROPOSED GOVERNMENT OF GUAM AQUACULTURE DEVELOPMENT ORGANIZATION



— Administrative Relationship
 - - - Coordination of Program
 Cooperative Interaction

training, marketing promotion, and research. This work should be closely coordinated with programs in the Lead Aquaculture Agency. Extension work would have to be closely coordinated with the hatchery operation on a continuous basis.

Recommendations (Lead Agency):

- 1) Establish a Lead Agency for the aquaculture program to advocate and coordinate research, development, planning and economic aspects of the industry.

AQUACULTURE INFRASTRUCTURE DEVELOPMENT REVOLVING FUND

As with any development plan, a reliable source of adequate funds for its implementation is essential. It will be necessary to secure an annual source of funds directed specifically for aquaculture projects. The establishment of an aquaculture fund would greatly assist in the implementation of the needed projects and programs for the development of this industry. Without such a minimum revenue base to support the progressive development of the industry the timely realization of an aquaculture industry on Guam will be seriously hampered.

The lack of a consistent directed program of support to this industry in the past has frustrated a number of the island's more adventurous entrepreneurs that have invested into developing aquaculture farms under the expectation of promised government support. For example, the continued lack of a permanent on-island hatchery that is capable of supplying the postlarvae or juveniles of the species being cultured has caused a number of farmers to abandon their aquaculture ponds after substantial investment. This is due to the high cost and inconsistent supply of imported postlarvae and the failure of the previously proposed government hatchery to materialize.

Federal funds available from such agencies as the Economic Development Administration and the National Marine Fisheries Service, which have assisted in Guam's aquaculture programs in the past, will be very limited if not totally eliminated. Other federal agencies that could assist in the development of Guam's aquaculture industry may receive drastic reductions in their budgets due to the reprioritization by the Reagan Administration. This necessitates Guam taking upon itself the responsibility of providing the financial support for establishing a viable aquaculture industry on Guam. Without such a commitment, the industry will continue to stagnate.

Local funding is required for the establishment of the Aquaculture Infrastructure Development Revolving Fund. The funds currently available in the Territorial Lottery Fund properly and legally could be the source of monies to support this Revolving Fund. The enabling legislation (Public Law 13-123) establishing the Territorial Lottery Fund identifies agricultural development as an area for which surplus funds may be used. Aquaculture has been identified as an agricultural activity in a number of previous Public Laws (e. g., P. L. 13-195, P. L. 14-22, P. L. 15-18, P. L. 15-74, Resolution 185, Resolution 195 and Resolution 220). The Territorial Lottery Fund is expected to receive between \$800,000 to \$1,000,000 in surplus funds annually.

The administration of the Aquaculture Infrastructure Development Revolving Fund should be the responsibility of the Lead Agency. In lieu of the establishment of the Lead Agency,

the Department of Commerce should administer the Fund, since it would follow Commerce's role in the development of the Island's economy and would provide the means for the implementation of the Plan prepared by the Department of Commerce. The Fund would be utilized for the construction of facilities and the implementation of projects that are consistent with the recommendations and the priorities set forth in this Plan. In addition, the funds could be used to match federal grants that become available for aquaculture projects. By utilizing available grants, this would maximize the benefits derived from the Fund. All projects to be funded by this Revolving Fund should be reviewed and approved by the Aquaculture Advisory Council.

The funding of the Aquaculture Infrastructure Development Revolving Fund should be on an incremental basis extending over a period of five years. The first year should be funded at \$600,000 with the addition of \$300,000 per year over the next four years. The larger amount of funds in the first year would allow for the construction of the hatchery, which will be the major capital improvement project and the foundation to many of the future projects assisting in the development of the industry.

Recommendations (Aquaculture Infrastructure Development Revolving Fund):

- 1) Establishment of the Aquaculture Infrastructure Development Revolving Fund.
- 2) Deposit funds into the Aquaculture Infrastructure Development Revolving Fund in the amount of \$600,000 for the first year and \$300,000 per year for the next four years.
 - a) Utilize monies derived from the territorial Lottery Fund or tapping a percentage of a specific tax revenue (e.g., liquid fuel tax, excise tax).

SCENARIOS FOR THE DEVELOPMENT OF THE AQUACULTURE INDUSTRY

To see a significant aquaculture industry become a reality on Guam, it will require a sincere commitment by the government to implement programs that will assist the industry's development. Private business will be much more willing to invest its capital in aquaculture if there is a strong and active support program within the government advocating this development. In the following scenarios the progressive implementation of policies and programs are presented in such a manner as to emphasize the interrelationship and step wise interaction of these programs with regard to their timely implementation for the progressive development of an aquaculture industry (Figure 10).

Figure 11 represents the flow and interaction between the three major actions in the aquaculture industry, namely the hatchery (postlarval and juvenile production of cultured species), aquaculture farm (grow-out) and market (marketing of product to consumer).

The hatchery component is the base of the industry supplying the postlarvae and juveniles of the cultured species to the aquaculture farms via the extension program, and is the coordinating center for all technical assistance. A disease control program, which includes the monitoring of all imports through the Fish Health Monitoring Program, provides the prophylactic measures to control disease outbreaks as well as the diagnosis and treatment when a disease problem occurs in the hatchery component as well as through the extension service to the aquaculture farm site.

The Technical Assistance Extension Program provides technical assistance to potential entrepreneurs and the aquaculture farms in the form of site evaluation, water analysis, soil analysis, construction design, construction cost estimate, operating cost estimates, permit requirements, sources of possible financial assistance, advice on which species to culture, stocking assistance, feeding requirements, use of fertilizers, general management assistance, and coordination of harvesting and marketing.

The aquaculture farm component represents the major investment by the private sector. The various species cultured are grown out to market size, harvested and delivered to the appropriate market. The farm component also serves as a source of mature animals that are collected by the extension program and returned to the hatchery as needed for the propagation of those species.

To develop the aquaculture farm component, adequate capital is required which may be obtained from various sources (e.g., proposed Aquaculture Loan Program, Farmers Small Loan Fund, Agriculture Development Fund, Farmers Home Administration, Small Business Administration, Growth Council Loan Program, or Private banking institutions and investors), and suitable land and water. Along with this, experienced personnel in both

management and the biological technical aspect of aquaculture are required. For small farms, the utilization of the training program (see Manpower) and the assistance of the extension service by the entrepreneur/farmer would be adequate.

The market component could be a centralized wholesale marketing outlet such as the Guam Fishermen's Cooperative Association, or one of the military purchasing offices retail markets, or direct sales to the consumer. The market component would be eventually composed of a local and export market. Market research and promotion would be required to develop the export market and to ensure the full exploitation of the local market.

SCENARIOS FOR HATCHERY OPERATION

SCENARIO I, GOVERNMENT OWNED/OPERATED HATCHERY

In view of the Government of Guam's present restrictive cash flow situation, a major concern has been the level of subsidy required to defray the hatchery's operating costs. However, the operating costs of a government hatchery are shown to have no or minimal additional burden on the government's limited financial resources. Through the identification and analysis of the operating needs of the hatchery, a method to limit budgetary impact on a Government owned/operated hatchery while permitting its proper management. Resources currently available within the government can be diverted to the hatchery operation. The hatchery operating costs can be minimized by reorganization, consolidating and economizing of the existing programs within the Government involved in aquaculture.

The projected net revenue to be generated by a prawn industry at the "Guam Based Industry" stage (50 acres), Intermediate stage (180 acres) and Mature Industry (500 acres) stage are shown below. The Guam Base Industry stage is expected to be reached within three (3) years after the construction of the hatchery.

	GUAM BASE INDUSTRY (50 pond acres)	INTERMEDIATE INDUSTRY (180 pond acres)	MATURE INDUSTRY (500 pond acres)
Annual Tax Revenue	\$50,815-80,815	\$163,670-273,000	\$416,810-716,810
Annual Hatchery Subsidy Requirement	\$ 27,160	-0-	-0-
NET ANNUAL TAX REVENUE	<u>\$ 23,655-53,655</u>	<u>\$163,670-273,000</u>	<u>\$ 416,810-716,800</u>

It is recommended that the government owned hatchery be initially operated by the government. Once the hatchery is near full operational capacity (support to 100 acres, expected five (5) years after construction), it can be turned over to a private firm on a management basis, or leased out to a private firm or non-profit cooperative with an established background in operating such a hatchery.

The initial three-year starting period for a commercial grow-out facility is the most crucial and requires the greatest capital investment by the entrepreneur. To stimulate growth of aquaculture on Guam, it is recommended that the purchase of postlarvae be subsidized for the first three years and thereafter the farmer should purchase the postlarvae at cost (subject to review in accordance with the degree of economic prosperity the private sector has obtained). This method is practiced in Hawaii through their State-operated hatchery and has proven very successful. During the first three years of operation of Hawaiian farms, the farmer can enter into an agreement with the State wherein he can receive postlarvae to stock his ponds at no cost. After the initial three year period, he pays at cost (estimated at the Hawaii State hatchery to be \$8-10/1000 postlarvae). A modified version of this is recommended for Guam. With the rise in operating costs plus the fact that the hatchery will be initially operating below its capacity, the actual cost of production per postlarvae will be much higher. During the first three years, the Guam farmer should be allowed to purchase the postlarvae at \$15/1000 postlarvae (refer to cost of production in Table 7), which will serve as a form of financial support and incentive for new prawn farmers to become established. This is considered a reasonable price that a serious farmer should be able to bear. Charging a price for postlarvae will also discourage farmers who would take the postlarvae only if they were free with no serious intentions of operating an efficient aquaculture farm. A stipulation should be made that the supply of postlarvae at the subsidized price shall only be stocked into ponds that are capable of being economically managed (consideration of such criteria as size of pond, water supply, potential land for further development, etc.), since it would be the intention of such a program to assist in the establishment of an economically viable industry and not for personal experimentation and delectation. After the initial three years, the farmer should purchase the postlarvae at cost, but not to exceed \$25/1000 postlarvae (1981 dollar value). The proceeds from the sale of the postlarvae and fry produced in the hatchery should be placed in a revolving fund and utilized to offset future operating expenses.

Since a function of government is to stimulate and assist in the economic growth and well being of a community while not directly competing with the private sector's entrepreneurship, an analysis should be made after the initial five years and periodically thereafter to determine if the continued operation of the hatchery by the government is appropriate. This will be dependent upon a number of factors including:

- 1) the development state of commercial aquaculture grow-out operations;
- 2) the financial success and stability of the industry;

- 3) the needs of the commercial aquaculture industry (quantity of stocking supplies, the types of species cultured, etc.);
- 4) the desire of the private sector to operate a hatchery on a commercial basis with interest in further stimulating aquaculture development; and
- 5) the interest and ability of a qualified and adequately experienced private group to operate the hatchery.

A decision determining the future operational status of the hatchery will require careful analysis with a consensus from both the private and government sectors on the overall state of the industry. Caution must be exercised, since the misjudgment of the status of the industry on Guam with subsequent premature withdrawal of support in the form of a government operated hatchery could have a very negative effect on the future of the industry. However, it is not the intention of the government to establish an industry that will be perpetually dependent on State subsidy for its existence even though this is required in the early phase of development. The government should be wary of setting a precedent where, over an extended period of subsidy to the new industry, it becomes dependent and expectant of continued subsidized support from the government to the financial detriment of the government's proportional income in revenue from the industry.

The Hawaii State operated hatchery program can serve as a guide. A State operated hatchery has been in operation since 1965 and has been the base of support in establishing and maintaining the present large commercial aquaculture industry. However, the private sector has advanced beyond the operation of grow-out facilities only, and has opened private hatcheries, which are capable of meeting at least a majority of the demand for postlarval prawns. The State with their policy of providing free of charge postlarvae for a certain period of time to new farmers entering into a contract with them and later at cost is currently in direct competition with the private sector. Therefore, a phasing out of the government operated prawn postlarval production has been proposed by December 31, 1985. It is expected that the prawn industry and aquaculture in general on Guam will develop proportionately faster than it did in Hawaii in the past 15 years since the establishment of Hawaii's State hatchery. This would be expected, since the state of the art/science has significantly advanced and the commercial feasibility of such an industry has been established. For this reason the comparatively early evaluation of the hatchery's operational status on Guam is necessary.

If it is decided that after the initial five (5) years of operation of the hatchery that a transfer to private management is appropriate, it would be strongly advised that such a transfer would be in the form of gradual phasing out of the government support at the hatchery level. This could be in the form of a graduated continued defrayment of the production costs so that the transformation would not be an abrupt shock to the industry, thus allowing for the gradual adjustment at all levels of the industry (production to market) to the additional costs.

TABLE 7

SCENARIO I

GOVERNMENT OWNED/OPERATED HATCHERY ANNUAL OPERATING COSTS

EXPENSE CATEGORY	Production Level I 10 Pond Acres 0.8 Million Postlarvae	Production Level II 20 Pond Acres 1.6 Million Postlarvae	Production Level III 50 Pond Acres 4 Million Postlarvae	Production Level IV 80 Pond Acres 6.4 Million Postlarvae	Production Level V 100 Pond Acres 8 Million Postlarvae
Rent	-	-	-	-	-
Property Tax	-	-	-	-	-
Insurance	-	-	-	-	-
Labor - Salary	\$ 50,000 ^{1/}	\$ 64,500 ^{2/}	\$ 64,500 ^{3/}	\$ 75,000 ^{3/}	\$ 75,000 ^{3/}
Benefits	10,000	12,900	12,900	15,000	15,000
Feed - Fish	100	200	473	800	945
Feed - Brine Shrimp	1,400	2,800	7,000	11,000	2,500
Larvae-Related Supplies	1,500	1,800	2,000	2,300	2,500
Lab/Office Supplies	4,800	4,800	4,800	4,800	4,800
Utilities	4,300	6,000	7,500	9,000	9,600
Delivery	500	1,000	2,500	3,500	4,770
Legal Audit	3,200	3,200	3,200	3,200	3,200
Loan	-	-	-	-	-
Sub Total	75,800	97,200	104,873	124,800	129,815
10% Contingency	7,580	9,720	10,487	12,480	12,982
Total	\$ 83,380	\$ 106,920	\$ 115,360	\$ 137,280	\$ 142,797
Cost/1000 Postlarvae	\$ 104.23	\$ 66.83	\$ 26.84	\$ 21.45	\$ 17.85

^{1/} Manager, Biological Aide, Marine Technician^{2/} Manager, Biological Aide, Marine Technician, Biologist^{3/} Manager, 2 Biological Aides, Marine Technician, Biologist

The research and development aspect of the hatchery would best be served by the joint operation of the Lead Agency with the Marine Laboratory.

The cost per unit of production of prawn postlarvae will be higher when the hatchery is operating below its capacity (Table 7 and 8). This is expected in the initial start up phase of an industry; however, the number of aquaculture farms will increase rapidly once an on-island supply of postlarvae becomes available through the permanent hatchery. In projecting the operating costs of the government hatchery the assumption is made that the cost for construction of the hatchery (estimated at \$650,000) would be mainly funded through a federal grant, thus eliminating the expense of loan repayment in the annual operating cost.

If production costs are initially passed directly onto the farmers, the development of pond grow-out acreage would be prohibitive. Since the purpose of the hatchery is to promote the grow-out sector of the developing aquaculture industry, a portion of this cost will initially have to be subsidized by local and federal government sources. There are a number of granting agencies (e. g., Sea Grant, National Marine Fisheries Service, National Science Foundation, U. S. Department of Agriculture, U. S. Department of Commerce, Department of Energy) from which the hatchery would be eligible to receive funds to defray a portion of the hatchery's operational costs. This is a means that Hawaii has utilized to reduce the level of State subsidy at its State-operated hatchery.

Since the major expenditure item for the hatchery operation is labor, assigning existing personnel within the Government agencies to the proposed hatchery would, in effect, reduce the amount of new local funds to be appropriated for the hatchery. For example, the Department of Agriculture has a biologist and two biological aide positions that carry out the Department's aquaculture program which could be assigned to the hatchery. The only additional personnel that would be required are a manager and marine technician, who likewise might even be filled from within the ranks of present Government employees. Assuming that at least the three mentioned positions can be filled by the transfer of duties of existing personnel, this would lower the expenditure for labor by up to \$35,500 annually.

TABLE 8

COST BREAKDOWN OF INDIVIDUAL EXPENSE CATEGORIES
(After Aquatic Farms, Ltd., 1978)

The following is a breakdown of the individual expense categories under the Government operated scheme:

<u>Labor (Salary)</u>	<u>Per Annum</u>
Manager/Biologist	\$ 25,000
Biological Aide	10,500
Biologist	14,500
Marine Technician	14,500

Benefits

Employee benefits such as retirement (social security), health, dental, life insurance is calculated on the basis of $0.2 \times$ Gross salary.

Feed - Fish

Approximately 150 pounds of fish will be utilized as prawn feed during each of the six (6) weeks of a hatchery run. There will be seven (7) cycles per year.

<u>Description</u>	<u>Amount</u>
Fish - 150 lbs.	1050 lbs./year
Total	1050 lbs./year

<u>Expense Category</u>	<u>Rate</u>
Fish - \$0.90/lb.	\$ 945

Feed - Brine Shrimp

Approximately 80 pounds of brine shrimp eggs will be utilized as prawn feed during the six (6) weeks of the hatchery run. There will be seven (7) cycles executed per year.

<u>Description</u>	<u>Amount</u>
Brine Shrimp	\$14,000
Total	\$14,000

<u>Expense Category</u>	<u>Rate</u>
Brine Shrimp	\$ 15/lb.

Larvae-related Supplies

A number of disposable items are needed for work with the prawn larvae. Examples of these goods are buckets, barrels, hoses, screens and small amounts of chemicals. Expenditures of this nature are estimated from the previous experience of other prawn hatcheries.

<u>Description</u>	<u>Amount</u>
--------------------	---------------

Larvae-related Supplies	\$ 2,500
-------------------------	----------

Total	\$ 2,500
-------	----------

<u>Expense Category</u>	<u>Rate</u>
-------------------------	-------------

Larvae-related Supplies	\$2,500/year
-------------------------	--------------

Laboratory/Office Supplies

This item represents the continuing needs of supplying the hatchery laboratory and office with expendable materials.

<u>Description</u>	<u>Amount</u>
--------------------	---------------

Lab/Office Supplies	\$ 4,800
---------------------	----------

Total	\$ 4,800
-------	----------

<u>Expense Category</u>	<u>Rate</u>
-------------------------	-------------

Lab/Office Supplies	\$ 400/mo.
---------------------	------------

Utilities

The utilities category includes all expenses incurred for power, water and communication needs. Electricity will be necessary to run the office/laboratory, the warehouse, three pumps, and one compressor. Fresh water will be utilized at a rate of 6,000 gallons per day during the period of the hatchery runs and intermittently during other times. The phone system will be in continual use. The cost estimates are based on historic use rates of other prawn hatcheries.

<u>Description</u>	<u>Amount</u>
--------------------	---------------

Electricity	\$ 6,000
-------------	----------

Water	1 500
-------	-------

Telephone	<u>2,100</u>
-----------	--------------

Total	\$ 9,600
-------	----------

<u>Expense Category</u>	<u>Rate</u>
Electricity	\$ 500/mo.
Water	\$ 125/mo.
Telephone	\$ 175/mo.

Delivery

The juvenile prawns will be transported live throughout the island. This will require expenditures for mileage, oxygen and repairs to all hatchery items.

<u>Description</u>	<u>Amount</u>
Oxygen	\$ 1,820
Mileage	\$ 1,950
Repairs	<u>\$ 1,000</u>
Total	\$ 4,770

<u>Expense Category</u>	<u>Rate</u>
Oxygen	\$260/cycle
Mileage	\$0.15 per mile
Repair	\$1,000/year

Legal Audit

Legal and accounting skills are additions to the hatchery if it is to function as a successful concern. The usage of these outside skills relates to the specific requirements of the hatchery.

<u>Description</u>	<u>Amount</u>
Legal	\$ 1,200
Audit	<u>\$ 2,000</u>
Total	\$ 3,200

<u>Expense Category</u>	<u>Rate</u>
Legal	\$ 40/hour
Audit	\$ 20/hour

Loan

The government owned/operated hatchery is assumed to receive a grant for the cost of construction for the hatchery.

The Cooperative owned/operated hatchery would have to obtain funding for the construction and initial operation through a loan. Two interest rates are considered.

TABLE 9

**ANTICIPATED REVENUES AND EXPENDITURES
GOVERNMENT OPERATED PRAWN HATCHERY**

	Production Level I 10 Pond Acres 0.8 Million Postlarvae	Production Level II 20 Pond Acres 1.6 Million Postlarvae	Production Level III 50 Pond Acres 4 Million Postlarvae	Production Level IV 80 Pond Acres 6.4 Million Postlarvae	Production Level V 100 Pond Acres 8 Million Postlarvae
Revenue					
1. Proceeds from sales	\$ 12,000 ¹	\$ 24,000 ¹	\$ 60,000 ¹	\$ 101,160 ²	\$ 124,560 ³
2. Grants*	---	---	---	---	---
Total Revenue	12,000	24,000	60,000	101,160	124,560
Expenditure					
1. Total Operating Costs	\$ 83,380	\$ 106,920	\$ 115,360	\$ 137,280	\$ 142,797
2. Less Salary in kind salary and wages by Government of Guam	<u>(13,700)⁴</u>	<u>(28,200)⁵</u>	<u>(28,200)⁵</u>	<u>(38,700)⁶</u>	<u>(38,700)⁶</u>
Total Additional Expenditure to the Government	69,680	78,720	87,160	98,580	104,097
PROFIT (LOSS)	(\$57,680)⁷	(\$54,720)⁷	(\$ 27,160)⁷	\$2,580	\$20,463

1. Charged at \$15/1000 postlarvae

2. 10 acres of ponds charged at cost (\$21.45/1000)
70 acres subsidized at \$15/1000

3. 20 acres of ponds charged at cost (\$17.85/1000)
80 acres subsidized at \$15/1000

4. Biological Aide @ \$10,500
Legal/Audit Fees - \$ 3,200

5. Biological Aide @ \$10,500
Biologist @ \$14,500
Legal/Audit Fees - \$3,200

6. Biological Aide (2) @ \$10,500
Biologist @ \$14,500
Legal/Audit Fees - \$3,200

7. Government of Guam Cash Subsidy Requirement

* The addition of grants (e. g., NMFS, Sea Grant, USDA) as a revenue source would have a positive effect on reducing overall operational costs of the hatchery.

The Department of Agriculture received a \$25,000 per year grant from the National Marine Fisheries Service for commercial fisheries development (under U. S. P. L. 88-309), which has been used exclusively for the Department's aquaculture program over the past eight years. These funds could be utilized by the hatchery to further defray hatchery expenditures which would otherwise be financed by the Government of Guam. However, these funds most likely will be eliminated in FY 82 as part of the Federal austerity measures.

The receipt of new and additional grants from various federal agencies for research and development should be pursued to further reduce costs to the Government of Guam. The hatchery facilities and operating expenditures can be used to meet matching fund requirements for federal grants. The legal and audit expenses can be minimized by utilizing those services existing within the Government.

Table 9 summarizes the Government of Guam's budgetary expense for the operation of the prawn hatchery utilizing the above recommended reorganization of personnel and federal grant funds that are already existing within the government structure. Further reduction in costs could be realized with the awarding of additional federal grants. As shown in Table 9, these costs are kept at a minimum and subsequently are reduced as the production capacity of the hatchery is reached. It should be noted that this does not include revenue to the government generated through the increased tax revenue by the industry (refer to Table 4).

If the government hatchery program is properly designed and managed, the additional cost to the Government of Guam's budget will be nominal in the beginning and will no longer be necessary once the hatchery becomes self-sufficient. The hatchery is expected to be self-sufficient within five (5) years after construction. This constitutes a small investment in the growth of the island's economy relative to the returns to the Government through income and gross receipts tax revenue (from retailers), increased employment, the replacement of imported products, and the generation of a potential export product.

SCENARIO II, COOPERATIVE OWNED/OPERATED HATCHERY (Agricultural Development Fund Loan)

Scenario II presents an alternative means of establishing and operating a permanent hatchery. This would be through a Cooperative (non-profit organization) of the farmers that would obtain a loan for the construction and the operating costs for the start up and first year operation of a hatchery.

The loan would be based on an estimated capital construction cost of \$600,000 and \$150,000 for the start up and first year of operating costs to give a total loan of \$750,000. The loan would be for a 30-year period; however, repayment of the loan would have to be deferred for the first one and a half (1.5) years, since this is the period when the hatchery would be in the construction phase followed by the initial testing of the systems, with no revenue being generated by the hatchery. This proposed hatchery is utilizing the same design (8 million postlarvae per year capacity) as that projected under the Government operated hatchery (Scenario I) so that a comparison can be made. The one exception would be the elimination of the hatchery's research capability, which was estimated at an additional cost of approximately \$50,000. This Scenario is based on the Cooperative obtaining a loan at a 3% interest rate through the Agricultural Development Fund (ADF) of the Guam Economic Development Authority (GEDA). It should be noted that GEDA only charges interest on that portion of the loan disbursed. So, if the full amount of the projected loan requirement is not needed, the repayment schedule would be reduced proportionately. However, if a loan request is made for a minimal expected cost without allowing for possible unforeseen costs, the resulting lack of adequate capital could hamper the construction and operation of the hatchery. To obtain such a loan, a transfer of funds from the General Development Fund of GEDA to the ADF or a special appropriation by the legislature would have to be made to provide adequate capital for such a loan. This would be a small concession on the part of the Government to make these funds available at the lower interest rate so as to promote the establishment of the industry.

Table 10 shows the projected breakdown of the operating costs for a Cooperative owned/operated hatchery (Scenario II). These operating costs would be the same as the Government hatchery with the exception of the following:

- 1) Rent- \$1.00/year

This is a token \$1.00 annual rental fee charged to the Cooperative under a lease agreement for the Government owned site (Ipan, Talofofo). No property tax would be charged.

- 2) Insurance - \$4,050

Since the Cooperative is a private group, it should purchase insurance. This is for the vehicle coverage, general liability, and fire and theft insurance on structures and equipment.

- 3) Labor - This would be reduced by the one biologist position, since research to any extent will not be carried out at the Cooperative operated hatchery. The manager serves as the hatchery's biological expert. This would reduce labor cost by \$14,500.

TABLE 10.

SCENARIO II

COOPERATIVE OWNED/OPERATED HATCHERY ANNUAL OPERATING COSTS
(ADF Loan, 3% Interest Rate)

EXPENSE CATEGORY	Production Level I 10 Pond Acres 0.8 Million Postlarvae	Production Level II 20 Pond Acres 1.6 Million Postlarvae	Production Level III 50 Pond Acres 4 Million Postlarvae	Production Level IV 80 Pond Acres 6.4 Million Postlarvae	Production Level V 100 Pond Acres 8 Million Postlarvae
Rent	1	1	1	1	1
Property Tax	4,050	4,050	4,050	4,050	4,050
Insurance	33,500 <u>1/</u>	50,000 <u>2/</u>	50,000 <u>2/</u>	60,500 <u>3/</u>	60,500 <u>3/</u>
Labor-Salary	7,100	10,000	10,000	12,100	12,100
Benefits	100	200	473	800	945
Feed-Fish	1,400	2,800	7,000	11,200	14,000
Feed-Brine Shrimp	1,500	1,800	2,000	2,300	2,500
Larvae-Related Supplies	4,800	4,800	4,800	4,800	4,800
Lab/Office Supplies	4,300	6,000	7,500	9,000	9,600
Utilities	500	1,000	2,500	3,500	4,770
Delivery	3,200	3,200	3,200	3,200	3,200
Legal Audit	47,500	47,500	47,500	47,500	47,500
Loan					
Sub Total	109,951	131,351	139,024	158,951	163,966
10% Contingency	<u>10,995</u>	<u>13,135</u>	<u>13,902</u>	<u>15,895</u>	<u>16,397</u>
Total	120,946	144,486	152,926	174,846	180,363
Cost/1,000 Postlarvae	\$ 151.18	\$ 90.30	\$ 38.23	\$ 27.32	\$ 22.54

1/ Manager, Biological Aide2/ Manager, Biological Aide, Marine Technician3/ Manager, 2 Biological Aides, Marine Technician

- 4) Loan repayment - The additional operating expense of the annual loan repayment is provided for in the Cooperative owned/operated hatchery. The Government hatchery does not show this, since it would be financed through a grant. The loan repayment schedule presented in the operating cost breakdown is based on a straight line calculation of the interest charge. This is done, since the first year of operation may be at any of the first three production levels (the industry could not expand beyond this without a permanent hatchery). However, once repayment of the loan is started the interest rate should be calculated on a declining balance (Table 12).

The operation of such a Cooperative owned hatchery would be on the priority basis of supplying its members first, non-members on Guam second, and the thirdly off-island orders all at a set price throughout the year. At the end of the year if there is a positive balance of funds received to that expended in the operation costs of the hatchery the members would receive a refund in proportion to the value of postlarvae or fry purchased. However, a reserve of approximately \$50,000 would have to be maintained as an operating capital reserve.

Membership to the Cooperative should be open to all on-island farmers at a yearly subscription rate based on the pond area of the farm. The yearly subscription rate should be sufficient to cover a minimum of 10% of the projected annual operating costs of the hatchery. These funds would then be incorporated into the annual operating costs scheme as the 10% contingency fund. For example, if the projected annual operating cost of the hatchery is \$139,024 and there is a membership with 50 acres of ponds then an annual charge of \$278 per acre would be assessed to each member farmer.

The price of the postlarvae and fry would be based on the cost of production (including the contingency fund) plus 25%. This would be the set price charged to members and non-members. The 25% addition over the projected operating costs at a given production would allow some leeway in the operation of the hatchery.

For example, a farmer with 10 pond acres would pay in an annual membership fee of \$278 per acre to the Cooperative (at production level III with an estimated hatchery annual sales of 4 million postlarvae at \$152,926 projected cost). Thus his total annual membership fee would be \$2,780. The cost of production of these postlarvae would be \$38.23 per 1000 postlarvae. The sale price would be \$47.79 (cost plus 25%). So the total revenue from the sales for the hatchery would be \$191,160. Assuming the actual operating costs were the estimated \$152,926 then there would be a net excess of \$38,234. This would then be divided among the membership at the rate of \$9.56 per 1000 postlarvae purchased. Since the normal annual stocking rate for a one acre pond is 80,000 postlarvae (20 postlarvae/m²), a return to the member farmer would be \$764.68 per acre. This would demonstrate the advantage of being a member of the Cooperative.

If and when a Cooperative owned/operated hatchery is completed it could start operation at anyone of the first three levels of production presented in the operating cost breakdown (Scenario II). This would depend on the extent of development of the industry as to how many pond acres have been constructed. Even though a significant number of pond acres may exist in the industry this would not mean all of them would be put into prawn culture, since many may have been taken out of operation due to the lack of on-island prawn postlarvae and other ponds have been converted from prawn culture to the culture of other species during the period of limited postlarval supply which may not be changed back into prawn culture. Therefore a number of production levels with the associated operating costs have been presented (Table 10). However, it is evident from Table 10 that the support of the 50 pond acres with a sale of 4 million postlarvae annually is the first stage where the cost of the postlarvae falls within a range that would be bearable to the farmer and allow the economic viability of the industry. Therefore without receiving a Government subsidy for the operation of the hatchery, the initial year of the Cooperative owned/operated hatchery would have to have a minimal sale (both on-island or off-island) of 4 million postlarvae. At a sale of 0.8 million postlarvae an annual subsidy of \$84,944 to \$92,944 would be required. At a sale of 1.6 million postlarvae an annual subsidy of \$72,480 to \$88,480 would be required. This subsidy from the government could be in the form of capital, deferment of the loan repayment, or technical assistance such as a hatchery manager or biologist thus reducing labor costs.

SCENARIO III, COOPERATIVE OWNED/OPERATED HATCHERY (General Development Fund Loan)

Table 11 presents a third scenario in which a Cooperative owned/operated hatchery that is identical to that presented in Scenario II, with the exception of the loan, being obtained through GEDA's General Development Fund Act (GDFA) at an interest rate of 15 5/8% (interest rate as of June 1981). This dramatic increase in the interest rate makes the loan repayment cost greater than all the other operating costs put together. A comparison in the loan repayment costs is shown in Table 12. One can see that at this interest rate the operation of the hatchery with all costs passed onto the farmers makes it financially an unworkable situation.

Only at Production Level V does the price of the postlarvae fall within an economically viable and affordable range. However, it would be impractical to expect the hatchery to start up at an annual sale of 8 million postlarvae, since the industry could not reach this stage of development without an on-island permanent hatchery. It is expected that the industry would not reach this level (100 pond acres of prawns) of development until approximately 5 years after the establishment of a permanent on-island hatchery.

TABLE 11.

SCENARIO III

COOPERATIVE OWNED/OPERATED HATCHERY ANNUAL OPERATING COSTS
(GEDA General Development Fund Act Loan, 15-5/8% Interest Rate)

EXPENSE CATEGORY	Production Level I		Production Level II		Production Level III		Production Level IV		Production Level V	
	10 Pond Acres 0.8 Million Postlarvae	1	20 Pond Acres 1.6 Million Postlarvae	1	50 Pond Acres 4 Million Postlarvae	1	80 Pond Acres 6.4 Million Postlarvae	1	100 Pond Acres 8 Million Postlarvae	1
Rent										
Property Tax										
Insurance	4,050	1	4,050	1	4,050	1	4,050	1	4,050	1
Labor-Salary	35,500	1/	50,000	2/	50,000	2/	60,500	3/	60,500	3/
Benefits	7,100		10,000		10,000		12,100		12,100	
Feed-Fish	100		200		473		800		945	
Feed-Brine Shrimp	1,400		2,800		7,000		11,200		14,000	
Larvae-Related Supplies	500		1,800		2,000		2,300		2,500	
Lab/Office Supplies	4,800		4,800		4,800		4,800		4,800	
Utilities	4,300		6,000		7,500		9,000		9,600	
Delivery	500		1,000		2,500		3,500		4,770	
Legal Audit	3,200		3,200		3,200		3,200		3,200	
Loan	142,188		142,188		142,188		142,188		142,188	
Sub Total	204,639		226,039		233,712		253,639		258,654	
10% Contingency	20,464		22,604		23,371		25,364		25,865	
Total	225,103		248,643		257,083		279,003		284,519	
Cost/1,000 Postlarvae	\$ 281.38		\$ 155.40		\$ 64.27		\$ 43.59		\$ 35.56	

1/ Manager, Biological Aide

2/ Manager, Biological Aide, Marine Technician

3/ Manager, 2 Biological Aides, Marine Technician

TABLE 12

**COMPARISON OF ANNUAL PAYMENT ON A \$750,000 LOAN BETWEEN AN AGRICULTURE
DEVELOPMENT FUND LOAN (3%) AND A GENERAL DEVELOPMENT FUND ACT LOAN (15-5/8%)
THROUGH THE GUAM ECONOMIC DEVELOPMENT AUTHORITY**

Year	Principal	3% Interest Rate ADF Loan		15-5/8% Interest Rate GDFA Loan		Balance
		Interest*	Interest + Principal	Interest *	Interest + Principal	
1	\$ 25,000	\$ 22,500	\$ 47,500	\$ 117,187.50	\$ 142,187.50	\$ 725,000
2	25,000	21,750	46,750	113,281.25	138,281.25	700,000
3	25,000	21,000	46,000	109,375.00	134,375.00	675,000
4	25,000	20,250	45,250	105,468.75	130,468.75	650,000
5	25,000	19,500	44,500	101,562.50	126,562.50	625,000

*Computed on a declining balance.

SCENARIO IV, COOPERATIVE OR PRIVATE OWNED/OPERATED HATCHERY WITH A REDUCED SCOPE OF PURPOSE

A fourth scenario (Table 13) is to change the scope of the previously proposed government permanent hatchery facility (Scenario I) which would be the basic support to the development of the industry, center for the production of a variety of species, and the location for the majority of applied aquaculture research, to one that provides the basic essentials and eliminates the research and non-essential facilities and equipment. This reduced scope and production oriented hatchery for *Macrobrachium rosenbergii* only (8 million post-larvae per year) would be directed towards private industry such as the Guam Aquaculture Association or a private entrepreneur, who could undertake such a project minimizing construction costs such as project management, architectural and engineering design, structural, mechanical and equipment expenses. The construction of such a modified hatchery facility was recently (8/81) estimated at \$150,000 (Aquaculture International, Inc., Hawaii, Personal Communication).

To encourage a private venture adequate incentives should be provided to the private sector by the government (e. g., low interest loan, lease of government land, GEDA Qualifying Certificate), but with covenants to insure a minimum quantity of postlarvae at a reasonable price.

The construction and initial operating costs (totalling \$275,000) could be financed by GEDA, preferably through the Agricultural Development Fund (30 year loan at 3% annual interest rate). This scaled down hatchery may prove to be the most viable alternative at this point to meet the immediate needs of prawn farmers for postlarvae. As the industry develops and the demand for fry and postlarvae of other species expands it would be necessary to modify and make additions to this hatchery or possibly construct a more comprehensive hatchery if the industry development warrants it and funds are available.

TABLE 13

SCENARIO IV

REDUCED SCOPE COOPERATIVE OR PRIVATE OWNED/OPERATED HATCHERY ANNUAL OPERATING COSTS
(ADF Loan, 3% Interest Rate)

EXPENSE CATEGORY	Production Level I	Production Level II	Production Level III	Production Level IV	Production Level V
	10 Pond Acres 0.8 Million Postlarvae	20 Pond Acres 1.6 Million Postlarvae	50 Pond Acres 4 Million Postlarvae	80 Pond Acres 6.4 Million Postlarvae	100 Pond Acres 8 Million Postlarvae
Rent	1	1	1	1	1
Property Tax	-	-	-	-	-
Insurance	4,050	4,050	4,050	4,050	4,050
Labor - Salary	33,500 ^{1/}	50,000 ^{2/}	50,000 ^{2/}	60,500 ^{3/}	60,500 ^{3/}
Benefits	7,100	10,000	10,000	12,100	12,100
Feed - Fish	100	200	473	800	945
Feed - Brine Shrimp	1,400	2,800	7,000	11,200	14,000
Larvae-Related Supplies	1,500	1,800	2,000	2,300	2,500
Lab/Office Supplies	4,800	4,800	4,800	4,800	4,800
Utilities	4,300	6,000	7,500	9,000	9,600
Delivery	500	1,000	2,500	3,500	4,770
Legal Audit	3,200	3,200	3,200	3,200	3,200
Loan	17,417	17,417	17,417	17,417	17,417
Sub Total	79,868	101,268	108,941	128,868	133,883
10% Contingency	7,987	10,127	10,894	12,887	13,388
Total	87,855	111,395	119,835	141,755	147,271
Cost/1,000 Postlarvae	\$ 109.82	\$ 69.62	\$ 29.96	\$ 22.15	\$ 18.41

1/ Manager, Biological Aide

2/ Manager, Biological Aide, Marine Technician

3/ Manager, 2 Biological Aides, Marine Technician

BIBLIOGRAPHY

- Anderson, et al. 1975. Kauai socioeconomic profile. Hawaii Agricultural Experimental Station, University of Hawaii, DP35.
- Annorin, 1976. Aquacultural planning in Asia. Report of the Regional Workshop on Aquaculture Planning in Asia, Bangkok, Thailand, October 1975. 154p.
- _____. 1978. Aquaculture development for Hawaii, assessments and recommendations. Aquaculture Planning Program, State of Hawaii DPED, 222p.
- Anonymous 1980. The new global fishing regime: impact and response. CIA. Nat. Tecn. Info. Ser. Springfield, Virginia.
- Anonymous. 1981. The Reagan budget: the figures 83 programs: a profile. New York Times 2/20/81.
- Approtech, Inc. 1980. A feasibility study to identify the economic/market barriers to the commercialization of aquaculture technology. Small Business Administration General Office for Advocacy. SBA-4885-OA-80.
- Aquacop. 1977. Reproduction in captivity and growth of *Peaneus monodon* Fabricius in Polynesia. Proceedings World Mariculture Society 8:927-945.
- Aquatic Farms, Ltd. 1978. Feasibility analysis prawn aquaculture on Guam. Department of Commerce, Government of Guam.
- Aquatic Farms, Ltd. 1979. Multiple-use options for a prawn hatchery on Guam. Department of Commerce, Government of Guam. EDA Technical Assistance Project No. 07-6-02028. 60p.
- Baldwin, M. J. 1972. A preliminary study on the feasibility of pond rearing sharpnose mollies (*Poecilia sphenops*) as a live baitfish for the skipjack tuna fishery, American Samoa. Report prepared for the Government of American Samoa. Kaneohe, Hawaii Institute of Marine Biology. 11pp.
- Baldwin, M. J. 1974. Raising mollies for skipjack bait may eliminate use of frail nehu. National Fishermen 45(9):67.
- Baldwin, W. J. and M. M. McGrenna. 1979. Problems with the culture of topminnows (Family Poeciliidae) and their use as live bait fishes. Proc. 10th Annual Meeting World Mariculture Society.
- Bardach, J. E., J. H. Ryther and W. O. McLarney. 1972. Aquaculture: the farming and husbandry of fresh water and marine organisms. Wiley-Interscience, New York. 868pp.

- Bell, F. W., and E. R. Canterbury. 1976. Aquaculture for the developing countries. Ballinger Publishing Co., Cambridge, Mass. 266pp.
- Brock, V. E. and Y. Yamaguchi, 1955. A limnological survey of Fena River Reservoir. Guam, Marianas Islands. Division of Fish and Game, Territory of Hawaii.
- Brock, V. E. and M. Takata 1956. A limnological resurvey of Fena River Reservoir Guam, Marianas Islands, Division of Fish and Game Territory of Hawaii.
- Bryan, P. G. 1975. Food habits, functional digestive morphology, and assimilation efficiency of the rabbitfish (*Siganus spinus*) (Pisces, Siganidae) on Guam. Pacific Science 29(3): 269-277.
- Bryan, P. G., B. B. Madraisau, and J. P. McVey, 1975. Hormone induced and natural spawning of captive *Siganus canaliculatus* (Pisces: Siganidae). Micronesia 11(2): 199-203.
- Bryan, P. G., and B. B. Madraisau, 1977. Larval rearings and development of *Siganus lineatus* (Pisces: Siganidae) from hatching through metamorphosis. Aquaculture 10: 243-252.
- Bryan, P. G. 1978. On the efficiency of mollies (*Poecilia mexicana*) as live bait for pole-and-line skipjack fishing trials in the tropical central Pacific. Technical Report Project No. 4-35D, American Samoa Baitfish Program, Pago Pago, American Samoa, 45pp.
- Buck, D. H., R. J. Baur, and C. R. Rose, 1976. Experiments in recycling swine manure in fish ponds. FAO Technical Conference on Aquaculture Kyoto, Japan.
- Buck, D. H. 1977. The integration of aquaculture with agriculture. Fisheries 2(g).
- Buck, J. and J. Roney. 1980. Economic utilization of cold water effluent from a proposed land-based OTEC plant. Prepared for: GovGuam. Marine Systems Engineering Department, Arlington, Virginia.
- Callaghan, P. 1978. Some factors affecting household consumption of seafood and fish products on Guam. Bureau of Planning, Economic Planning Division Report 77-3. 45pp.
- Carpenter, R. L. 1974. Wastewater use in production of food and fiber. Proceedings, Environ. Protect. Tech. Ser. Wash., D. C., (EPA-660/2-74-041): 568pp.
- Chen, T. P. 1976. Aquaculture practices in Taiwan. Page Bros. (Norwich) Ltd. 161 pp.
- Clay, G. S., S. Broder, R. Turner, D. S. Kitaoka, G. L. Rhodes, and D. K. Yamase. 1981. Ocean leasing for Hawaii. Aquaculture Development Program, Department of Planning and Economic Development Department of Land and Natural Resources, State of Hawaii,

- Coastal Resources Management Council. 1978. State of Rhode Island coastal resources management program. Rhode Island.
- Coleman, M. S., et al. 1974. Aquaculture as a means to achieve effluent standards. Environ. Protec. Tech. Ser. Washington, D. C. (EPA-660/2-74-041): 199-214.
- Conte, F. S., and A. T. Manus. 1980. Aquaculture and coastal zone planning. University of California. Sea Grant Marine Advisory Program. U. C. NOAA 04-8-MOI - 189.
- Corbin, J. S. 1976. Aquaculture in Hawaii 1976, progress, resources and organization, State of Hawaii. DEPD. 107 p.
- De Leon, F. and O. N. Liming. 1956. Tilapia introduction to Guam. Guam Department of Agriculture.
- Dickinson, R. E. 1977. The occurrence and natural habitat of the mangrove crab *Scylla serrata*. (Forsk.) on Ponape and Guam. M. S. Thesis in Biology, University of Guam. 71 pp.
- FAO 1977. Control of the spread of major communicable fish diseases. Food and agriculture organization of the United Nations FAO Fisheries Report, No. 192 44p.
- Fassler, C. R. (ed.). 1981. Aquaculture in Hawaii. Aquaculture Development Program, Department of Land and Natural Resources.
- FitzGerald, Jr. W. J. 1975. A study to determine the aquaculture potentials of Guam. NMFS Project No. 4-23-D-3. Aquatic and Wildlife Res., Government of Guam, 14pp.
- 1976. Development of polyculture fish farming under tropical conditions. Annual report July 1, 1975 - September 30, 1976. NMFS Project No. 4-32-D-3. Aquatic and Wildlife Res., Government of Guam. 12pp.
- 1977. Development of polyculture fish farming under tropical conditions. Annual report October 1, 1976 - September 30, 1977. NMFS. Project No. 4-32-D-3. Aquatic and Wildlife Res., Government of Guam. 24pp.
- 1977. Aquaculture and its potential environmental impact on Guam's coastal waters. Bureau of Planning, Coastal Zone Management, Government of Guam, Agana, Guam 57pp.
- 1978. Development of polyculture fish farming under tropical conditions. Annual report October 1, 1977 - September 30, 1978. NMFS Project No. 4-32-D-4. Aquatic and Wildlife Res., Government of Guam, 8pp.
- 1978. Environmental parameters in influencing the growth of *Enteromorpha clathrata* (Roth) J. Ag. in the intertidal zone on Guam. Botanica Marina 21: 207-220.

- . 1979. The red-orange tilapia hybrid that could become a world favorite: A reddish-orange variety of the hybrid cross *Sarotherodon mossambicus* and *Sarotherodon niloticus*. Fish Farming International 61:26 - 27.
- FitzGerald, Jr., W. J. and S. G. Nelson. 1979. Development of aquaculture in an island community (Guam, Marianas Islands). Proc. World Mariculture Society 10:39-50.
- Foreign Fishery Information Release. 1976 - 1981. Supplement to market news report. ed. S. C. Sonu. USDC, NOAA, NMFS Terminal Island, CA.
- Fournier, F. 1975. Institutional constraints to the development of aquaculture. Mar. Fish. Rev. 37(1): 21-32.
- Gillett, R. D. and R. E. Kearney. 1980. Second interim report of the activities of the skipjack survey and assessment program in the waters of French Polynesia. South Pacific Commission Report November 21 (May 1980).
- Glude, J. B. 1972. Report on the potential for shellfish aquaculture in Palau Islands, Yap Islands, Guam, Truk, Ponape, Ellice Islands.
- Goldschmidt, Y. 1970. Water quality management of the Israeli national water system. In Developments in water quality research, ed. H. I. Shural, Michican, Ann Arbor Science Publ. 13-17.
- Hanson, J. A., ed. 1974. Open sea mariculture: perspectives, problems, and prospects. Dowden, Hutchinson and Ross, Stroudsburg, Pa. 413pp.
- Hawaii Aquaculture Planning Program. 1977. Permits and Environmental requirements for aquaculture in Hawaii. Department of Planning and Economic Development, State of Hawaii. 69pp.
- Heslinger, J. In press. Larval development settlement, and metamorphosis of the coral reef gastropod *Trochus niloticus* (L.). Malacologica.
- Hill, P. G. (ed.) The marine newsletter. Coastal Plains Center for Marine Development Services. Wilmington, N. C.
- Hougart, B., et al. 1977. The economics of aquaculture in the United States. National Research Council, Washington, D. C.
- Huet, M. 1970. Textbook of fish culture breeding and cultivation of fish. Fishing News (Books) Ltd. England, 436p.
- International Foundation for Sciences. 1980. Giant prawn 1980. Bangkok, Thailand. June 15-21, 1980.

- Jameson, S. C. 1976. Early life history of the giant clams *Tridacna maxima* (Roding) and *Hippopus hippopus* (L.) Pacific Science 30(3): 219-233.
- Japan External Trade Organization. 1978. Access to Japan's import markets: shrimp imports. JETRO, Tokyo.
- Japan Report. 1980. Issued by the Japan Information Center, Consulate General of Japan. 6/16/80. New York. 26 (10).
- Jenkins, R. L. and J. G. Halusky (Editors). 1980. Aquatic animal medicine a state of the art. Proceedings of Conference April 25, 1979 Florida. Report No. 32 State University System of Florida. Sea Grant College Program. 127pp.
- Johnston, R. S. 1976. The relationship between property rights arrangement and the nature of aquaculture development. Small scale Fisheries Development Planning Meeting. Honolulu, Hawaii. August 1976.
- 1979. Some economic issues in aquaculture. Department of Agriculture and Res. Econ., Oregon State University.
- Johnston, R. S., R. D. Langmo, R. B. Rettig and F. J. Smith. In press. Relationships between institutional arrangements and aquacultural development. Oregon State University.
- Joint Standing Committee on Marine Resources, Maine. 1979. A study of marketing activities of the Department of Marine Resources. Augusta, Me: p. 13.
- Kami, H. T., and I. Ikehara. 1979. Notes on the annual juvenile siganid harvest in Guam. Micronesia 12(2): 323-325.
- Kearney, R. E. and M. L. Rivkin. 1981. An examination of the feasibility of baitfish culture for skipjack pole-and-line fishing in the South Pacific Commission area. SPC Tech. Report No. 4.
- Klontz, G. W. 1979. Fish health management; concepts and methods of intensive aquaculture. Fishery Resources and Office of Continuing Education University of Idaho. 123pp.
- 1979. Fish health management: Concepts and methods of fish disease epidemiology. Fishery Resources and Office of Continuing Education University of Idaho. 142pp.
- Klontz, G. W. and J. G. King. 1974. Aquaculture in Idaho and nationwide. Idaho Department of Water Resources. IDWR45-080. Boise, Idaho.

- Klontz, G. W., I. E. Brock, and J. A. McNair. 1978. Aquaculture techniques: water use and discharge quality. Office of Water Research and Technology, U. S. Department of the Interior, Washington, D. C. Project A-05401DA.
- Lam, T. J. 1974. Siganids: their biology and mariculture potential. *Aquaculture* 3:325-354.
- Lanchner, E. C., Robbins and W. Courtenay. 1970. Exotic fishes and other aquatic organisms introduced in North America. *Smithsonian Contributions to Zoology*. 59:29p.
- Lee, S. R. 1979. The Hawaiian prawn industry, a profile. Aquaculture Development Program, Department of Planning and Economic Development, State of Hawaii. 32p.
- Lundy, B. A. 1975. Constraints on aquaculture projects. *Marc. Fish. Rev.* 37(1): 33-35.
- Maguire, Inc. 1978. Towards a fisheries development strategy for Marine Department of Marine Resources, Augusta, Me.: p-3.
- May, R. C., D. Popper, and J. P. McVey. 1974. Rearing and larval development of *Signus canaliculatus* (Park) (Pisces: Siganidae). *Micronesia* 10(2); 285-298.
- Mayo, R. D. 1974. A format for planning a commercial model aquaculture facility. Kramer, Chin and Mayo, Inc., Technical Report No. 30. Seattle, Washington - 15p.
- Mink, J. F. 1976. Groundwater resources of Guam: occurrence and development. University of Guam Resources and Research Center, Technical Report 1.276pp.
- National Academy of Sciences. 1978. Aquaculture in the United States constraints and opportunities. National Research Council. Washinton, D. C. 123p.
- NOAA. 1975. NOAA aquaculture plan. Nat. Mar. Fish. Ser. and Office of Sea Grant, Washington, D. C. 157pp.
- Odum, W. E. 1974. Potential effects of aquaculture on inshore coastal waters. *Environ. Conserv.* 1(3): 225-230.
- Pillay, T. V. R. 1973. The role of aquaculture in fishery development and management. *J. Fish. Res. Board Can.* 30; 2202-2217.
- 1974. Planning of aquaculture development an introductory guide. FAO Fishing Manual. Fishing, News Books, Ltd. Surrey, England. 72pp.
- Pillay, T. V. B., and W. A. Dill (ed) 1979. Advances in aquaculture. Fishing News Books Ltd., Surrey, England. 672pp.
- Rosenberry R. (ed) 1978 - 1981. Aquaculture digest. San Diego, California.

- Ryther, J. H. 1975. Preliminary results with a pilot plant waste recycling marine - aquaculture system. Woods Hole Oceanographic 1st. 75-41; 50p.
- Schroeder, G. 1975. Some effects of stocking fish in waste treatment ponds. Water Res. 9: 591-593.
- Schroeder, G., and B. Hopher. 1976. Use of agriculture and urban wastes in fish culture. FAO Technical Conference on Aquaculture, Kyoto, Japan.
- Schuster, W. H., G. L. Kesteven, and G. P. Collins. 1954. Fish farming and inland fishery management in rural economy. FAO Fisheries Study No. 3, Rome.
- SCSFDCP. 1977. The international market for shrimp. South China Sea Fisheries Development and Coordinating Programme, FAO, Manila. 105p.
- Secretan, P. A. D. 1978. Insurance or subsidy in the USA. Fish Farming. Int. 5(2): 28.
- Shang, Y. C. 1972. Economic feasibility of fresh water prawn farming in Hawaii. University of Hawaii Economic Research Center. 49pp.
- 1981. Freshwater prawn (*Macrobrachium rosenbergii*) production in Hawaii: practices and economics. UNIH-Sea Grant-MR-81-07. 36p.
- 1981. Aquaculture economics: basic concepts and method analysis. Westview Press. Colorado.
- Shang, Y. C. and T. Fujimura. 1977. The production economics of freshwater prawn (*Macrobrachium rosenbergii*) farming in Hawaii. Aquaculture 11 (1977): 99-110.
- Sinderman, C. J. (ed). 1974. Diagnosis and control of mariculture diseases in the United States. Mid. Atl. Coast-Fish-Cent. NMFS. Technical Series No. 2.
- Smith, B. D. 1979. Growth rate, abundance and distribution of the topshell *Trochus niloticus* on Guam. Unpublished Thesis, U. O. G.
- Smitherman, R. O., W. L. Shelton, and J. H. Grover (ed.). 1978. Symposium on culture of exotic fishes. Amer. Fish. Soc. Fish Ad. Sec. Aquaculture/Atlanta 178.
- South Pacific Commission. 1979. Eleventh regional technical meeting on fisheries. Noumea, New Caledonia. December 5 - 10, 1979.
- Stojkovich, J. O., and B. D. Smith. 1978. Survey of edible marine shell fish and sea urchins on the reefs of Guam. Aquatic and Wildlife Resources Division, Guam Department of Agriculture Technical Report 2. 65pp.

- Swerdloff, S. F. 1973. Current fisheries projects in American Samoa. South Pacific Isl. Fish. Newsl (9): 44-45.
- Takata, J. A. 1978. Hawaiian prawn recipes. University of Hawaii. Sea Grant Marine Advisory Program. UNIH-SEAGRANT-AB-78-06.
- Tal, S. 1979. The concept of aquaculture. Bamidgeh. 31(2): 23.
- Timble, G. M. 1972. Legal and administrative aspects of an aquaculture policy for Hawaii - an assessment. Hawaii Department of Planning and Economic Development, Center for Science Policy and Technology Assessment, Honolulu and Western Interstate Commission for Higher Education Resources Development Internship Program. Boulder, Colorado, 69pp.
- The Marine Newsletter. 1980. Reporting marine developments of interest to the coastal plains region of Virginia, the Carolinas, Georgia, and Florida. CPCMDS, Wilmington. 11(5).
- Tobias, W. J. 1976. Ecology of *Siganus argenteus* (Pisces: Siganidae) in relation to its mariculture potential on Guam. M. S. Thesis, University of Guam. 48pp.
- Tracey, Jr., J. I. C. H. Stensland, D. B. Doan, H. G. May, S. D. Schlanger, J. T. Stark. 1959. Military geology of Guam, Mariana Islands. Part I & II. Chief of Engineers, U. S. Army.
- Warner, D. C. 1980. Recommendations for an aquaculture financing program for the territory of Guam. Department of Commerce, Government of Guam. EDA Project No. 07-25-01669-02.
- Webber, H. H. 1973. Risks to the aquaculture enterprise. Aquaculture 2: 157-172.
- Webber, J. S. and P. F. Riordan. 1976. Problems of large-scale vertically-integrated aquaculture. FAO Technical Conference on Aquaculture.
- Woynarvich, E. 1976. The feasibility of combining animal husbandry with fish farming with special reference to duck and pig production. FAO Technical Conference on Aquaculture, Kyoto, Japan.
- U. S. D. A. 1980. Aquaculture, a program for the eighties. U.S.D.A. Washington, D. C. 59p.
- U.S.D.C. 1980. National aquaculture plan (draft). U. S. Department of Commerce, NOAA. 532p.

- U. S. Environmental Protection Agency. 1974. Aquaculture projects: requirements for approval of discharges. Federal Register 39(115): 20769-20775.
- U. S. Geological Survey. 1953 - 1975. Water resources data for Hawaii and other Pacific areas. II. Trust Territory of the Pacific Islands. Guam, American Samoa, and the Northern Marianas Islands. 90pp.
- Yamaguchi, M. 1977. Conservation and cultivation of giant clams in the tropical Pacific. Biol. Conserv. 11: 13-20.

APPENDIX A

PUBLIC LAWS, RESOLUTIONS AND EXECUTIVE ORDERS

Below is a listing of Public Laws and Resolutions that have been passed and adopted in the 10th thru 15th Guam Legislature and Executive Orders (1968-1979) pertaining to Agriculture, Fisheries (Marine Resources) and Aquaculture.

Bills Passed/Resolutions/Executive Orders Adopted

Month/Year	Public Law/Resolutions Executive Orders	Agriculture	Fisheries Marine Resources	Aquaculture
<u>10TH GUAM LEGISLATURE</u>				
7/69	P. L. 10-67	X		
8/69	10-87	X		X
3/70	10-139	X		
	E.O. 68-5		X	
	68-9	X		
	68-15			X
	68-21	X		
	68-26			X
	69-16	X		
	69-17	X		
	69-28	X		
<u>11TH GUAM LEGISLATURE</u>				
10/72	P.L. 11-178		X	
12/72	11-205	X		
12/72	11-215	X	X	
	E.O. 70-11	X		
<u>12TH GUAM LEGISLATURE</u>				
6/73	P.L. 12-28	X		
2/74	12-106	X		

Appendix A (continued)

Month/Year	Public Law/Resolutions Executive Orders	Agriculture	Fisheries Marine Resources	Aquaculture
9/74	P.L. 12-163		X	
1/75	12-215		X	
	E.O. 72-5	X		
	72-13		X	
	73-1		X	
	73-19	X		
	73-29		X	

13TH GUAM LEGISLATURE

5/75	P.L. 13-15 (Sec. 4)	X		
6/75	13-27 (Sec. 14 & 18)	X		
6/75	13-33 (Sec. 3)	X		
6/75	13-34 (Sec. 9 & 10)	X		
7/75	13-49		X	
7/75	13-53	X		
10/75	13-63	X		
10/75	13-83	X	X	
10/75	13-84	X		
12/75	13-122 (Sec. 4)		X	
1/76	13-123 (Sec. 62323)	X		
2/76	13-136	X		
6/76	13-146	X		
7/76	13-153	X		
7/76	13-161	X		
10/76	13-192	X		
10/76	13-195	X		X
12/76	13-200	X		
12/76	13-203		X	
12/76	13-204	X		
3/75	Res. 28	X		
5/75	66	X		
5/75	90	X		
8/75	130	X		
10/75	167	X		
7/76	307		X	
4/77	E.O. 74-2	X		
	74-25	X		
	75-26	X		
	75-29	X		

Appendix A (continued)

Month/Year	Public Law/Resolutions		Fisheries	
	Executive Orders	Agriculture	Marine Resources	Aquaculture
<u>14TH GUAM LEGISLATURE</u>				
3/77	P.L. 14-8 (Sec. 7)		X	
4/77	14-22	X		
6/77	14-34	X		
7/77	14-56	X		
8/77	14-58 (Sec. 6 & 7)		X	
12/77	14-85		X	
4/78	14-120 (Sec. 7)	X		
6/78	14-127	X		
8/78	14-140 (Sec. 29 & 30)	X		
10/78	14-149		X	
12/78	14-154	X		
3/77	Res. 61	X		X
4/77	72	X		
4/77	89	X		X
6/77	Res. 115		X	
6/77	120	X		
8/77	169			X
9/77	185	X		X
11/77	191	X		X
10/77	202	X		
10/77	217	X		
2/78	222	X		
1/78	224	X		
6/78	338		X	
8/78	347		X	
	E.O. 77-15	X		

Month /Year	Public Law/Resolutions		Agriculture	Fisheries		Aquaculture
	Executive Orders			Marine Resources		
<u>15TH GUAM LEGISLATURE</u>						
4/79	P.L.	15-18	X			X
6/79		15-36	X		X	
10/79		15-74	X		X	X
1/80		15-97	X		X	
2/80		15-101	X			
3/80		15-107	X			
3/80		15-114			X	X
6/80		15-129				X
3/79	Res.	21			X	
2/79		41	X			
4/79		44			X	
2/79		62	X			X
9/79		220	X			X
2/80		471	X			
3/80		459				X
7/78	E.O.	78-16	X			
2/79		78-21	X			X
2/79		79-6			X	
9/79		79-20	X			
9/79		79-22				X
9/79		79-24	X			

APPENDIX B

PRIVATE AQUACULTURE OPERATIONS ON GUAM

Baza Farm's

Pond culture of *Macrobrachium rosenbergii*. Located in Merizo. Started 1977. 1.5 acres.

Flores Farm's

Pond culture of *Macrobrachium rosenbergii*. Located on the Inarajan River. Started 1975; Inoperative since 1978. 2 acres.

Giusti Farm

Pond culture of *Macrobrachium rosenbergii*. Located on the Ajayan River. Started 1981. 5 acres.

Guam Aqua Research (subsidiary of Trafalgar Housing, Ltd. Hong Kong)

Experimental station for the culture of penaeid shrimp and other marine species. Located at Perez Coral pits. Started operation 1980. 5 acres.

Guam Marine Products, Inc.

Concrete pond culture of freshwater eels *Anguilla japonica* and *A. rostrata*, *Penaeus monodon*, tilapia. Located on the Agfayan River. Started 1977. 9 acres.

Inarajan Aquaculture Enterprises, Inc.

Pond culture of *Penaeus monodon* and the hybrid tilapia. Located on the Ajayan River. Started 1981. 15 acres.

Oceania Farms, Ltd.

Pond culture of *Macrobrachium rosenbergii*. Located on the Talofoto River. Started 1979. 1.5 acres.

Pedro's Farm

Pond culture of *Macrobrachium rosenbergii*. Located at Dan Dan. Started 1976. discontinued 1978. 2 acres.

Perez/Lin Farm

Concrete tanks, circular plastic pools, earthen ponds for the culture of *Trionyx sinensis*, tilapia, *Macrobrachium rosenbergii* and carp. Located at the Perez Coral Pits. Started 1976. 2 acres.

Appendix B (continued)

Quitugua Farm/4H Aquaculture Club

Pond culture of *Macrobrachium rosenbergii*. Located on the Talofoto River. Started 1980. 3 acres.

Roberto/Mendiola Farm

Pond culture of *Macrobrachium rosenbergii*. Located on the Ugum River. Started 1980. 15 acres.

Torres/McDonald Farm

Pond culture of *Macrobrachium rosenbergii*. Located on the Fonte River. Started 1980. 1 acre.

APPENDIX C

GOVERNMENT HATCHERY CONSTRUCTION COST ESTIMATE*

Site: Ipan, Talofoto

PHASE I - Prawn Hatchery (Production Capability 8,000,000 Prawn Postlarvae/Year)

I. DESIGN PARAMETER:

Survey, Soil-Testing, A/E Design,
Permits
Project Management

\$ 91,475.00

II. CONSTRUCTION PHASE:

1. Site Development

a) Earthwork	\$ 10,600.00
b) Roadways	18,000.00
c) Drainage Trenches	3,200.00
d) Walkways	<u>3,800.00</u>

Subtotal

\$ 35,600.00

2. Architectural/Structural

a) Office/Laboratory	\$ 40,000.00
b) Warehouse	67,500.00
c) Modular Home	38,000.00
d) Pump House	3,000.00
e) Ancillary Services	17,000.00
f) Fencing (1,500/LF, 12.50/LF)	<u>25,000.00</u>

Subtotal

190,500.00

3. Mechanical

a) Mechanical System	\$ 33,550.00
b) Salt-water Well	12,000.00
c) Larvae Tanks	22,000.00
d) Plankton Tanks	13,000.00
e) Storage Tanks	9,000.00
f) Artemia Tanks	5,500.00
g) Pumps	18,000.00
h) Generator	20,000.00
i) Injection Well	<u>14,000.00</u>

Subtotal

\$ 147,050.00

Subtotal (Construction Phase)

\$ 373,150.00

Appendix C (continued)

III. COLLATERAL EQUIPMENT (Associated Costs)

1. Office Equipment	\$ 8,000.00	
2. Laboratory Equipment	36,000.00	
3. Tools	5,500.00	
4. Delivery Equipment	6,500.00	
5. Vehicle	<u>16,500.00</u>	
Subtotal (Collateral Equipment)		<u>\$ 72,500.00</u>

SUMMARY: Cost Estimate

1. Design Parameter (Project Initiation)	\$ 91,475.00
2. Construction Phase	373,150.00
3. Collateral Equipment	72,500.00
4. Contingency Fund (10% of Project Cost)	<u>53,712.00</u>
Total Project Cost Estimate	\$ 590,837.00

PHASE II - Multispecies Hatchery

EXPANSION OF FACILITY TO MULTISPECIES HATCHERY (Aquatic Farms, Ltd., 1979)

Marine Shrimp	\$ 6000.00	
Carp Culture	13,500.00	
Catfish Culture	500.00	
Rabbitfish Culture (No Modification Necessary)	-0-	
Baitfish Culture	<u>10,000.00</u>	
Total Cost Estimate for Expansion of Hatchery to Multispecies Capability		<u>\$ 30,000.00</u>
Phase I and Phase II Hatchery Total Project Cost		<u>\$ 620,837.00</u>

*This is based on an original cost estimate by Aquatic Farms, Ltd. (1978) with the modification to a more durable and permanent larvae and plankton tank construction and the allowance for cost adjustment for the rise in construction costs on Guam (15-20% per year, DPW).

APPENDIX D

ABBREVIATIONS

ACOE	Army Corps of Engineers
ADF	Agricultural Development Fund
ADS	Agricultural Development Service (DOA)
AHRD	Agency for Human Resources Development
BOP	Bureau of Planning
CALS	College of Agriculture and Life Sciences
CEDP	Comprehensive Economic Development Plan
CETA	Comprehensive Employment Training Act
CNEXO	Centre National pour l'Exploitation des Oceans
DA	Department of the Army
DOA	Department of Agriculture (Guam)
DOC	Department of Commerce (Guam)
DPR	Department of Parks and Recreation
EDA	Economic Development Administration
EDP	Economic Development and Planning (DOC)
EPA	Environmental Protection Agency (Federal)
ERC	Economic Research Center (DOC)
ESCAP	Economic and Social Commission for Asia and the Pacific
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration
FmHA	Farmers Home Administration
FTE	Full Time Equivalent Jobs
GAA	Guam Aquaculture Association
GDFA	General Development Fund Act
GEDA	Guam Economic Development Authority

Abbreviations (continued)

GEPA	Guam Environmental Protection Agency
GPA	Guam Power Authority
ICLARM	International Centre For Living Aquatic Resources Management
JSA	Joint Subcommittee on Aquaculture
KVA	Kilovolt Amp
LA	Lead Agency
ML	Marine Laboratory
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NSF	National Science Foundation
NOAA	National Oceanographic Atmospheric Administration
OEDP	Overall Economic Development Plan
OTEC	Ocean Thermal Energy Conversion
PBDC	Pacific Basin Development Council
P. L.	Public Law (Guam).
PUAG	Public Utility Agency of Guam
SBA	Small Business Administration
SEAFDEC	Southeast Asian Fisheries Development Center
UN	United Nations
UOG	University of Guam
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USDOC	United States Department of Commerce
USDOE	United States Department of Energy
USFWS	United States Fish and Wildlife Service
US DOI	United States Department of Interior
U.S.P.L.	United States Public Law
WERIWP	Water and Energy Research Institute of the Western Pacific