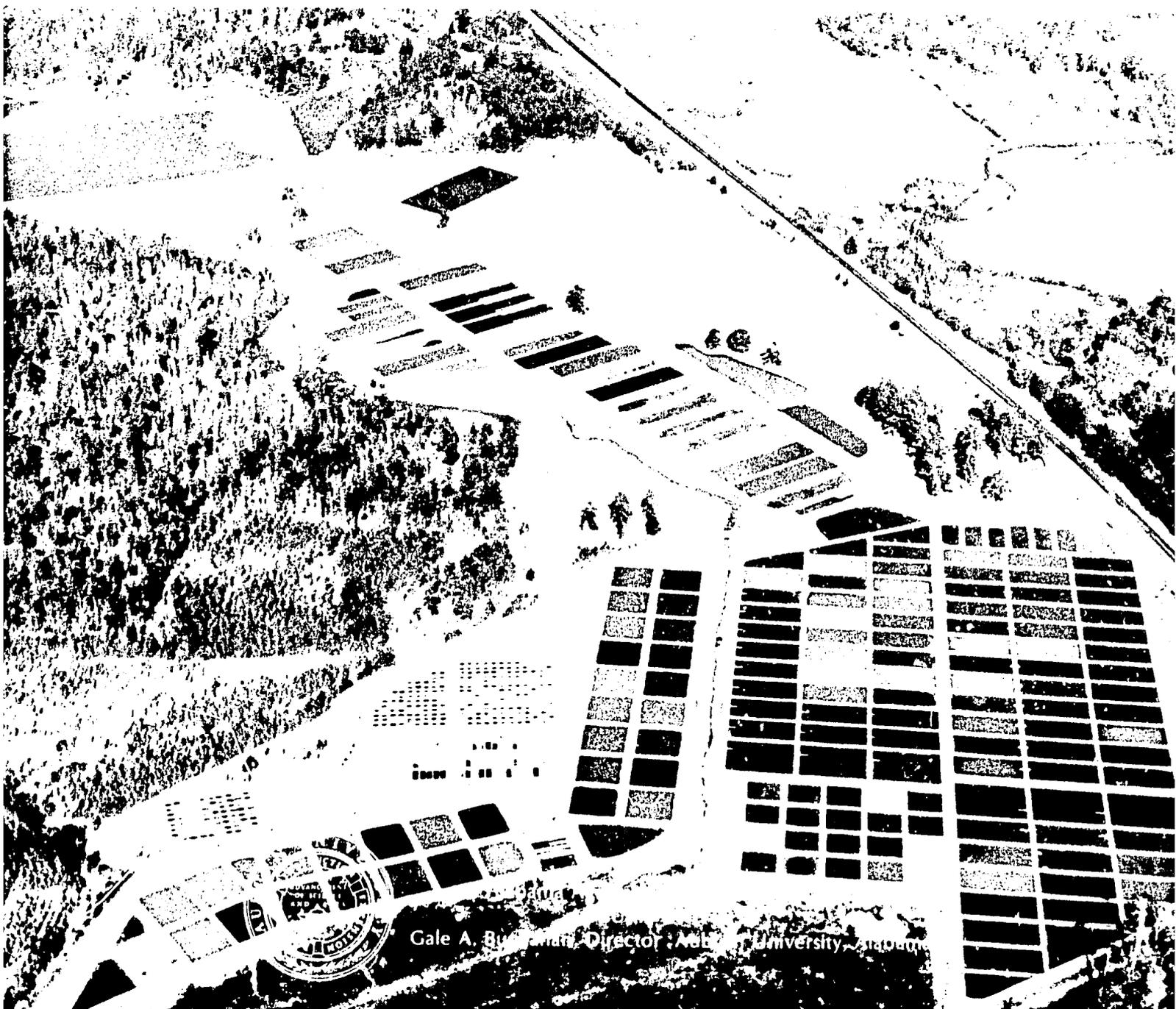


PN-AAK-470

# The International Center for AQUACULTURE



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**AQUACULTURE DEVELOPMENT  
IN ECUADOR**

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## PREFACE

The warmwater aquaculture development and potential in Ecuador was evaluated July 14 to August 13 by Dr. Ronald P. Phelps, International Center for Aquaculture, Auburn University, Auburn, Alabama. This work was provided through the Agency for International Development at the request of the Direccion General de Pesca of Ecuador. The following is a summary of his observations and recommendations.

## INTRODUCTION

The diverse geography and resources of Ecuador offers potential for a wide variety of aquaculture. Shrimp culture is expanding rapidly in the coastal provinces. Warmwater fish culture is becoming established at the small farmer level in some provinces. The highland lakes and rivers are available for trout production.

Fish are becoming more important in the Ecuadorian diet. In 1972, 71.2% of the total meat consumption was red meat and fish was 28.8%. In 1974, 66.2% was red meat and 33.6% fish. The per capita consumption of fish has increased from an average of 7.9 kgs per capita in 1970 to 10.9 kgs in 1975. Retail fish prices during the period of this report were generally 10 to 20 surces\* less than beef (60 surces/kg), depending on the fish species. Freshwater fish are only seasonally available in most markets. Even in coastal markets there was an expressed demand for freshwater fish. To meet the increasing demand for fish, more emphasis will need to be given to aquaculture.

The resources needed for aquaculture are available in most regions visited. This includes adequate soils, water, fertilizers and feeds. The acceptance of aquaculture at both the commercial and family farm level has been demonstrated by the shrimp culture industry and the extension program of PREDSUR. The continued expansion of aquaculture in Ecuador will require that the necessary infrastructure be developed. This infrastructure should include appropriate research and technology transfer channels and training capabilities. This infrastructure is presently weak in Ecuador.

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\* US\$1 = 26.30 surces

## AQUACULTURE RELATED AGENCIES AND ORGANIZATIONS

### Departamento de Piscicultura

The Departamento de Piscicultura has existed since 1979 as a part of the Dirección General de Pesca. It is divided into a coastal section, and a mountain and eastern section. Its functions include regulatory and extension aspects of fisheries. No research is presently being conducted. The coastal section's activities are centered around regulatory aspects of shrimp culture. Little aquaculture field work is being conducted because of limited resources available.

There are six professionals in the coastal section stationed in Guayaquil and three in the mountain and eastern section. Most have had short term training in aquaculture and one has a Master of Science degree in aquaculture. The field facilities are limited. The Cotopaxi trout station is in operation but a recent flood severely damaged the Pungyaro trout station. The Papallacta trout station is in the planning and development stage. No warmwater aquaculture stations presently exist but plans are being made to build a freshwater station near Babahoyo with Comisson para el Desarrollo de Cuenca Rio Guayas (CEDEGE) (see page \_\_\_). A brackishwater station is also being planned near Guayaquil. Only limited equipment and supplies are presently available to the Departamento de Piscicultura. Additional equipment and supplies are expected as a part of a larger assistance project by the Japanese government.

The observations made by Drs. Swingle and Pagan in 1969 regarding the difficulties hindering the progress of the Departamento generally still hold true in 1981. They were:

1. Insufficient funds for the successful operation of the administrative, technical and scientific phases of the Department.

2. Lack of adequately trained personnel to accomplish the broad operational scope proposed.
3. Lack of adequate experimental facilities (research stations, laboratories, hatchery production ponds and equipment).

Instituto Nacional de Pesca (National Institute of Fisheries)

The Institute is dedicated to investigations of fisheries resources of Ecuador. Its primary orientation is toward the marine fisheries, however, there are approximately ten professionals working in some aspect of aquaculture. The Institute is planning to develop two trout stations. The Chirimachay station is due to be completed this year and another station is planned for construction at a later date.

Shrimp culture investigations were begun last year in private ponds. Additional studies are planned for next year. Studies have been conducted regarding the biology of some freshwater fishes. Some informal extension work is being conducted by the Institute and a more active program is planned when the trout stations are completed. Contacts and cooperation between the Institute and agencies responsible for extension such as the Departamento de Piscicultura appear limited at present.

Subcomision Ecuatoriano-Peruana (PREDESUR)

PREDESUR is an autonomous regional development program located in the south of Ecuador. It began an aquaculture program in 1976 which expanded in 1978 with the assistance of Peace Corps. There are presently eight Peace Corps Volunteers and three PREDESUR professionals in the project. Six small aquaculture stations have been built, whose principal function is to provide fingerlings for the extension programs.

The program is directed to the small farmer with emphasis on intergrating fish and livestock production. There are over 500 private ponds in production at present. The ponds average approximately 400 m<sup>2</sup> in size. Tilapia niloti and common carp are the fish species used in the extension program. Silver and grass carp broodstock are being developed at the aquaculture stations for later incorporation into the extension program. The use of organic manures and some supplemental feeding are the basic pond management practices. Pig and or duck production is encouraged at the pond site. However, accurate data were not available.

The fish produced are generally for home consumption with some being marketed at the pond bank for 30 to 36 surces per kilo. In the public market of Loja, marine fish of poor quality from the shrimp by-catch were available at 40 s/kg and shark at 50 s/kg.

The PREDESUR aquaculture project may soon receive needed assistance from FAO. A five-year project is being developed to better establish aquaculture in the region. The fish culture system being practiced in the PREDESUR project is applicable to many parts of Ecuador and can serve as an example of how aquaculture can be developed in Ecuador.

#### Ministerio de Agricultura - Santo Domingo

The Ministerio de Agricultura with the help of Peace Corps is renovating a small aquaculture station with five ponds with a total water surface of less than 2000 m<sup>2</sup> of water. The station was originally built by the Instituto de Pesca in 1972 and later abandoned. The project is extension oriented similar to the PREDESUR project. AID is providing 46,520 surce to assist in the development of this project.

### Other Programs

In addition to the above mentioned programs other groups are interested in some aspects of fisheries. A regional development program CREA is said to have a trout station. Another regional development program CEDEGE is beginning a Departamento de Piscicultura to foster aquaculture development. The Foundation Ciencia and Foundation Natural have conducted studies on the taxonomy and biology of some freshwater fish species. In addition to the Peace Corps projects already mentioned, other programs are being developed at Rancho Ronald near Santo Domingo and another near Tena.

### Universities

There are four universities planning to offer training in aquaculture. The Escuela Superior Politecnica del Litoral is developing a three-year program for technicians. This university presently offers technician training in marine fisheries and food technology as well as offering B.S. degrees in Marine Engineering and other technological areas. The majority of the faculty in this program have Master degrees and two have training in fishculture. A small-scale shrimp hatchery is being developed and plans are being made for a larger facility at another site. The University staff appears to be highly motivated and the institution appears to have excellent potential for offering aquaculture training.

The Facultad de Biologia of the Universidad de Guayaquil offers B.S. degrees in biology with the option of specialization in terrestrial or marine biology. The curriculum is currently being modified to include courses in aquaculture. Presently the majority of the biologists involved in aquaculture in Ecuador are graduates of this university. Plans are being made to build pond facilities for aquaculture training and research.

In addition to these two universities, the Universidad de Loja and the Universidad Technica de Machala plan to offer aquaculture training in the next year. The Universidad de Loja presently has a small aquaculture station that is suitable for training and some research. Details were not available on the Universidad Technica de Machala.

Encouragement should be given to one or possibly two universities to establish aquaculture sound training programs, but it is not felt that four universities offering aquaculture training are needed at this time. It is highly important that whatever university offering an aquaculture curriculum have adequately trained staff and the necessary experimental and training facilities. Careful consideration also should be given to the level of training needed and the employment opportunities available for those students completing the program.

#### GENERAL OBSERVATIONS AND COMMENTS

##### Shrimp Culture

There has been a rapid development of shrimp culture in Ecuador in the last twelve years. An estimated 30,000 ha are now in production. The export value of pond produced shrimp was approximately US\$34 million dollars in 1980. Pond produced shrimp are the sixth most important item in the export trade of Ecuador.

The development of shrimp culture has occurred principally in saline soils (Salitrales) above the normal tidal zone, where large ponds of 10 ha or more have been built. Canals are dug from a tidal stream or bay to the pond sites. Water is then pumped into the ponds using diesel powered pumps. Some farms exchange large volumes of water daily while others only replace evaporation and seepage.

The culture practices generally are extensive rather than intensive. No fertilizers or feeds are used on most farms. Some add chicken litter at 500-750 kg/ha to the pond before filling with no fertilizer added later. Supplementary feed is used occasionally during the last two months of culture. A shrimp feed is made nationally and a Purina shrimp feed is imported from Panama.

The rapid development of shrimp culture has not been without its problems. The government has established procedures for obtaining permission to develop coastal land into shrimp ponds. This process involves receiving permission from three different government agencies. The involved process and other factors has led to the procedures being circumvented in many instances. This in turn has led to mangrove areas being exploited. As suitable salitrales areas are used, mangrove areas have been cut to provide additional areas for expansion. The uncontrolled cutting of mangroves undoubtedly will have serious ecological consequences if continued.

A national inventory of existing shrimp ponds, salitrales and mangrove areas is essential for the rational management of the coastal zones. Areas most suitable for shrimp culture can be identified and utilized while ecologically important mangrove areas can be preserved. Such a survey should be conducted by aerial photography every 3 to 6 months. Interpretations of the photos will identify areas where mangroves are being cut, thus permitting a better control over this resource.

Presently the vast majority of the post-larvae used in shrimp culture are captured from the wild. This resource is one of the principal factors which has favored the rapid development of shrimp culture in Ecuador. The dimensions of this resource should be defined in terms of seasonal abundance, species composition, geographic distribution and degree of exploitation. Nursery areas should be preserved to permit wild stocks of shrimp to continue to exist in abundance.

The continued collection of post larvae in certain areas may produce local scarcities of post larvae as well as affect the commercial shrimp fishery. These possibilities require to be investigation.

The shrimp culture techniques used have been developed through the private sector with little government input. This has resulted in a wide range of management practices. It is important that improved management practices be developed to increase the yield per hectare. Increased government support is needed to provide appropriate research data and information transfer. An adequately staffed and financed shrimp culture research station is needed to support the shrimp culture industry. This station should be a part of the program of the Departamento de Piscicultura.

#### Chame

The chame, Dormitator latifrons, is a highly prized food fish in the Province of Manabi but of considerably less importance in the other provinces. The most common form of exploitation is a flood plane fishery. Natural lakes are flooded during high water when fingerlings of various species including chame enter. The lakes are partitioned with bamboo fences and fish are trapped as the water level recedes. Another approach is the collection of chame fingerlings and stocking them into ponds. These ponds receive no other management and are harvested as the water level drops. Chame are also taken as an incidental catch in the shrimp culture ponds.

The chame is a very hardy fish tolerant to low oxygen, resistant to handling and accepts supplemental feed. It thus possesses characteristics that favor its use in aquaculture. Its apparent local appeal as a food fish needs to be better documented before intensive efforts are devoted to its intensive culture.

### Other Fish Species

A variety of native fish may have potential for aquaculture. These species should be studied. However, such studies require a long term commitment of staff and facilities and positive results are not guaranteed. One of the first native species that should be studied is Dama (Brycon sp). In Colombia, it has been possible to produce 1500 kg/ha of Brycon in six months using a pelleted chicken feed. It may be that Ecuadorian species of this genera could give even higher production. The rivers of the Amazon drainage also offer possible aquaculture species. Members of the genus Colossoma native to the Amazon drainage system have been shown to be among the best species for aquaculture in tropical countries. Immediate efforts should be made to obtain fingerlings for later broodstock.

A number of exotic fish species have been introduced into Ecuador which have proven value as aquaculture species. These species offer the greatest potential for the immediate development of aquaculture in Ecuador as demonstrated by the PREDESUR project. Species such as Tilapia nilotica and common carp can be easily reproduced and respond well to low cost management techniques. They have both been well accepted as food fish in Ecuador and should be the principal species used in a small farmer aquaculture program. Tilapia nilotica and common carp should be included in the species to be cultured at the CEDEGE station. Tilapia mossambica is more accessible to the CEDEGE project but the more favorable aquaculture characteristics of T. nilotica favor culture of the latter species. Efforts should be made to obtain T. nilotica from PREDESUR and while the T. mossambica available at Quevedo should not be used at the CEDEGE project.

### Other Aquaculture Possibilities

The large acreages of irrigated rice in Ecuador would permit the development of rice-fishculture. There presently is a small seasonal artisanal fishery in the rice fields and irrigation canals. A more intensively managed fishery will increase the fish harvest without significantly effecting rice yield. This should be an area of investigation for the CEDEGE project.

Another area that should be investigated is cage culture. Many artisanal fishermen live on the river and presently use floating cages to hold their catch. These cages could be modified for fishculture and species such as Brycon could be fed table scraps or chicken feed.

### Fisheries Management

The Rio Guayas drainage system has a large freshwater fishery but little information is available which will lead to the rational management of this resource. A fish catch and effort survey should be conducted over a period of a few years to describe the fishery. Such a survey will serve as a base line and permit fluctuations to be observed, which in turn, will enable rational exploitation of the fishery to be achieved. The biology and life history of the major commercial species also should be studied. The combination of such information will allow the development of scientifically valid management regulations.

There are a number of warmwater reservoirs and lakes that can support a productive fishery. These should be identified and management plans established. The stocking of Lago Yaguarcocha near Ubarra with T. mossambica has resulted in a fishery, but management procedures need to be established for the fishery to continue at an optimal rate.

CEDEGE: Proyecto de Babhoyo

The Comision para el Desarrollo de Cuenca Rio Guayas (CEDEGE) is developing an 11,000+ ha irrigation project near Babahoyo using the Rio Chico as the water supply. Various sites exist in this project for the construction of several ponds. The staff of CEDEGE is cooperating with the Departamento de Piscicultura in the construction of several ponds. One pond is located between an irrigation canal and the river. This pond has severe seepage problems and will require extensive renovation if it is to be used. Further, the pond is threatened by part of the dam bordering directly on an outside curve of the river. Continued erosion of the river bank will lead to the collapse of the dam. Efforts to renovate this pond should be postponed until all other sites are developed.

A rectangular 2-ha borrow pit, located near the main building complex of the project, presently holds water and can be drained. This site could easily be subdivided into 5 to 10 more manageable pond units. A 15-ha tract of land adjacent to the borrow pit could be developed into a fish production complex or an aquaculture research station.

The site is bordered by a 180-l/sec. irrigation canal and also has a main drainage canal nearby. Further evaluation of the site is needed to insure that any ponds built could be drained and filled by gravity. Soil profiles also need to be made to determine if adequate clay content of soil is present. The water quality of the irrigation water appears good with a total hardness of 200 mg/l and a total alkalinity of 179 mg/l. Possible danger exists when using irrigation water in that upstream users may contaminate the water with pesticides. The irrigation canal to the site should be enlarged to avoid water supply problems.

A government warmwater fishculture station is needed. Such a station would serve as a training and demonstration center, and provide applied research needed for aquaculture development in Ecuador. The 15-ha site at the CEDEGE

project can be developed into such a station. Immediate steps should be taken to reserve this tract of land for future development of an aquaculture station. The Departamento de Piscicultura should give priority in 1982 to construction of this station.

#### Possible Project Sites Involving the Departamento de Piscicultura

Plans are being developed for a water storage project near Jipijapa in the Province of Manabi. Consideration should be given to including aquaculture as a component of the project. Rainfall data suggest that 6-month aquaculture seasons may be possible. Many areas seen had suitable clay soils for pond construction. There is an abundance of chicken manure in the area that could be used for pond fertilization. Various feed materials are also available in the area.

The availability and price of fish in the Jipijapa area should be documented. The quality marine fish appear to be transported directly from Manta to the major cities. As a result only limited amounts of marine fish may be available to the smaller towns in the area. A water storage project that includes aquaculture in the area will permit fish to be produced and marketed locally.

The Chota valley in northern Ecuador is an impoverished area which would benefit from an aquaculture project. An irrigation canal furnishes water to the communities of Juneal and Carpuela. A school in Carpuela has a small tract of land that could be made into a demonstration fishpond. The conditions in the area are not optimum for aquaculture but the impact made could be significant. Such a project could best be carried out by Peace Corps with support from the Departamento de Piscicultura.

## RECOMMENDATIONS TO THE DEPARTAMENTO DE PISCICULTURA

It is important that the Departamento de Piscicultura, with its national responsibilities, provide the leadership for aquaculture development in Ecuador. There are presently a number of organizations in Ecuador involved in some aspect of aquaculture, but the contacts between the various organizations are limited. A meeting of all organizations to present their program would be of great value. A national aquaculture plan should be developed to better define the government's role in aquaculture development. Special consideration should be given to the roles of the Departamento de Piscicultura and the Instituto Nacional de Pesca. It is suggested that the Instituto Nacional de Pesca concentrate on basic studies regarding the biology of aquatic organisms and the Departamento de Piscicultura conduct applied research regarding the culture of aquatic organisms as well as conduct aquaculture extension.

Consideration should be given to reorganizing the Departamento de Piscicultura with the objective of reducing its regulatory responsibilities. Presently regulatory functions related to the allotment of land for shrimp culture occupy a major portion of the staff's time. The control of land used for shrimp culture is an important function and more emphasis should be given it, particularly if an aerial survey program is to be conducted. However, if the Department is to become more active in aquaculture research and extension there needs to be a reallocation of staff. A separate section or unit outside the Departamento de Piscicultura should be responsible for allocation of land used for shrimp culture and other regulatory aspects of the industry.

Consideration should then be given to forming a mariculture and freshwater aquaculture sections under the Departamento de Piscicultura. The freshwater section could be further divided into coastal and sierra branches. The function of these sections should be primarily applied research and extension. Additional

biologists will be needed to accomodate the new organization. But it is important that the necessary logistical support be available before the program is expanded.

Both marine and warmwater freshwater aquaculture stations should be established as a part of the Departamento de Piscicultura program. The CEDEGE site should be considered for a freshwater station. Provisions should be made to adequately supply and maintain these stations. So often the difficult part is not the building of the stations but properly maintaining them after construction is completed. A critical factor is also having adequate transportation and funds to allow the biologists to go out from the stations and conduct research or extension programs.

Continued emphasis should be given to both long- and short-term training as this is the key to development of any technically oriented program. The training element becomes particularly important as the program grows and becomes more complex. Plans should be made to have at least one Master of Science degree trained biologist at each of the new stations.

It is very important that the Director General de Pesca, the Chief of the Departamento de Piscicultura and the chiefs of the coastal and sierra sections visit the PREDESUR project. This project is demonstrating how aquaculture can reach the small farmer in Ecuador. Much can be learned by the Direction General de Pesca from this project, both in terms of progress that has been achieved and constraints encountered. It would be of benefit that the other biologists of the Departamento de Piscicultura also visit the project at a later date.

Consideration should be given to the Departamento de Piscicultura providing a biologist to the Ministerio de Agricultura program in Santo Domingo on a part- or full-time basis during the next year. The assistance could well be used and

it would help develop linkages between the Department and other organizations involved in aquaculture.

As the extension program of the Departamento de Piscicultura becomes more active, consideration should be given to Peace Corp participation in the field program. A request should be made to have one volunteer stationed at the CEDEGE project during the next year.

A number of technical topics were discussed earlier as a part of General Considerations and Observations. These topics should be reviewed and the Departamento de Piscicultura initiate the various studies that present staff and resources will allow. Particular consideration should be given to studies regarding mangrove exploitation, shrimp post larvae abundance, tilapia and carp culture, and fisheries management.

The Direccion General de Pesca should request technical assistance in aquaculture and fisheries biology for a period of three to five years from an international development agency such as USAID, CIDA or FAO. This technical assistance should include helping to develop the stations, provide training for biologists and in conducting the technical program.

#### RECOMMENDATIONS TO USAID

Warmwater aquaculture has a great deal of potential in Ecuador both in the coastal region and the lower valleys of the sierra. Its development should be considered for AID support.

The Departamento de Piscicultura of the Direccion General de Peces is expanding its program both in brackishwater and freshwater areas. The brackishwater culture of shrimp is a very important sector of the ecuadorian economy that is developing rapidly. USAID support in several areas relating to shrimp culture should be considered.

Presently shrimp culture is expanding faster than the government can effectively monitor. This rapid expansion has made the national management of the coastal zone difficult and has resulted in ecologically important mangrove areas being lost. To monitor the change in land use in the coastal zone from salt flats, mangroves or agricultural land to shrimp ponds, an aerial photographic survey is needed every 5 to 6 months. The possibility of USAID support through the US Department of Agriculture and its satellite crop monitoring program should be considered. The satellite photos must be of adequate detail to distinguish between: tidal flats; salt flats; live, dead or cut mangrove areas; and shrimp ponds. If these distinctions can be made, it will be a very valuable tool in Ecuador in controlling its coastal development.

USAID supported technical assistance is needed in conducting an inventory of shrimp post larvae. The abundance of postlarvae shrimp from the wild is one of the major factors which has allowed shrimp culture to develop in Ecuador. But no information is available on the dimensions of this resource and to what extent it is being exploited.

Consideration should be given to USAID assistance in the establishment of shrimp hatcheries to produce post larvae such as being developed by the Escuela Superior Politecnica del Litoral. Such hatcheries can help reduce the fishing pressure on natural postlarvae stocks.

Consideration should also be given to USAID support in the establishment of a shrimp culture research station. Such a station is needed to develop methods to improve management procedures and increase yields.

Although the Departamento de Piscicultura is responsible for developing a nationwide program, it presently does not have the resources to conduct such a program. International assistance is needed to help it meet its mandate. This would include assistance in developing its staff, establishing facilities and

furnishing equipment. If all components were included such a project probably would cost between 5 to 10 million dollars. Financing a national program may not be justified at this time but consideration should be given to the support of a particular project. The Departamento de Piscicultura plans for an aquaculture station as a part of the CEDEGE irrigation project should be considered as one project. Support to a fisheries biology study of the Rio Guyas drainage would be another possibility.

Another area where AID support could have an impact is in the area of training. This should include in-country training, short-term training in other countries and advanced degree training. This could be limited to the Departamento de Piscicultura or also include other aquaculture programs in Ecuador. Assistance to one of the universities such as the Escuela Superior Politecnica del Litoral should also be considered.

The regional development projects such as CEDEGE, CRM or CREA may offer the possibility of aquaculture reaching the small farmer more effectively than nationally oriented programs. Such a program should have its primary emphasis as aquaculture extension. This could be incorporated into an integrated rural development program as well.

AID support to small Peace Corps projects such as at Santo Domingo is a valuable method to establish aquaculture in Ecuador. This support should continue. Based on the results of such projects, larger projects can be developed with AID support.

Aquaculture in the Jipijapa area is possible if the proper water storage system can be developed. There is an abundance of chicken manure that could be used for pond fertilization. Feed materials are available in the area. The soils in general appear to have sufficient clay for pond construction.

Before AID makes any commitment to aquaculture development, it is advisable that a meeting of various donor agencies be held to discuss fisheries and aquaculture projects. Although no details were available it was said that Great Britain, Canada, Nationalist China, Japan, Israel and FAO were giving assistance to some aspect of fisheries.

There are numerous possibilities for AID involvement in aquaculture. One program that might have the most benefit is the development of a Departamento de Piscicultura aquaculture station at the CEDEGE project near Babahoyo. Such a project would include construction of a station. This could be done in phases completing a 2-hectare pond complex and fish hatchery building during the first two years and additional ponds and buildings later. Training of staff should receive emphasis in the first phase. This should include in-country training as well as advanced degree training.

One technical advisor would be needed from the start of the project. Also one to two Peace Corps Volunteers would be needed in the first phase of the project and others as the extension program expands.

A minimum of \$50,000 dollars of equipment would be needed for the first phase. Additional equipment would be needed as the project expands.

## Itinerary

- July 14 Arrived Quito
- 15 Quito, met with Fausto Maldonado of USAID, and Captain Francisco Garcia, Direccion General de Pesca, Michael H. Hirsh, Sub-Director Peace Corps, Pablo Maldonado, Peace Corps Advisor, Zachary Macy, PCV.
- 16 Guayaquil, met with Marcos Zambrano Director General de Pesca, Andres Estrella, Chief Department of Piscicultura, and other biologists.
- 17 Visited fish market Babahoyo and CEDEGE project.
- 18 Guayaquil
- 19 Guayaquil
- 20 Visited shrimp ponds near Guayaquil
- 21 Visited Jipijapa, chame ponds near Bahia
- 22 Visited shrimp ponds near Bahia
- 23 Visited shrimp ponds near Bahia
- 24 Guayaquil
- 25 Guayaquil, visited fish market
- 26 Guayaquil
- 27 Fisheries Office Guayaquil
- 28 Visited shrimp ponds El Oro province, met with Ing. Alfredo Samaniego, Gerente de Recursos Renovables PREDESUR.
- 29 Visited Zamora Fish Culture Station and farm ponds, visited Villcabomba Fish Culture Station, met with Jeffrey Bakken and Catherine Mawn, PCV's.
- 30 Met with Ing. Alfredo Samaniego and Ing. Rowe Espinosa PREDESUR, visited Yamana Fish Culture Station.
- 31 Visited fish market Manchala, PREDESUR office Manachala, returned to Guayaquil.

Itinerary continued

- August 1            Guayaquil
- 2            Guayaquil
- 3            Visited Escuela Superior Politecnia del Litoral, met with Ing. Cristobal Mariscal, Director Department of Marine Engineering and Marine Science, and faculty.
- 4            Visited Insititute Naccional de Pesca, met with Dr. Efrin Lopez, Sub-Director, and Francisco Yoong, biologist.
- 5            Visited University of Guayaquil, met with Dr. Jose Cuenca, Dean of the School of Natural Sciences, Dr. Flor de Maria Valverde, Director of the Biology Department.
- 6            Visited private ponds Quevedo and Ministry of Agriculture fishculture station, Santo Domingo.
- 7            Visited Chota valley
- 8            Quito
- 9            Visited site for trout station, Papallacta
- 10            Quito
- 11            Quito, met with Capt. Francisco Garcia, Direccion General de Pesca, Fausto Mandonado, debriefing with USAID Director John Sanbrailo.
- 12            Left Quito to return to the US.