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FISHCULTURE SURVEY REPORT

FOR ECUADOR

H. S. Swingle and F. A. Pagan
Auburn University
Agricultural Experiment Station
Auburn, Alabama

Project: AID/csd-2270

Date: December 20, 1969

Title: Increasing Fish Production
by Improved Fishcultures

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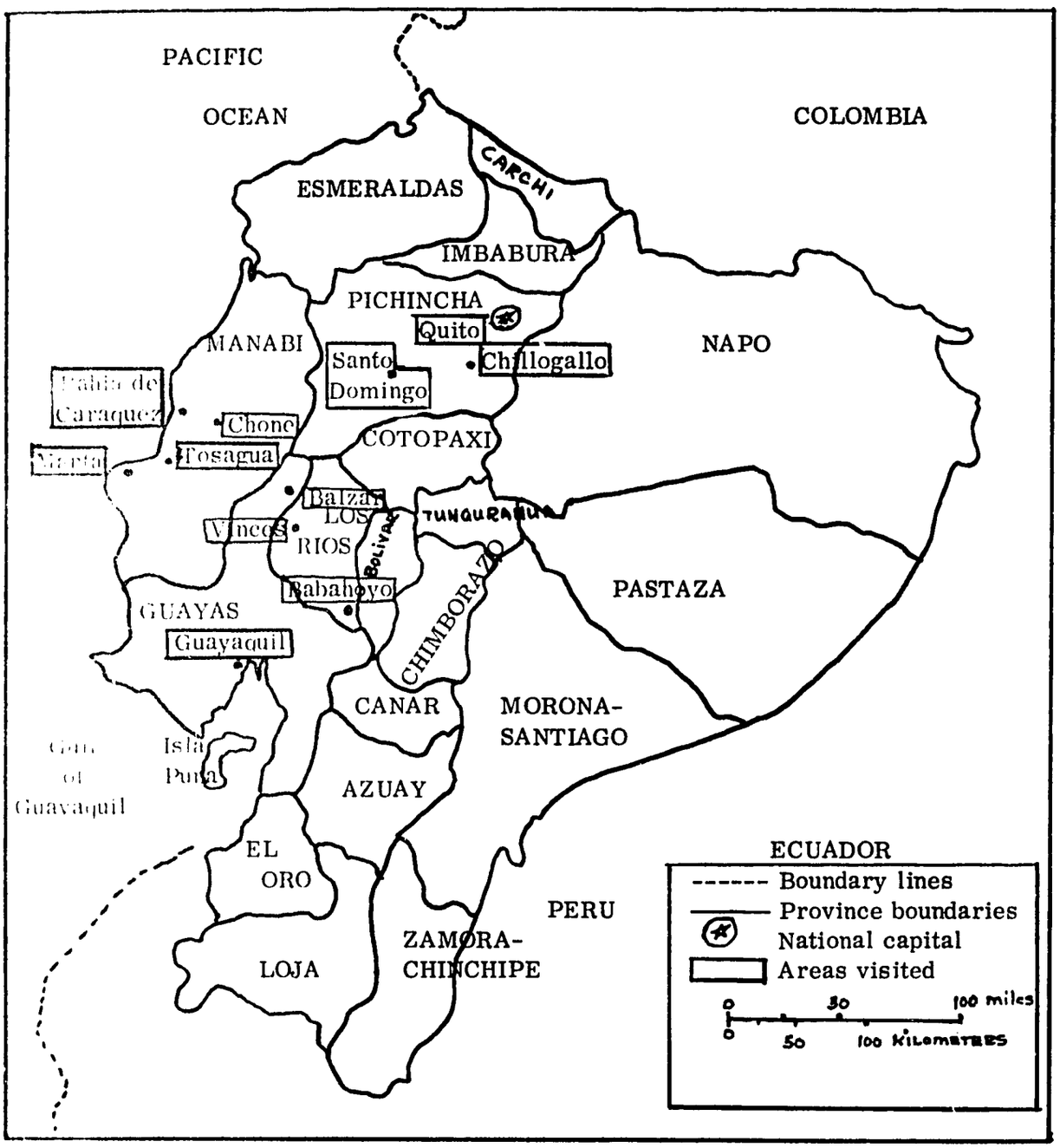
1.0 ITINERARY AND MAP OF ECUADOR INDICATING AREAS VISITED DURING SURVEY OF ECUADOR, OCTOBER 18 - OCTOBER 28, 1969

October 18	Arrived in Quito
October 19	Fishculture Experimental Farm Carmela Cordovez de Donoso at Chillogallo, Province of Pichincha
October 20	Town of Manta, Province of Manabi
October 21	INEPACA (Industria Ecuatoriana Productora de Alimentos, Compania Anonima), a tuna cannery managed by Van Camp Company in Manta; Chameras of Tosagua, Chone and Bahia de Caraquez, Province of Manabi
October 22	San Vicente Fish Market, Bahia de Caraquez; Guayaquil, Province Del Guayas
October 23	General Directorate of Fishing (Direccion General de Pesca), Guayaquil; National Institute of Fishing (Instituto Nacional de Pesca), Guayaquil; IPESA (Industria Pesquera Ecuatoriana Sociedad Anonima), a shrimp processing factory; Meeting with Mr. Helge Friis Olsen, General Manager, Botica y Laboratorios H.G., Compania Anonima
October 24	River fishery at Babahoyo River, city of Babahoyo and Barreiro Parish, Province De Los Rios
October 25	Chameras of Vinces and adjacent areas, Province De Los Rios; Balzar, visit to Hacienda (Farm) Piedad of Mr. Helge F. Olsen, Province Del Guayas; Santo Domingo de los Colorados, Province of Pichincha
October 26	Return to Quito
October 27	Meetings with USAID - Point IV staff; the Minister of the Ministry of Industries and Commerce (Ministerio de Industrias y Comercio); the Departamento de Piscicultura; Mr. John R. Bromley (Andean Development Compania), Quito; Mr. George T. Walker, President, Kennett Square Products, Inc., Quito
October 28	Return to U.S.A.



Map of Ecuador indicating localities visited by Auburn Team.

2.0 RECOMMENDATIONS

2.01 That a reference collection of freshwater fishes and shrimps of Ecuador be set up, starting with species of commercial importance. Samples of fish and shrimps should be sent to Auburn University, where they will be identified. Properly identified and labeled specimens will be returned to the Departamento de Piscicultura in the Ministerio de Industrias y Comercio for use in training personnel.

2.02 That the Inspectors in the Departamento de Piscicultura responsible for accumulation of fisheries statistics on the catch from natural waters be given a 1-week training course in Quito on identification of commercial species, methods for obtaining and recording catch statistics and principles of fishery management. A specialist from Auburn could assist in the training.

2.03 That standard forms be prepared for use by Inspectors in recording catch statistics. These can be prepared with aid from Auburn University.

2.04 That a suitable site be selected for a warmwater pondcultural station. This should have an area of approximately 20 to 25 hectares. The soils must be examined with a soil auger before purchase to determine if they are suitable for pond construction. The water supply at the driest period of the year must be adequate to maintain at least 10 hectares of water. Minimum flow required to maintain 10 hectares of ponds constructed in good soils is 250 gallons (950 liters) per minute

to replace seepage plus evaporation. The ponds should be constructed where they can be filled by gravity and drained by gravity. Pond sizes should be 1,000 square meters and 500 square meters in surface area. The minimum number of ponds required for a good station is 100. During the first year of construction, a minimum of 30 ponds should be planned, with the remainder constructed in succeeding years.

2.05 That a short-term visit (1 week) to Auburn University Fisheries Experimental Unit be arranged for the Chief of the Departamento de Piscicultura and one or more associates to become familiar with experimental pond systems and methods of research. The most suitable time would be between April 1 and October 1.

2.06 Because of the shortage of trained personnel in the Departamento, that 1 or 2 persons with training in science be sent to Auburn for a period of 6 months to learn methods of sampling, methods of stomach analyses of fishes and identification of fish-food organisms so that they may initiate the first step in investigation of native species.

2.07 That fellowships be made available for training abroad of 4 persons for 2 years each at the graduate level over the next 3-year period to increase the competence of the Departamento de Piscicultura.

2.08 That 4-week visits every 6 months be made by a team of 2 to 3 experts from Auburn to assist the Departamento in planning fisheries research, developing fisheries management, the planning of extension services and to assist in training fisheries personnel within the Departamento.

2.09 If a full-time Fisheries Advisor is placed in Colombia under the Auburn Project AID/csd-2270, periodic visits of this specialist to Ecuador could be arranged to replace one of the two trips recommended under item 2.08 above.

2.10 That a program of surveys be initiated by the Departamento on the species composition, lengths and weights of fishes being harvested commercially in lakes and rivers, the catch per unit of effort, and other data necessary as a basis for improved management.

2.11 That a program of research be initiated to determine the feeds and feeding habits of various species and their ecological requirements. The initial phase would consist of a collection of fishes from natural waters, their identification, their measurement for length-weight relationships, examination of stomach contents to determine fish-food organisms utilized and ecological description of their habitats. This would be followed by testing fish species individually and in various combinations in experimental ponds to develop the basis for their management and culture.

2.12 If a full-time Fishery Advisor is provided by FAO, their program and those sponsored by USAID should be coordinated to make the assistance most beneficial to the host country.

2.13 If the USAID or FAO program is initiated, the additional trained technical staff should be added to the Departamento at the approximate rate of 3 per year for a 3-year period.

3.0 SUMMARY

3.01 FRESHWATER FISHES AND SHRIMPS

Two hundred seventy-six species of freshwater fishes are known to occur in Ecuador, and probably an equal number remain to be identified. Approximately 45 species are harvested in commercial quantities. Several unidentifed species of Macrobrachium shrimps have been found in the Calceta River, in the Chone Valley and in the Guayas River, Province Del Guayas. From Rio Carrizal, one species of Larrea had been captured. Specimens of various shrimps were in the museum of the Instituto Nacional de Pesca, along with a collection of identified marine fishes. No collection of identified freshwater fishes was available in the country.

No information presently exists upon the feeding habits, ecological requirements, biology or relative efficiencies of these species. Accumulation of such information is necessary in developing methods of management, culture and utilization.

The initial step would be to collect specimens from fishermen or directly from the water, identify the species, record the area from which they came, make accurate length-weight measurements and examine the stomach contents to determine the types of biota most frequently utilized as food.

A necessary second step is to bring the species into a pond culture research station and determine the following:

1. Requirements for spawning
2. Methods for raising fry to fingerlings in ponds

3. Relative efficiency of various species as measured by the production in ponds obtained within a 6-months period with a particular species individually and in combination with other species under the following conditions:

   a. With unfertilized water

   b. With phosphate fertilization

   c. With feeding

3.02 RESERVOIR FISHERIES

Because of very limited rainfall in the coastal region along the Pacific and because of the seasonal nature of the rainfall, many large and small reservoirs will be constructed in future years to provide water for irrigation and other usages. These can be stocked to provide productive fisheries in areas where the protein is greatly needed. At present, however, there is practically no information on the feeding habits or relative efficiencies of the various native fishes upon which to base stocking ratios and densities. A productive reservoir placed in areas previously suffering from lack of water and food can completely change the lives of inhabitants of those areas. Many areas between the coast and the lower range of mountains appeared to be suitable sites for water impoundment. A preliminary examination with a soil auger could be used to evaluate rapidly the suitability of many areas for small impoundments that would store water in the rainy season for use during the dry season.

3.03 COASTAL AQUACULTURES

Large acreages in the estuarine areas along the Gulf of Guayaquil

have soils too salty for agriculture, but quite suitable for brackishwater or seawater pondcultures of shrimp and fish. These could be operated to produce large amounts of shrimps, fish and other coastal seafoods for use within the country and for export. Also, similar suitable areas were observed in the upper part of Bahia de Caraquez where ponds could be constructed on the intertidal areas. Other coastal areas to the north and south were not visited.

A careful survey is needed to properly evaluate the acreage available for development, to estimate probable costs and returns per acre, and the need for establishing an experimental station in the area to develop highly productive methods of culture.

3.04 INLAND POND CULTURES

The present prices of fish appear too low to encourage rapid development of commercial culture of fish in ponds in the inland areas. It is probable that fish cultures in localized areas could make available fish of good quality and thus command a higher price. The river corvina is a high quality fish which brings a good price (38 cents per pound) on the market, whereas the catfishes bring only 10 cents per pound. Cultures would have to be developed for the fish species commanding good prices because high production of fish principally results from feeding where 1 to 1.5 pounds feed are needed to produce 1 pound of fish. The minimum wholesale price of fish must be at least 25 cents per pound for intensive fish culture to be sufficiently profitable to encourage its rapid growth. With fertilization alone, lower production is obtained, but crops of fish can be produced at substantially lower costs.

Although there is no commercial pondfish culture in Ecuador at the present time, there is a fishery in the chameras. Chameras are temporary or permanent lakes formed as the result of a river changing its course through the meandering process. The chameras are stocked naturally with fish from the rivers at flood stage, and the owner harvests the fish as the water recedes 5 to 8 months later in the dry season. Here, production and income could be greatly increased merely by construction and proper manipulation of water control structures that retain water over a longer period of time. This would provide a longer growing period before harvest and allow harvest at times when the market price is high. Further increases in production could be made if more effective combinations of fish are developed through research, and if phosphate fertilization is used.

Many hundreds of acres of ponds could be developed in the Chone Valley and smaller acreages of ponds could be developed near Vinces and in the Balzar River Valley areas.

Individuals with private capital to invest indicated their interest in establishing commercial fish and shrimp farms in various parts of the country. There was interest in development of trout culture in the upland areas and warm-water fish culture in the lowland areas. There is, unfortunately, insufficient information available on the feeds and feeding habits, ecological requirements and efficiencies of native species upon which to base commercial fish culture.

3.05 ESTABLISHMENT OF A PONDCULTURAL EXPERIMENT STATION

Needed in Ecuador is an experiment station with approximately 100

ponds to develop suitable information for management of natural populations, to determine relative efficiency of various species, and to develop cultural methods for those species that are most efficient converters of low quality wastes and natural feeds into high quality protein.

3.06 RIVER FISHERIES

Little reliable data are available on the composition of riverine fish populations, the annual catch and its composition, the fishing effort, or the ecological requirements of the fish for spawning and growth. Information of this nature is necessary for intelligent management of the fishery. A system should be devised to acquire these data at selected fish landing locations on the various river systems.

3.07 LAKE FISHERIES

The lakes in Ecuador vary from those at high elevations suitable only for culture of trout or other cold-water fish to those at low elevations that are suitable for warm-water fish culture. The trout fisheries in the upland lakes are available for exploitation by the local inhabitants as well as by the more affluent sportsmen. Little is known of the fish populations in warm-water lakes. These should be studied to determine the species composition of the standing crop and of the catch as the species doing well in this environment will probably be suitable for stocking warm-water reservoirs.

4.0 FISHCULTURE SURVEY REPORT FOR ECUADOR

4.01 INTRODUCTION

The Auburn Team made its survey of fisheries in Ecuador October 18-28, 1969. This was done under the joint auspices of USAID and the Ecuador

Ministerio de Industrias y Comercio. The itinerary is given on page 1. The Auburn Team was accompanied on the survey by Mr. Fausto V. Silva-Montenegro Jefe of the Departamento de Piscicultura and Mr. Ralph Van Dixhorn of the AID/ Mission.

On the tour, four different provinces were visited: Pichincha, Manabi, De Los Rios, and Del Guayas. The first province is located in the Sierra region and the remaining three provinces are located in the coastal region.

Ecuador is divided into 20 provinces: 10 in the Sierra, 6 in the coastal region (including the Galapagos Islands), and 4 in the Oriental. The provinces are subdivided into districts and these into parishes (counties).

The national economy is mainly based on agriculture. Bananas, coffee, cocoa, and rice are the principal agricultural products. Ecuador is the largest producer of bananas in the world and the second largest producer of cocoa

4.02 NUTRITIONAL ASPECTS

The population of Ecuador is 5.5 million with an annual rate of increase of 3.42 per cent. At the present rate, the population will double in 21 years, thus calling for immediate action toward the qualitative and quantitative improvement of the food supplies and nutritional diets of the people of Ecuador.

It is a well established fact that the most urgent nutritional needs in developing countries are those of increasing both the supplies of calories and of good quality protein. The worldwide average protein requirement has been estimated to be 57.3 grams per capita per day, of which 19 grams should be animal protein.

The following Table[1] indicates the amounts of protein per capita available in Ecuador from various sources for the years 1959 - 1961.

Product	Grams of Protein per Capita per Day
Cereals	19.0
Sugar, bananas, potatoes, pulses, cacao, etc.	16.9
Meat	6.3
Fish	2.2
Fats	0.1
Milk and cheese	7.4
Eggs	1.4
Total	53.3

The total average available protein was 53.3 grams per capita per day, with that from animal sources totaling 17.4 grams per capita per day. Only 2.2 grams of the latter were fish protein. The average available protein in 1956 - 1958 was 49.4 grams per capita per day, indicating an average annual increase of 2.3 per cent in protein per capita with a 3.42 per cent annual increase in population.

Projections of the USDA indicate that available protein will increase by 1970 to 57.2 grams per capita per day and animal protein will increase to 19.5 grams per capita per day. These projections would appear to indicate adequate proteins would be available to meet nutritional needs by 1970. Unfortunately, this is not a true picture. The estimates are based on an equitable distribution of food among all segments of the population, but the hard reality in Ecuador, as in most countries, is that food apportionment is not uniformly

1. USDA. Economic Research Service. Foreign Regional Analysis Division. Food balances for 24 countries of the Western Hemisphere, 1959-61. ERS-Foreign 86, 29 p. August, 1964.

available to all segments of the population. Consequently, a high percentage of the people are undernourished or have diets lacking in nutritional quality.

4.03 GEOGRAPHICAL DATA

Ecuador has a land area in excess of 275,000 sq. km. The Pacific borders the country on its western side, while Colombia borders the north, and Peru the south and east. Because of the climatic conditions, Ecuador is divided into four different regions.

The Oriental or eastern region makes up about half the country. The numerous rivers in the area belong to the watershed of the Amazon River. Numerous lakes are also present. The climate is very hot and humid, but the temperature never exceeds 100.4^{o}F. Due to difficulties of access and the lack of roads, the region is not yet developed.

The Sierra region (Andean mountains and valleys) is located between the Coastal and Oriental regions and consists of two north-south Andean chains. It is commonly referred to as the region of "everlasting spring", with a mean annual temperature of 59°F. The Sierra comprises about 25 per cent of the country.

The Coastal region (Pacific Ocean slopes) has a hot, humid climate with a mean temperature of 77°F during the months of November through June and a lower mean temperature of 68°F between July and October. The region, except for some isolated hills, is mostly gently sloping and possesses numerous rivers, which flow from the Andes into the Pacific Ocean. The two main river systems are the Guayas, which empties into the Gulf of Guayaquil in the south, and the Esmeraldas in the north. The main tributaries of the former are the

Zapotal, Vinces, and Daule Rivers. Those of the latter are the Blanco, Quininde, and Guayllabamba Rivers. There are also in the region many small lakes and a large one, Lake Sade, in the Province of Esmeraldas.

The fourth region is the Insular, consisting of the Galapagos and other adjacent islands.

4.04 RAINFALL DATA

The following figure shows mean annual precipitation in various regions of Ecuador. In the coastal areas along the Pacific where the average rainfall is 300 mm (11.8 inches), the rainy season lasts about 3 months - January, February and March. In those areas with an average yearly precipitation of approximately 500 mm (19.7 inches), the rainy season is 3 to 6 months in length. Where the precipitation ranges between 1,000 and 1,500 mm annually (39 and 59 inches, respectively), the rainy season lasts between 6 and 12 months. Finally, in areas with an annual rainfall ranging between 2,000 and 5,500 mm (79 and 217 inches, respectively), the rainy season lasts 9 to 12 months.

No information was available on the amounts of runoff or evaporation.

4.05 SOILS

A preliminary report on the soils of Ecuador was made by FAO in 1957[1] Based on this information, the following map shows the principal areas where there is sufficient clay in the soils and subsoils for the impoundment of water.

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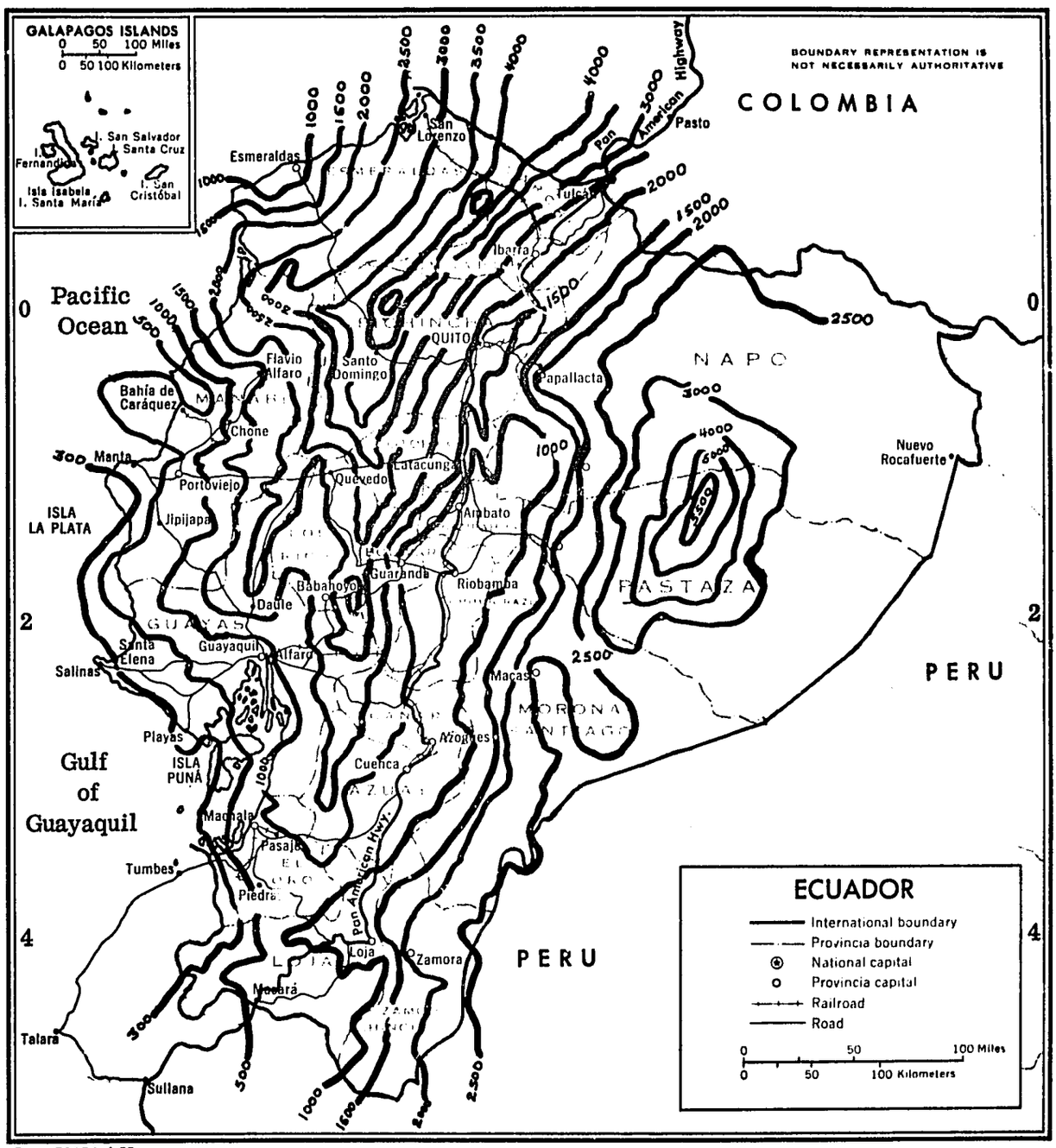
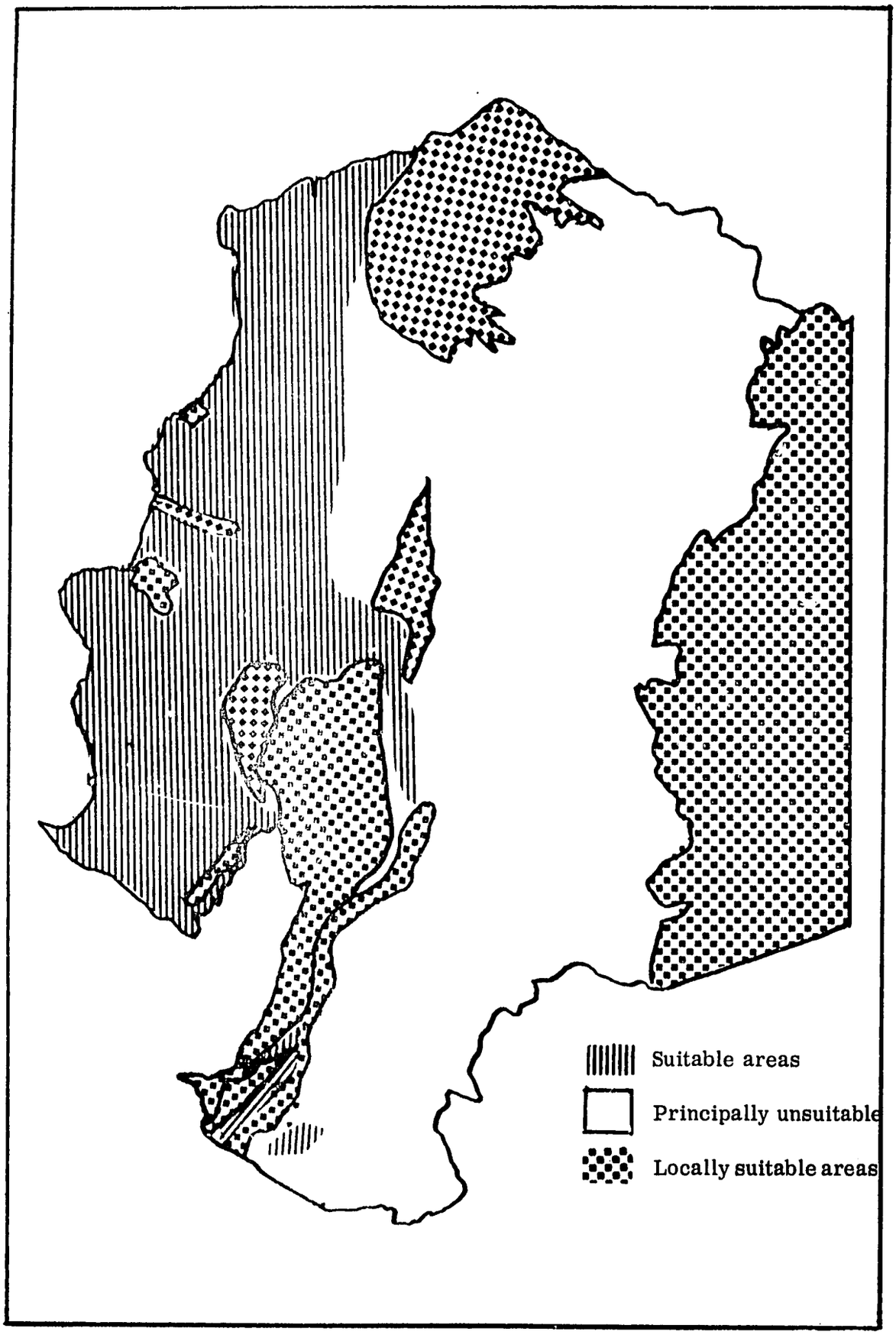
1. Informe al Gobierno del Ecuador sobre Reconocimientos Edafologicos Exploratorios. Dr. Edwin Frei. FAO/57/8/5190. 35 p. 1957.



Base 58056 4-68

Precipitation map showing mean annual rainfall in mm. This information is based on data gathered from 1931 through 1960 by the National Service of Meteorology and Hydrology in Ecuador.



Map indicating areas with soils suitable for pond construction in Ecuador.

The soils apparently suitable for pond construction were as follows:

Tierra negra tropical (Regur)

Pardo forestal tropical

Latosol pardo

Sierozem

Locally suitable areas would also occur in:

Aluviales humedos

Negro aluvial

Latosol amarillo-rojiso

Other suitable areas undoubtedly occur locally and their suitability can be readily determined by use of a soil auger.

4.06 STATUS OF THE FISHERIES

Most of the records available on the fisheries of Ecuador refer only to the marine and brackishwater fishery. The freshwater fishery is known just superficially, making it extremely difficult to appraise the resource as a whole.

The most recent complete statistics on the total catch of commercially important marine organisms in Ecuador are those for the year 1966[1]. A total catch of 48.2 thousand metric tons, representing a total value of 141,069,000 sucres ($7,838,000 U.S.), was reported for that year. The composition of the catch by major fish groups, weight and value is given in the following Table.

1. FAO (1968). Yearbook Fish. Statistics (24):p. b-56.

Composition of Catch	Weight (thousand metric tons) (landing and live weight)	Value in thousands of U.S. dollars
Various demersal percomophs Redfishes, basses, etc.	0.9	107.0
Various marine clupeoids	8.1	108.0
Tunas, bonitos, skipjack	12.0	971.0
Miscellaneous fishes	16.8	2,307.0
Crustaceans		
Shrimp	5.3	3,763.5
Lobsters	0.2	111.2
Others	1.4	155.2
Molluscs	3.5	315.0

The 48.2 thousand metric tons represent a reduction of 5,300 tons from the total catch of 1965. On the other hand, fragmentary records of the total catch for 1967, indicate that the catch of marine clupeoids and scombrids (tunas, bonitos, skipjack) increased by 8.5 thousand metric tons over that of 1966. The reason for the increase is not certain. It appears reasonable to assume that increased fishing pressure on a partially unexploited resource, such as the skipjack tuna, has raised the annual yield. Seventy-seven per cent (6.6 thousand metric tons) of the increase was due to skipjack.

Fragmentary information on the price of freshwater and marine fishes was obtained. The following Table shows the common and scientific names and the average price per pound of various species of freshwater and marine fishes. This price was the average price listed in fish markets, supermarkets, and grocery stores in Quito and at the city of Babahoyo, near the Babahoyo River.

Species	Price per pound Sucres	Dollars
Freshwater Fishes		
Rainbow trout (*Salmo gairdnerii*)	12.00	0.57
River corvina (*Cynoscion sp.*)	8.00	0.38
Bocachico (*Ichthyoelephas* sp.) and other small freshwater fishes	6.00	0.28
Sabalo* (*Brycon* sp.)	3.00	0.14
Guanchiche* (*Hoplias microlepis*)	2.00	0.10
Dica* (*Curimata* spp.)	2.00	0.10
Bagre* (Catfishes spp.)	2.00	0.10
Dama* (*Brycon* sp.)	2.00	0.10
Chame** (or Chalaco) (*Dormitator* spp.)	2.00	0.10
Marine Fishes		
Lenguado (Flounder)	7.00	0.33
Ocean corvina (*Cynoscion* spp.)	5.00	0.23
Pargo (Snapper)	5.00	0.23
Cherna (Grouper)	5.00	0.23
Lisa (Mullet)	5.00	0.23
Picudo (Marlin)	5.00	0.23
Atun (Tuna)	4.00	0.19
Dorado	4.00	0.19
Jurel (Jack)	3.00	0.14

*Price based on information gathered at the river fishery market at city of Babahoyo in Barreiro Parish.

**Price obtained at San Vicente Fish Market, Bahia de Caraquez.

The prices for most freshwater and marine fishes were very low. This could probably be due to a number of factors, two of which certainly are lack of proper transportation and refrigeration from the point of capture to the markets around the country, thus producing a problem of distribution, spoilage, and unappetizing appearance of the fish when displayed at the markets. Another factor may be that Ecuadorians are not traditionally known as "fish-eating" people. This appears to be true, if it is considered that for the years 1951 - 1963 (latest statistics on the subject) the annual fish consumption was estimated at 6.5 kg per capita, which is low compared with 12 kg for the United Kingdom and France, 20 kg for the Philippines and Spain, and 40 kg for Norway during the same period. Projections for 1985 indicate that annual fish consumption by then would have increased to only 9.3 kg per capita, still below those of the countries just cited. However, the problem of low consumption appears largely the result of low availability. At Manta, it was pointed out that the fishermen were not interested in use of ice because they could sell all fish caught, regardless of the poor quality.

Lack of knowledge and of trained personnel to gather and analyze relevant data are presumably responsible for the scarce statistics and records available on the freshwater fisheries. There are no reliable statistics or basic information (food habits, lengths, weights, identification, etc.) on the various species of fishes, shrimps, and other organisms inhabiting the freshwaters of Ecuador.

At least 276 species of freshwater fishes have been reported from Ecuador[1]. These include nine introduced species. Forty-five of the native species are presently considered as having some commercial value. The total number of species of native freshwater fishes has been estimated as approximately 500 to 700. No reference collection of identified species of freshwater fishes is available in Ecuador for use by those engaged in research, management surveys, or for teaching.

4.07 GOVERNMENT DIVISIONS RESPONSIBLE FOR FISHERIES MANAGEMENT

4.071 Departamento de Piscicultura (Division General de Pesca y Caza, Ministerio de Industrias y Comercio)

The Departamento de Piscicultura of Ecuador was founded in 1963 under the Division General de Pesca y Caza, Ministerio de Industrias y Comercio. Its general objectives are to promote and develop the fisheries and aquaculture in the Sierra, Oriental, and Coastal regions of the country. All operations pertaining to freshwater fisheries and aquacultures are under the jurisdiction and supervision of this Department.

The staff of the Department is composed of:

1. A Director or Chief (Jefe) - Mr. Fausto V. Silva-Montenegro
2. Three secretaries
3. Four fishery inspectors
4. Nine assistant fishery inspectors
5. One laborer

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1. Freshwater Fishes of Ecuador. Michael M. Ovehynnyk. Michigan State University Latin American Studies Center. Monograph Series 1:44 p. 1967.

The Department's budget[1] for 1969 totaled 494,500 sucres, equivalent to US $23,548. In the following Table, the budget for 1969 is itemized.

Funds		Item
75,000 sucres	($ 3,571 U.S.)	Research and development of various fish culture operations
370,000 sucres	($17,619 U.S.)	Salaries
49,500 sucres	($ 2,357 U.S.)	Administrative operations, transportation and traveling expenses, maintenance and other services
494,500 sucres	($23,548 U.S.)	

Presently, the work being done in the Department is directed toward the development of the rainbow trout culture in the Sierra and Oriental regions. Other programs for future development, such as construction of research stations, pilot aquaculture farms (granjas) and hydrobiological laboratories have been proposed. These future plans include the construction of 4 fishculture stations for salmonids, 1 pilot station for salmonids, 4 experimental fishculture farms, 14 commercial fishculture farms, and 2 hydrobiological laboratories.

Experimental work with different species of fish, crustaceans, and phyto- and zoo-plankton is also projected.

The main difficulties hindering progress by the Department

1. Finalidades, objectivos y metas de la piscicultura en el Ecuador, Fausto V. Silva-Montenegro, Ministerio de Industrias y Comercio, Division General de Pesca. Boletin de Difusion Piscicola No. 1; 41 pp. 1969.

may be itemized as follows:

1. Insufficient funds for the successful operation of the administrative, technical, and scientific phases of the Department.
2. Lack of trained personnel to accomplish the broad operational scope proposed.
3. Lack of adequate experimental facilities (research stations, laboratories, experimental ponds and equipment).

Due to lack of trained personnel, plans for the selection of sites and land acquisition for the construction of experimental or research facilities must be carefully designed or delayed until trained personnel becomes available or outside assistance is obtained. In this manner, costly and irreversible mistakes can be prevented. Guidelines on how to evaluate suitable locations were given to Mr. Silva-Montenegro. These guidelines include the following:

1. Land area should be at least 20 hectares with enough flatland to allow for economical construction of ponds.
2. Soil examination to determine soil texture and composition. Basically, this can be done with a "homemade" soil auger consisting of several detachable sections that, when assembl can bore into the ground to a depth of 10 to 12 feet.
3. Determine whether or not the supply and source of water is sufficient and of suitable quality for the operation of an experimental station.

It may be desirable for the name of the Department to be changed to Departamento de Aquacultura to indicate that the Department will be responsible for development of methods for culture of shrimps, molluscs, and other aquatic organisms as well as of fish.

4.071 Chillogallo Fishculture Experimental Farm

The Chillogallo station is operated by the Departamento de Piscicultura. It is located about 20 km southwest of Quito in the Province of Pichincha. The facility was inaugurated in May, 1969. The statioı has a land area of 2 hectares, which was donated to the Department by Mrs. Carmela Cordovez de Donoso. Three ponds totaling approximately 0.25 hectares (0.6 acre) have been constructed: ı with a total surface area ranging between 0.08 and 0.09 hectares (0.19 and 0.22 acre, respectively). The water supply is an underground spring at the station, having a flow of only 1 liter of water per second - an amount that would not be sufficient to fill and maintain the water level in experimental ponds more than 0.25 hectare (1 acre); a statioı of adequate functional size should have at least 10 hectares in ponds. Mr. Silva-Montenegro indicated that the flow could be increased to about 20 liters of water per second (sufficient for 8 hectares of ponds) as soon as the station begiı obtaining water from the new reservoir that supplies water to the town of Chillo gallo. The summer mean water temperature at the station is 60.8°F and in the winter is is 53.6°F.

Some tests had already been conducted at the station since it began operation in May, 1969. One of them dealt with the culture of

Israeli strain of the carp (Cyprinus carpio) in cages suspended at the surface of ponds. Unfortunately, no records of the results have been published. Other fish being used in experiments are: rainbow trout, brown trout, Tilapia mossambica, and the goldfish (Carassius auratus). The results of the experiments with fishes have not been published.

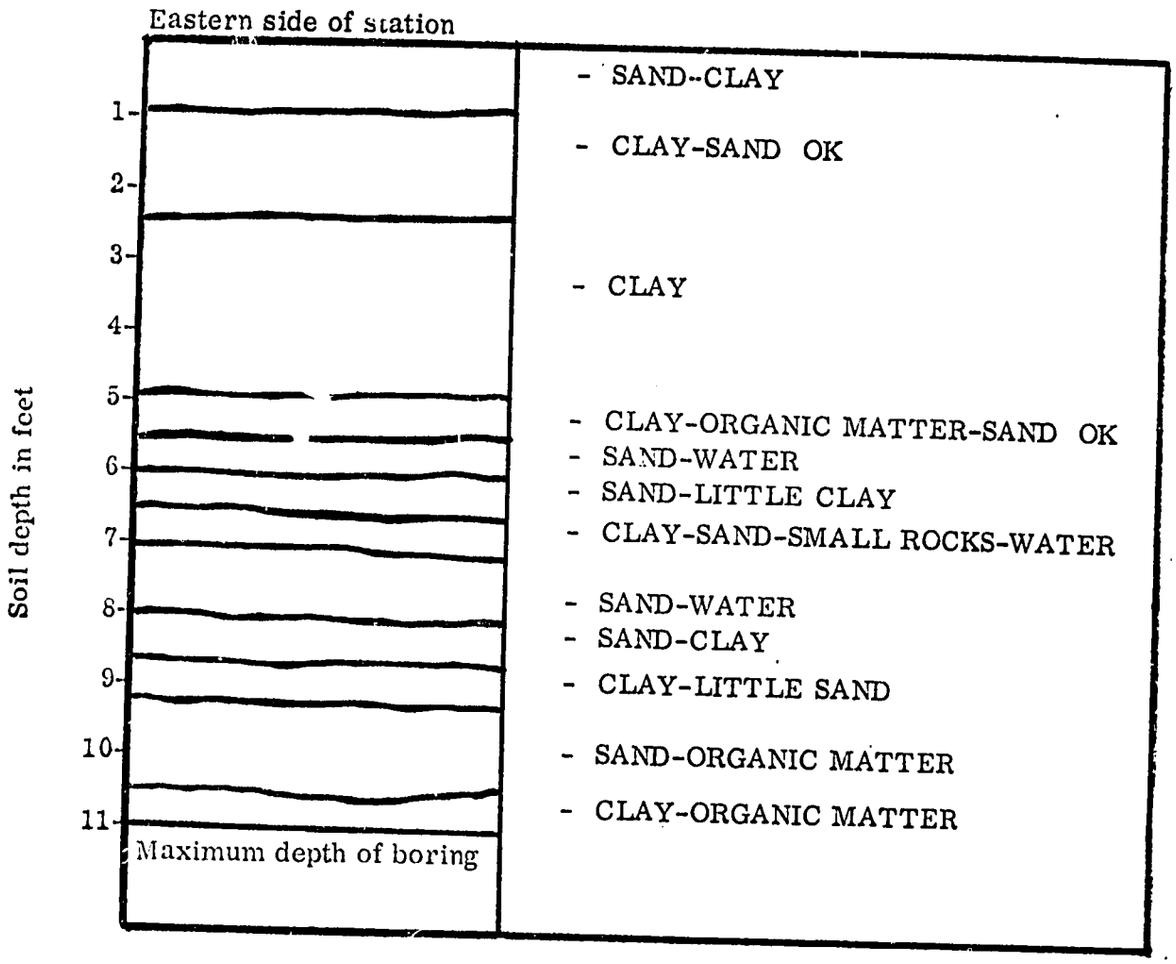
An additional facility on the farm is a small building housing the offices and the school of fish culture (one classroom). The facilities did not appear to be in full use at the time of our visit, obviously due to limitations of trained personnel.

A soil boring was made at the eastern end of the station, on the farm's vacant land, to determine its suitability for construction of experimental ponds. (See Soil Profile Chart on following page.)

The Chillogallo farm would present a number of problems if it were to be used as a research station for the study of warm-water fishes. First, the temperature of the water in the area is too low (annual mean temperature is less than 60°F) and would not allow rapid growth nor reproduction of many warm-water fishes. Second, the supply of water is not sufficient to meet the needs of an experimental research station having 10 hectares in ponds. Third, the land area presently owned by the Department is not large enough to provide for a suitable research station. At least 20 hectares should be available for a station; 10 to be used for experimental ponds, 5 hectares for physical facilities other than ponds (laboratories, administrative offices, storerooms, etc.), and 5 hectares for future expansion of the station. Mr. Silva-Montenegro

Chillogallo Fishculture Experimental Farm

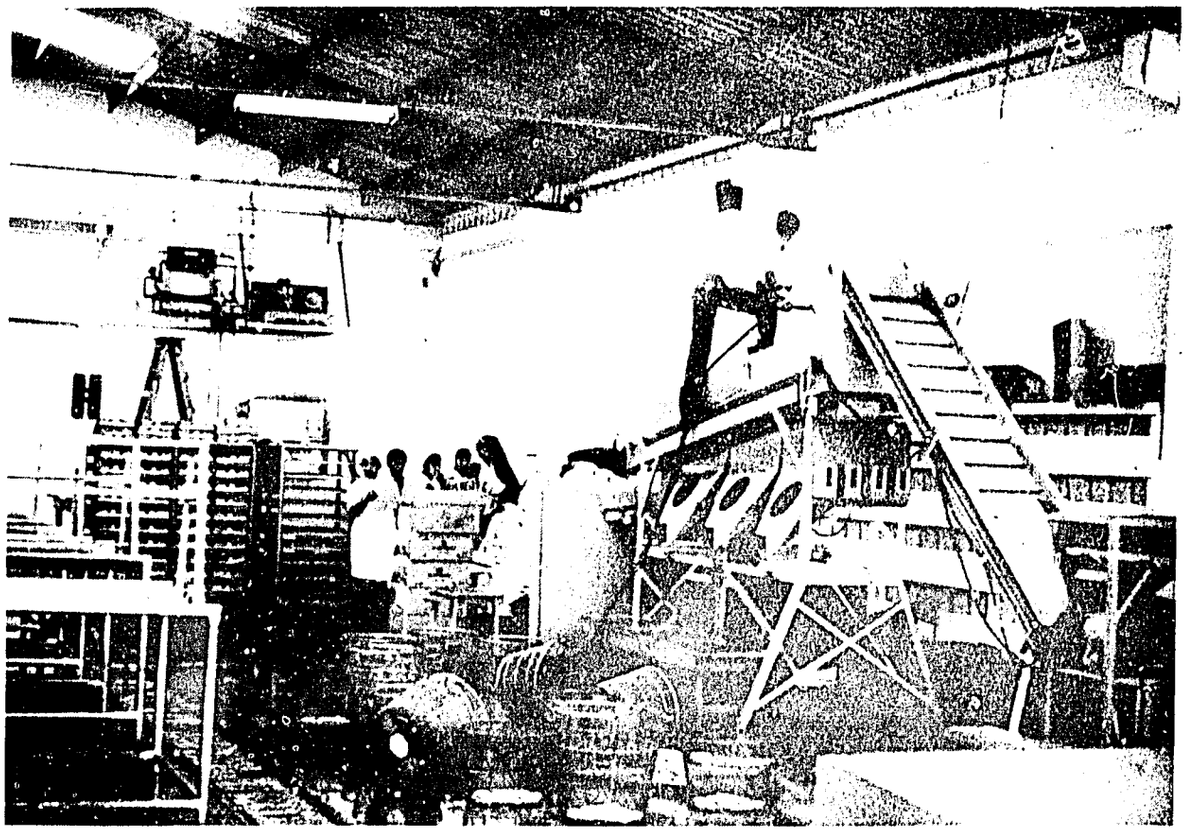
SOIL PROFILE CHART



This soil was considered usable for ponds provided the site for the dams was excavated and refilled with clay and provided the pond bottoms were packed. The depth of excavation for the pond bottoms should not be over 2 feet, leaving at least 3 feet of packed clay-sand below the pond bottoms. Seepage would be higher than where the ponds are constructed in good clay without layers of sand.

Fig. 1. Photo showing 2 of the 3 experimental ponds on the Chillogallo Fishculture Experimental Farm near Quito, operated by the Departamento de Piscicultura.

Fig. 2. Seafood processing plant for frozen shrimp in Guayaquil.



suggested that the adjacent land might be acquired by the Department by buying, leasing or as a donation.

4.072 Instituto Nacional de Pesca

The offices of the Instituto Nacional de Pesca are located in Guayaquil. The Institute was created in 1960 and was partially supported and managed by FAO until December, 1966. In January, 1969, the Institute became a semi-autonomous agency and is attached to the Ministerio de Industrias y Comercio. Its main responsibility is the development of the marine fisheries in the country. The Institute is organized into four technical departments and one administrative section. The departments are:

1. Department of Fishery Biology and Marine Biology
2. Department of Oceanography and Experimental Fishing
3. Department of Statistics and Commerce
4. Department of Fish Products

The scientific staff of the agency is composed of 5 persons with degrees in veterinary medicine, 2 naturalists, 3 chemical engineers, 1 pharmaceutical chemist, and 3 economists. The Director of the Institute is Dr. Luis Arriaga. Only the offices of the Department of Fishery Biology and Marine Biology were visited by the Auburn Team.

The Chief of the Department of Fishery Biology and Marine Biology is Dr. Mario Cobos-[illegible]eno, who has a degree in veterinary medicine and has specialized in marine fishery biology. The Department has four other staff members: 3 with degrees in veterinary medicine and 1 naturalist.

Presently, the Department is working on the taxonomy of marine fishes and other marine organisms (shrimps, lobsters, and oysters). Dr. Cobos-Cedeno mentioned that specimens of 340 species of marine fishes have been collected and identified. The staff of the Department is preparing a book on the marine fishes of Ecuador that will include the scientific and common Spanish and English names of these fishes.

The Institute publishes periodically three different types of bulletins. These are: (1) Boletin Cientifico, (2) Boletin Informativo, and (3) Boletin de Pesca. The Institute possesses a collection of marine and freshwater fishes and aquatic invertebrates. Most of the marine organisms are properly identified. In contrast, identification of the freshwater fishes and shrimps is lacking.

4.08 FISHERIES TRAINING IN ECUADOR

Dr. Cobos-Cedeno indicated that none of the universities in Ecuador offers a degree in fisheries biology or related fields. The University of Guayaquil offers degrees in veterinary medicine and natural sciences. Individuals obtaining either one of these degrees are then sent away to other countries to specialize in marine fisheries and oceanography.

4.09 SEAFOOD PROCESSING PLANTS

INEPACA (Industria Ecuatoriana Productora de Alimentos, Compania Anonima) is a tuna cannery located in the city of Manta along the Pacific coast. It is managed by the Van Camp Corporation of the U.S. in coordination with the government of Ecuador. The manager of the company is Mr. Herbert Glover.

The plant was originally built to process shrimp, but as tuna became more important, the plant was converted into a tuna cannery. Initially, it was relatively easy to catch tuna within a short distance offshore. More recently, due to increased fishing pressure, the tuna have apparently been depleted in the near waters and it is necessary to go farther offshore to bring in sufficient tuna for canning. In fact, the factory presently operates only part-time due to insufficient amounts of fish.

The principal fishes processed in the cannery are skipjack and yellowfin tunas. It appears that the skipjack resource is possibly underfished whereas the yellowfin is overfished. It was pointed out by Mr. Glover that to get sufficient tuna, it would be necessary to have greater investments in vessels, since these would have to be larger, better equipped, and have freezing equipment aboard to be able to remain out at sea several days to bring back fish in good condition. Their present fishing fleet has no refrigeration, thus, the boats must return to port the same day after completing fishing operations. This severely limits the ability of the fleet to catch more fish and it also requires too much time traveling to and from the fishing grounds.

IPESA (Industria Pesquera Ecuatoriana Sociedad Anonima) operates a shrimp-freezing plant in Guayaquil. The same problem of insufficient catch was evident here. Usually, the entire catch is processed within one hour in the morning, indicating that most of the time the facilities are inefficiently utilized.

These situations are similar to those found in other canning plants for marine fishes and shellfish in other parts of the world. When first built,

they have a considerable volume of material to process, but after a few years, there is insufficient material and the plant is idle a large per cent of the time. To alleviate the problem, it would be desirable to develop aquaculture along the coastal and inland waters so that these plants might be used near their capacity, subsequently making the whole operation more economically feasible.

4.10 INLAND FISHERIES IN ECUADOR

4.101 Rivers

The two main river systems flowing into the Pacific are the Guayas in the south and the Esmeraldas in the north. These are heavily fished and the fishermen at Babahoyo believe that the catch is declining.

In the Oriental region numerous small rivers arise in the foothills of the Andes and flow into the Amazon River system. No information was available concerning the fisheries in this area.

The river fishery at Babahoyo in the Province De Los Rios was visited as this is an important industry there. The 375 registered fishermen of this city are organized into a syndicate and have agreed to cooperate with the fishery inspector of the area by complying with fishing regulations and reporting their catch on a daily basis. They began the program in January, 1969, but due to technical difficulties, the program has not developed as expected. Several suggestions were made to the fishery inspector to assist him in properly organizing the collection of the necessary statistics and other pertinent information.

The Babahoyo market received 1,500 to 2,000 pounds fish per day. The number of fishermen involved and the fishing hours utilized were not

known. Good fishing and the rainy season are apparently directly related. When the rainy season is over, the catch drops considerably. The fishermen claimed also that in the last couple of years, the number of fish in the river has decreased markedly due to the presence of cormorants. They thought that these birds preyed heavily on the young fish of the commercially important species, as well as on the fish serving as forage to some of these commercial species. Although this might be partly true, it is probable that other factors, such as fluctuations of the natural populations of these fishes due to a number of environmental factors or overfishing might be more closely related to the decrease. However, since no records have been kept over the years, there is no reliable evidence of a decrease in the catch.

Fishermen salt part of their catch to preserve the fish until they are transported to Quito, Guayaquil, and to other cities. In spite of this salting process, even at the local market, the external appearance and odor of the fish leaves much to be desired.

Mr. Luces, the local fishery inspector, had obtained at the market for our examination a sample of fish commonly caught in the river. The common names of these fishes were: vieja, barbudo, guanchiche, dica, sabalo, bagres, campeche, guabina, dama, ciego, bio raton, bocachico, and corvina de rio. Proper identification of most of these fishes is needed. The fishes are usually caught by means of cast nets, seines, and hand lines, and during the rainy season, harpoons are used.

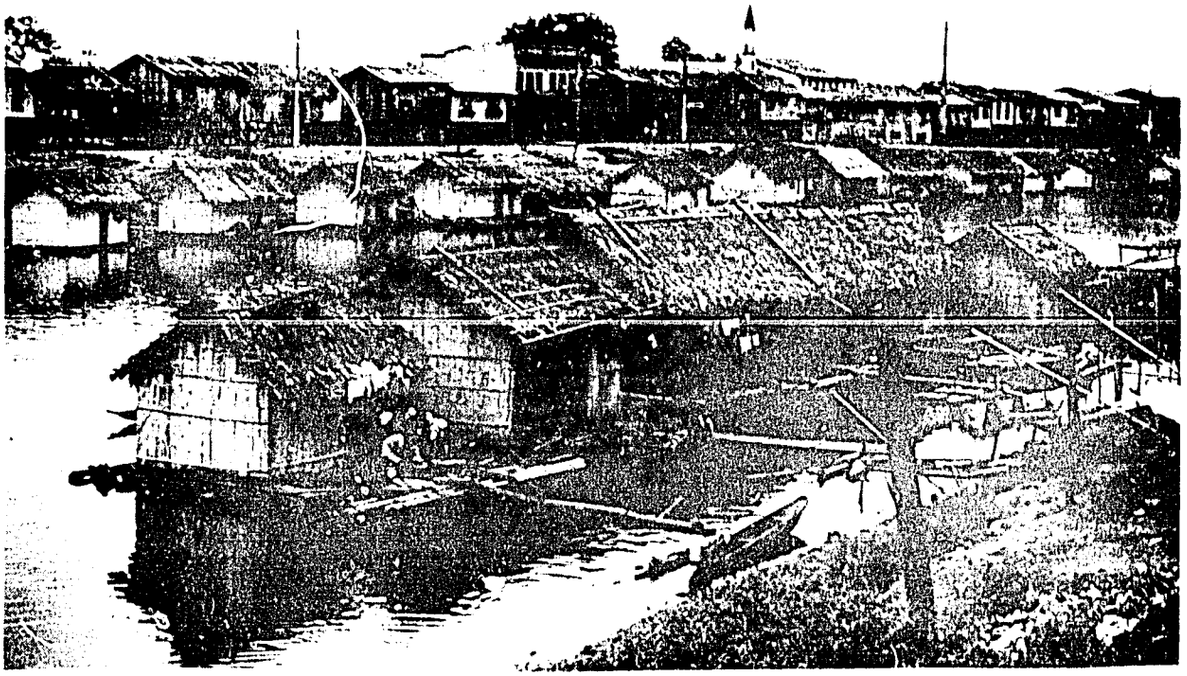


Fig. 3. Houseboats of fishermen on the river at Babahoyo. Culture of fish in floating baskets could be developed to increase the income of the fishermen.

Fig. 4. Fish that cannot be sold within 24 hours of capture are salted, usually under unsanitary conditions, for transportation inland. Photo taken at Babahoyo Fish Market.

An aspect of the river fishery that has received only cursory attention is the shrimp resource. Because of this lack of information, a detailed study to determine the cultural potential of the various species of freshwater shrimps is needed. Although the Babahoyo River was the only river visited by the Auburn Team, samples of freshwater shrimps presently deposited in the fish and invertebrate collection of the Instituto Nacional de Pesca indicate that other rivers in Ecuador harbor populations of various species of shrimps. For instance, several unidentified species of Macrobrachium have been found in the Calceta River (Chone Valley) and in the Guayas River (Province Del Guayas); one species of shrimp of the genus Larrea was collected in the Carrizal River. The freshwater shrimp resource should be given the attention it certainly deserves.

In a meeting with the fishermen of Babahoyo, the fishery inspector, and the Chief of the Departamento de Piscicultura, several aspects of fisheries were discussed. The importance of the collection of statistics and their subsequent interpretation as an attempt to provide a better understanding of the river fishery and its dynamics was emphasized. At present, no reliable statistics are available on any of the riverine fisheries.

It was suggested that cage (basket) culture of fishes could be developed by the people living in the floating river houses. Additionally, "rural pond culture", including the mixed culture of fish and rice, in the rice lds located at the outskirts of the city of Babahoyo was discussed as a distinct possibility to improve the income of fishermen.

4.102 Lakes

The Ecuadorian lakes located at high elevations are suitable only for culture of trout or other cold-water fish while those at low elevations are suitable for warm-water fish culture. The trout fisheries in the upland lakes are available for exploitation by the local inhabitants.

Little is known of the fish populations in warm-water lakes. These should be studied to determine the species composition of the standing crop and of the catch, as the species doing well in this environment will probably be suitable for stocking warm-water reservoirs.

No survey has been made to determine the numbers and areas of the lakes, or of their fish populations.

4.103 Reservoirs

There are presently relatively few reservoirs constructed across watersheds for power, irrigation and/or water supplies. However, it can be expected that large numbers will be built in future years because of increased demands for both power and water.

The dry land area below the mountains toward the Pacific (Chone Valley and adjacent areas) is caused by the fact that as the moisture comes in off the Pacific Ocean, there are no high mountains to cause its precipitation at this point. Therefore, the clouds move inland until they hit the lower and upper mountain ranges where precipitation occurs. This leaves a band of desert-like areas from the mountains on down to the Pacific. In many of these areas, the inhabitants must haul water for miles in barrels carried on the sides of burros. It appeared that in some of these areas there was good

clay on the top of the hills. If there is good clay in the valleys, then it should be possible to impound the water during the rainy period and hold it at least far into the dry period, if not for the entire period. Quite a sizable area could be developed into ponds with dams of sufficient height to prevent overtopping by the floods. This would greatly change the lives of the people in this area.

If these reservoirs will hold water for periods in excess of 4 months, productive fisheries can be developed as a supplemental usage of the water. A survey of the fish populations and catch in existing reservoirs and natural lakes would provide the basis for development of productive fisheries in new reservoirs.

4.104 Chameras

The chameras are natural temporary or permanent lakes occurring in the dry-land areas of Ecuador. They get their name from the most common fish of commercial importance inhabiting these waters - the chame (*Dormitator latifrons*). Most of the chameras are the beds of old rivers which meandered to some other area. They are found mostly in the lowland areas of the valleys. The people who own these old stream channels harvest them to obtain annual crops of fish. There is no actual culture involved. The process is more or less as follows: during the rainy period, when lowland areas are inundated, the fish move out of the stream into the chameras and spawn. The young fish continue to grow and 5 or 6 months later, the waters begin to recede. During these months, considerable numbers of fish reach harvestable size and then as the water recedes, the fish are harvested. In some of the chameras, the water dries up completely while others hold water until the following rainy

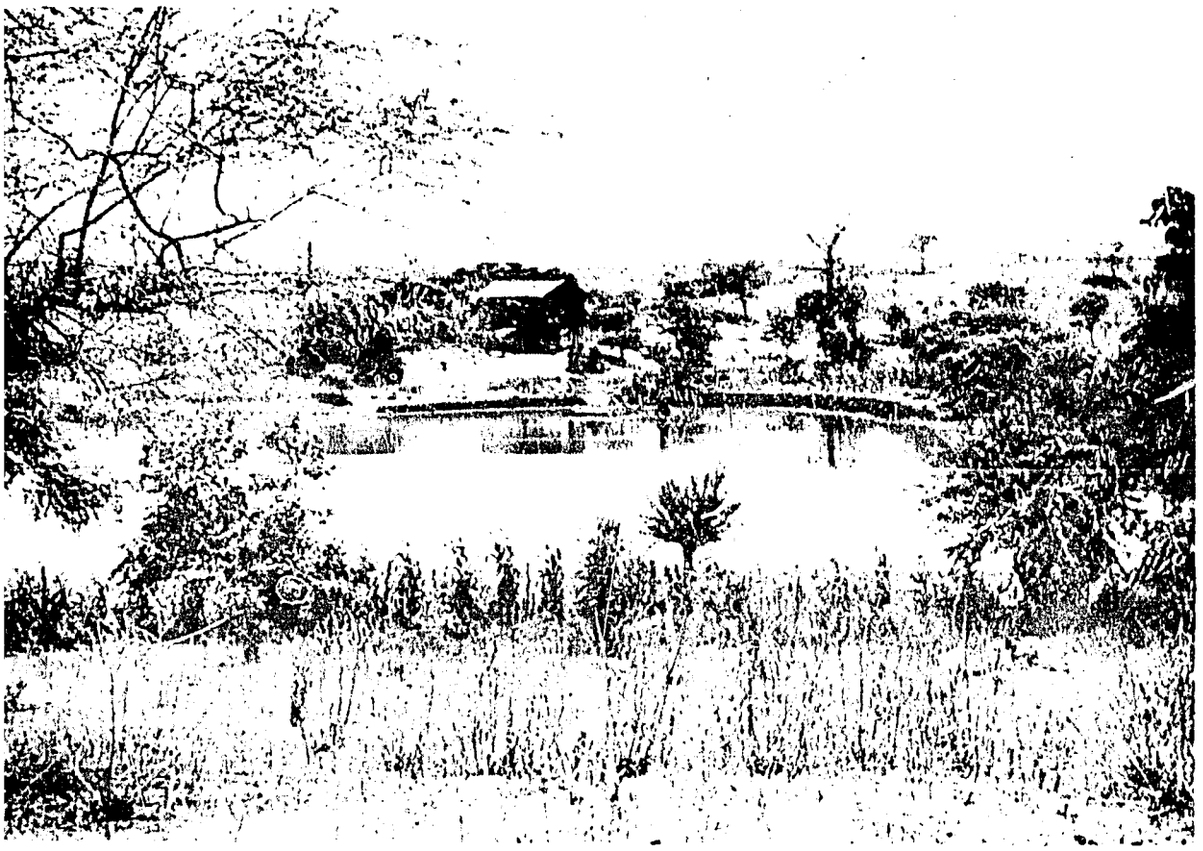


Fig. 5. The chameras produce annual crops of fish and rice. Rice is planted in the shallow waters and harvested on the dry bank as the water recedes.

Fig. 6. Salt flats in the lower part of the Valle de Chone are flooded during the rainy season. Water could be impounded in such areas for raising crops of shrimps and fish.

season. Actually, under such conditions, the chamera that has the deepest channel will yield the greatest harvest of fish on an annual basis since fish usually grow so long as sufficient water is present.

The fish are harvested by a number of means. The principal method is to place fences of bamboo across an area of water, thus stranding some of the fish as the water recedes. The process is repeated until only the main channel remains. There, a large number of fish are caught by using cast nets.

The portable fences or traps used in the operation are made out of bamboo with a gate and trap in the middle. The split bamboo is interwoven at the top, middle, and bottom with pliable vines. The fishery is similar to the swamp fisheries in Asia, mainly that of Thailand.

Not all the fish are harvested at one time. After the harvest for a given day is completed, the crop is transported in square wooden or bamboo boxes, without ice, to the fish markets.

The ideal chamera would be one that has gently sloping banks extending toward the deeper end, thus facilitating harvesting. Rarely is a chamera formed in this manner. Therefore, usually the harvest of the fish crop is a very laborious and time-consuming operation.

The chameras used for fish production are usually managed by the owner or a lessee (a fisherman or a group of fishermen). The rent of a chamera varies with its size. One 20-hectare chamera was rented for 20,000 sucres ($950 U.S.) for a period of one year. No records of the catch per hectare were available.

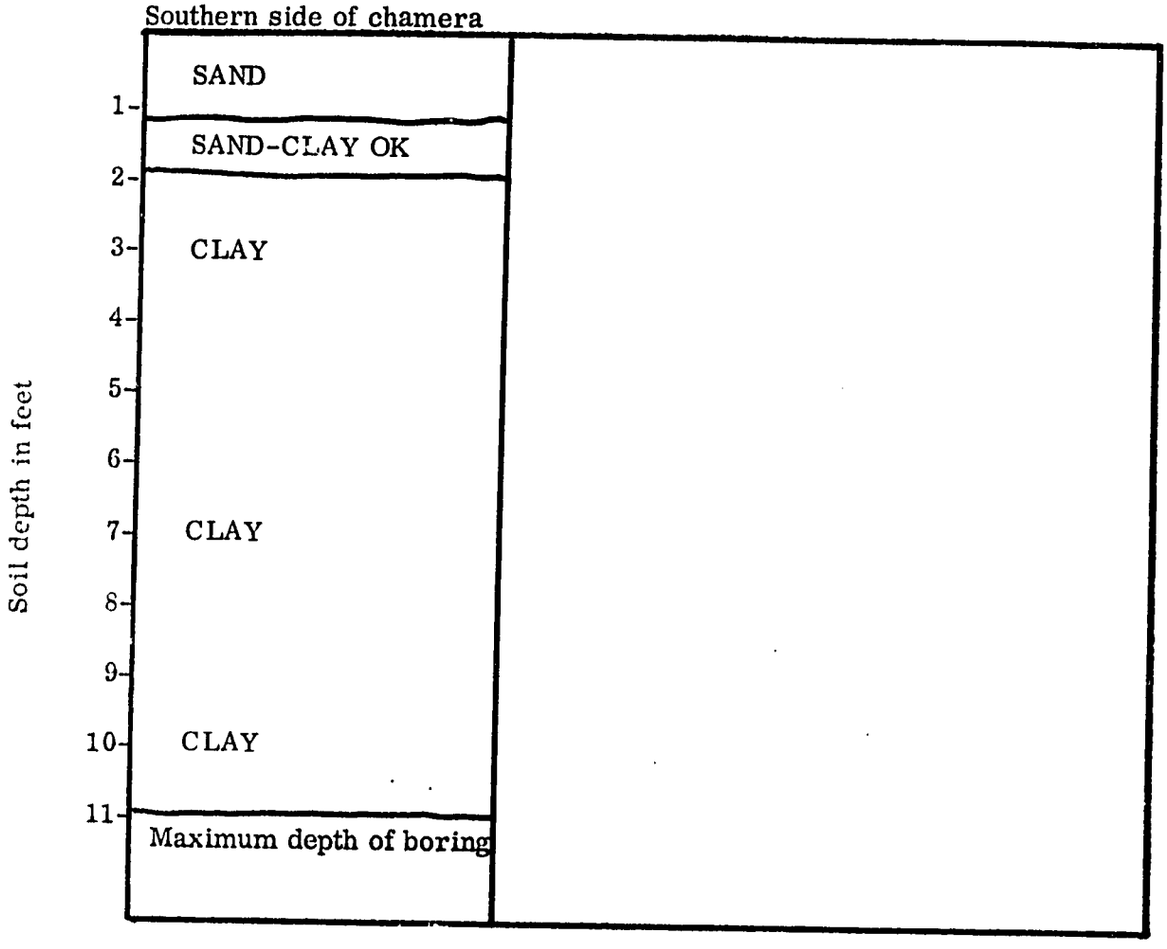
Chameras were observed near Tosagua, Chone, and Vinces. The largest were located in the Chone Valley. The Chone River runs north of Chone, while the Tosagua River borders the eastern side of Tosagua. The Chone Valley has the appearance of being the bed of an ancient lake through the center of which a stream meandered. During the period of heavy rainfall (December through April or May), the entire area is flooded to a depth of 5 or 6 feet. The area remains flooded for a period of about 5 to 6 months, after which it begins to dry up. At this time, the waters begin to recede, leaving behind in the swamp isolated bodies of water of variable sizes (the Auburn Team visited one that had an area of about 250 acres). The principal fish harvested is the chame, Dormitator latifrons: Family Gobiidae. Also harvested are the guanchiche, Hoplias microlepis: Family Characinidae; and a cichlid called vieja.

The gross income per hectare from the sale of fish was reported to vary from $22 to $115 U.S. Some of the chameras also produced crops of rice. The rice plants were set out in the shallow waters as the water level receded and harvested later as the chamera became dry land. It appears probable that more productive combinations of fishes could be developed for the chameras. Production could also be increased by constructing levees or dams around the perimeter of chameras to retain more water for longer periods of time, and by use of phosphate fertilizer to increase the basic productivity.

The following Soil Profile Chart gives results of a soil boring made at the Chamera El Desquite, Clara Natalia Farm, in the Chone Valley.

Chamera El Desquite, Clara Natalia Farm

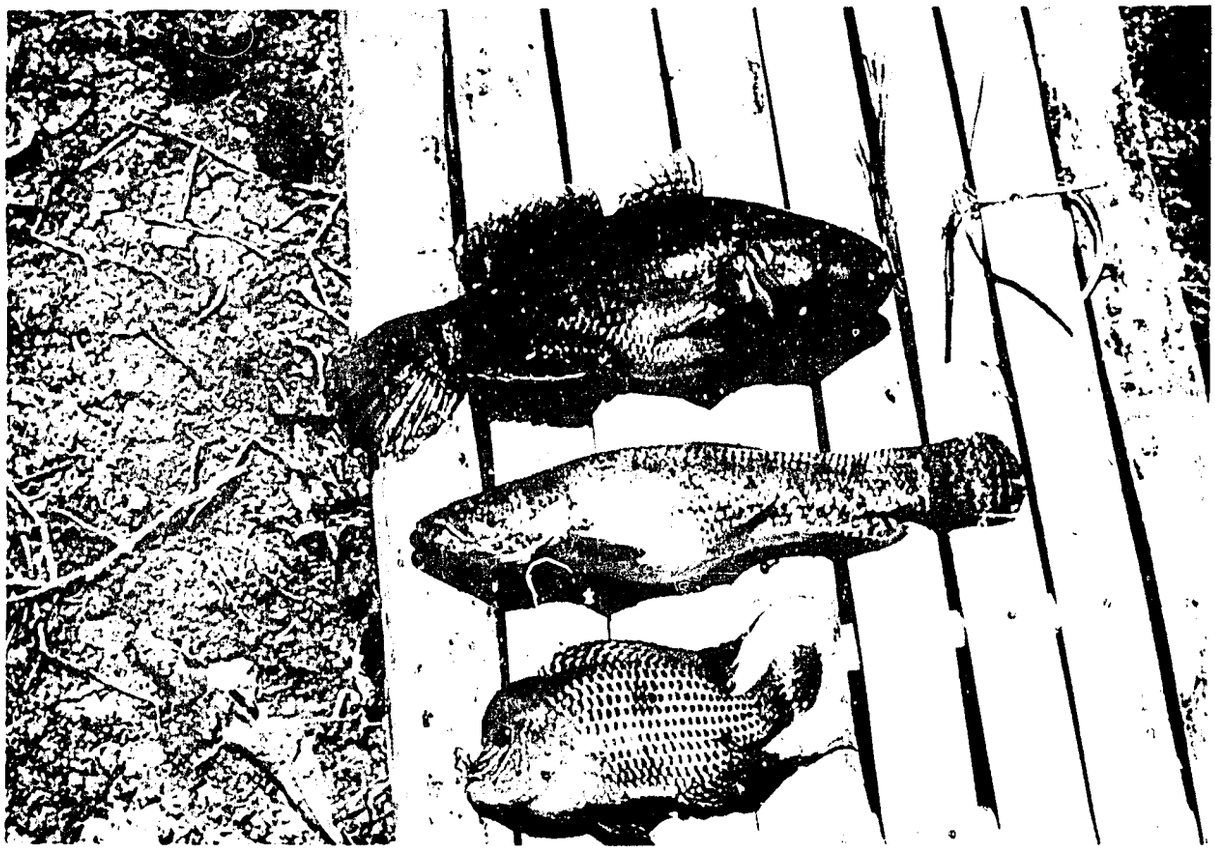
SOIL PROFILE CHART



Clay was of a very stiff, heavy texture. Naturally, this is the reason why water is being held in that area and why the area could be successfully divided into a large number of smaller ponds. The construction of ponds would allow for a better utilization of the water present in the area, both for maximum fish production and its use for other purposes, such as irrigation.

Fig. 7. The chameras are sections of old meandering streams that are filled by overflowing streams during the rainy season. Fish migrate into them to spawn and they produce crops of fish before drying up.

Fig. 8. Three most common fishes harvested from the chameras. Top: chame (Dormitator latifrons). Middle: guanchiche (Hoplias microlepis). Bottom: vieja (scientific name unknown).



4.105 Ponds

There is at present practically no pond fishculture in Ecuador. However, improved operation of chameras is the first step toward pondculture of fishes. In managed ponds, undesirable fishes can be excluded and desirable species stocked, and productivity can be increased by fertilization of the pond water or by feeding the fish. Also, ponds can be constructed in areas where the fish are needed, thus eliminating costly transportation.

Several individuals with private capital to invest expressed their interest in establishing commercial fish and shrimp farms in various parts of the country. One individual owned a ranch bordered on one side by the Balzar River. Prior to our visit, he had constructed a pond on his ranch by building a dam across the outlet of a swamp to raise the water level. Before construction of the dam, the area served as a pasture during the dry period. The owner was very much interested in developing many additional ponds on his ranch in the wet-lowland valleys both to store water and to raise fish. When time comes to harvest the fish, the water could be pumped out on the pasture lands which are quite dry and dusty unless irrigated.

Another land owner near Vinces had constructed a low dam across a valley impounding 0.10 hectare (0.25 acre). Four years ago, it was stocked with 60,000 chame. During that year's rainy season, rainfall was heavy and as a result, all the fish were lost in the flood and carried downstream. The pond has since been abandoned. This pond had been incorrectly constructed in the first place; it had no spillway and just a low dam across the hollow. It was

pointed out that if this were to be used again as a pond, the water level should be raised to the top of the small hill so there would be a long, natural spillway to take care of the excess water. A soil boring was made in the area and it was found that the soil to depths of over 5 feet was a stiff, heavy clay, very impervious to water. Seepage from ponds constructed in clay of this type would have total seepage of less than 0.3 meter per year. Similar clays were found in the Balzar River valley.

However, fishculture or any other kind of aquaculture at this time is severely handicapped from lack of trained personnel to advise on pond construction. Also, no one in the country knows what species of fish or other organisms are best to culture, optimum rates of stocking, whether or not artificial feeding is economically feasible or what can be done with fertilization of the pond waters. In fact, there is no information whatsoever on how to use any fish in the country or even the types of materials the fish feed upon in nature. Rice bran is available in the area and might be used as a fish feed. It costs 0.2 sucre per pound ($0.01 U.S.).

4.11 COASTAL AQUACULTURES

During the visit to Guayaquil and to Bahia de Caraquez, the Auburn Team observed large acreages of land in the estuarine areas that have soils too saline for agriculture, but suitable for brackishwater pondcultures of shrimp and fish. These areas could be developed and managed to produce large quantities of shrimps, fish, and other coastal organisms highly desirable as seafood.

Bahia de Caraquez extends inland from the Pacific Ocean about 30 miles and is surrounded by mountains on both sides. Two sides of the bay are

populated, with most of the people living on the southern side. Two rivers, the Chone and Tosagua, flow into the bay. Bahia de Caraquez presents a very interesting view, especially from the sides of the hills bordering it. The average tide in the area is approximately 6 feet, with spring tides a maximum of 10 feet. Consequently, a long, broad band of intertidal land in the upper and middle parts of the bay is exposed at low tide. This exposed area could certainly be utilized to develop brackishwater and seawater aquacultures of various types. An air strip constructed on the northern side of the bay should enhance the development of coastal aquacultures in this area since products of harvest could be transported inland by air for distribution.

Conditions encountered in the areas along the Gulf of Guayaquil were similar to those described above, except that there were much larger acreages of land available for culture that are presently idle because of salt in the soils and periodic flooding. This area appeared to be satisfactory, however, for culture of marine fish and shrimp. The intertidal areas at this location were not examined.

A detailed survey of the coastal areas should be made to determine acreages of land available for aquacultures that could provide fish and shrimp for export as well as for consumption locally.

5.0 FAO FISHERIES PROGRAM IN ECUADOR

The Ecuadorian National Planning Board under its Seccion de Programacion Pesquera had formally requested technical assistance in fisheries from FAO. The project, "Piscicultura Agricola y Administracion de la Pesca Continental" was to begin January, 1970, for a 2-year period. The project will be directed by

a fishery specialist who is experienced in investigations of natural resources of continental waters and in the culture of fish. This project has been approved by FAO. The duties of the fishery specialist are listed as follows:

1. To survey all waters to determine present use of each and potential for future development.
2. To compile a list of species in these waters that are of commercial importance, with emphasis on acquiring relevant information on the biology of each species, data on the ecology, and suitability for culture
3. To re-structure the present government fisheries organization and create a center of investigation adequate for complete study of the biology of cultivated fish.
4. To make an economic-technical study of fishculture on farms.

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