AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
BATCH #18

1. SUBJECT CLASSIFICATION
A. PRIMARY: Agriculture — AM00-0000-G520
B. SECONDARY: Fisheries--Ecuador

2. TITLE AND SUBTITLE
Proposed cooperative fishery program for Ecuador

3. AUTHOR(S)
Swingle,H.S.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1971	42p.	ARC EC334.68392.S978

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Auburn

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-RAA-946	

12. DESCRIPTORS	13. PROJECT NUMBER
Ecuador Technical assistance	14. CONTRACT NUMBER CSD-2270 GTS
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

PROPOSED COOPERATIVE FISHERY PROGRAM

FOR ECUADOR

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International Center for Aquaculture
Agricultural Experiment Station
Auburn University
Auburn, Alabama 36830

Project: A. I. D./csd-2270

Date: May 25, 1971

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March 29	Oriente; Mera to Santa Clara to Tena and return to Baños
March 30	Baños to Santo Domingo to Esmeraldas
March 31	Esmeraldas and vicinity
April 1	Esmeraldas to Chame ponds near Atacama; to Sua and to Quito
April 2	Conference with Mr. Richard Green, Assistant Director Social Development, U.S.A.I.D. Departed Quito, Ecuador, for Puerto Rico

RECOMMENDATIONS FOR PROPOSED COOPERATIVE FISHCULTURE PROJECT FOR ECUADOR INVOLVING USAID, FAO AND AUBURN UNIVERSITY
1971 - 1972

Item	Auburn University	FAO	AID/Ecuador	Departamento Piscicultura
Surveys	1969 - 2 weeks 1971 - 10 days	Dr. Meschkat - 6 months, 1970-1971		
1. Introduce new fishing gear for rivers.		Dr. Meschkat - to increase the catch near Vinces.	Program - $2,000	Inspector and assistants
2. Measure periodically the catch: species, numbers and weights to determine the effect on the river fish population.		Will train inspectors and assistants in species recognition and measurements of catch.		Will provide assistants to make measurements and records.
3. Identification of commercial species of fishes and shrimps.	Will send Dr. Ramsey and 1 or 2 assistants for 3-week survey in August, 1971.	Will cooperate in surveys and collect fish for identification.	Will furnish transportation within Ecuador; Send fish to Auburn by air freight.	Will furnish necessary assistance, collect fish and maintain fish collection.
4. Food habit studies to determine their usefulness in cultures or reservoirs.	(Fish from surveys and from other sources) Can train personnel at Auburn University.	Will train personnel in methods of stomach analysis.		Will furnish personnel.
5. Determine species of fish and shrimps in warmwater lakes to discover species suitable for culture in ponds.	Surveys by Dr. Ramsey as in Item 3 above.			Will assist and continue surveys.

Item	Auburn University	FAO	AID/Ecuador	Departamento Piscicultura
6. Initiate fishculture in ponds.		Dr. Meschkat: Culture; tilapia, carp in ponds at Vinces and trout culture in the Andes.	Project: $2,000 total for this and Item 1.	Will furnish personnel and expenses.
7. Establish regional stations (Andes, Coastal, Oriente).	Will assist in planning, check locations, and soils.	Advisory	Advisory	Select sites; Planning; Cost of Construction; Staffing and Maintenance.
8. Identification of fish.	Will send Dr. Ramsey to various museums in U.S. to establish correct names of fishes.			
9. Special and academic training (B.S., M.S. and Ph.D.) in fisheries.	Available as needed to students granted fellowships by AID or FAO.			

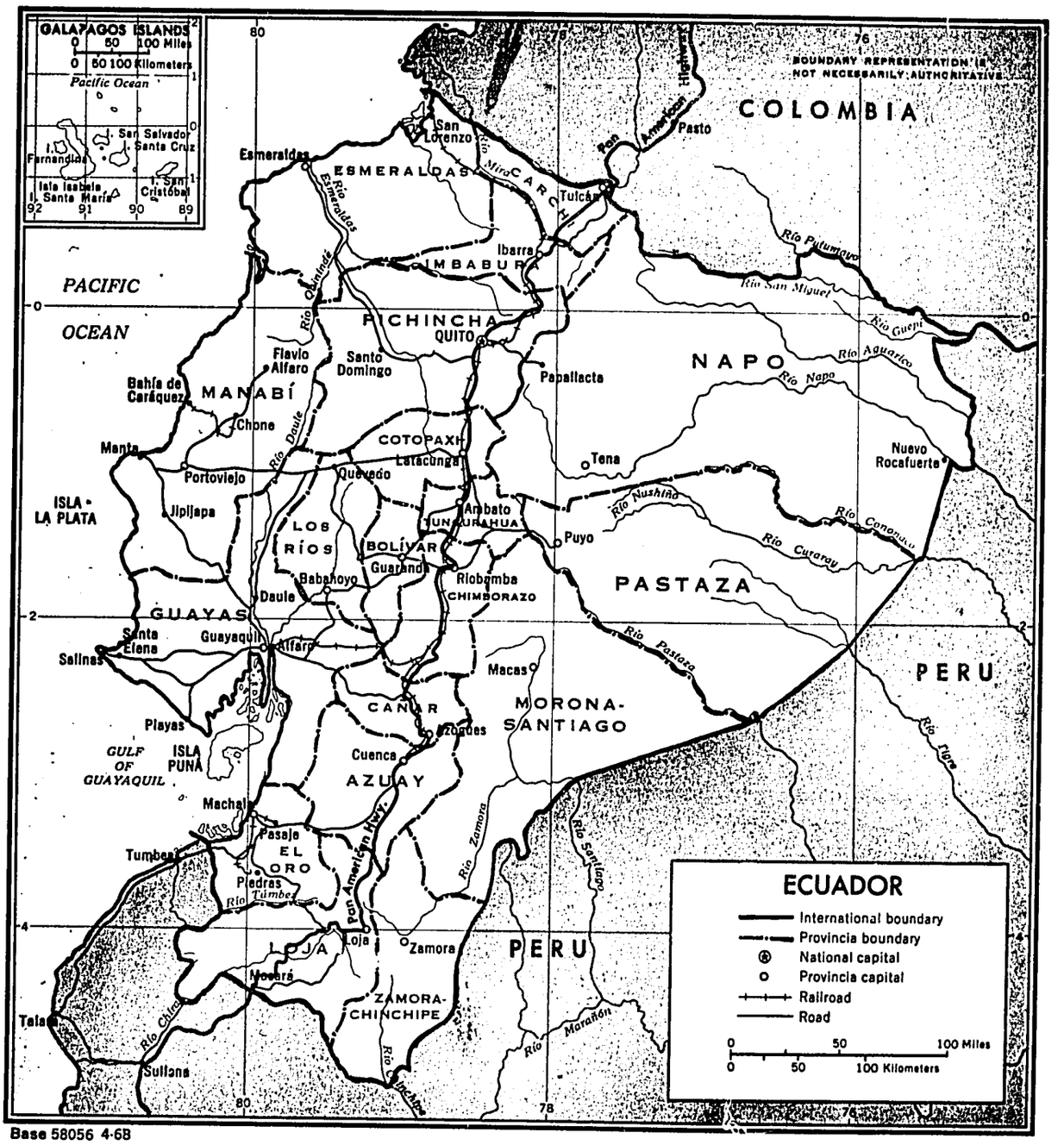


Figure 1. Map of Ecuador

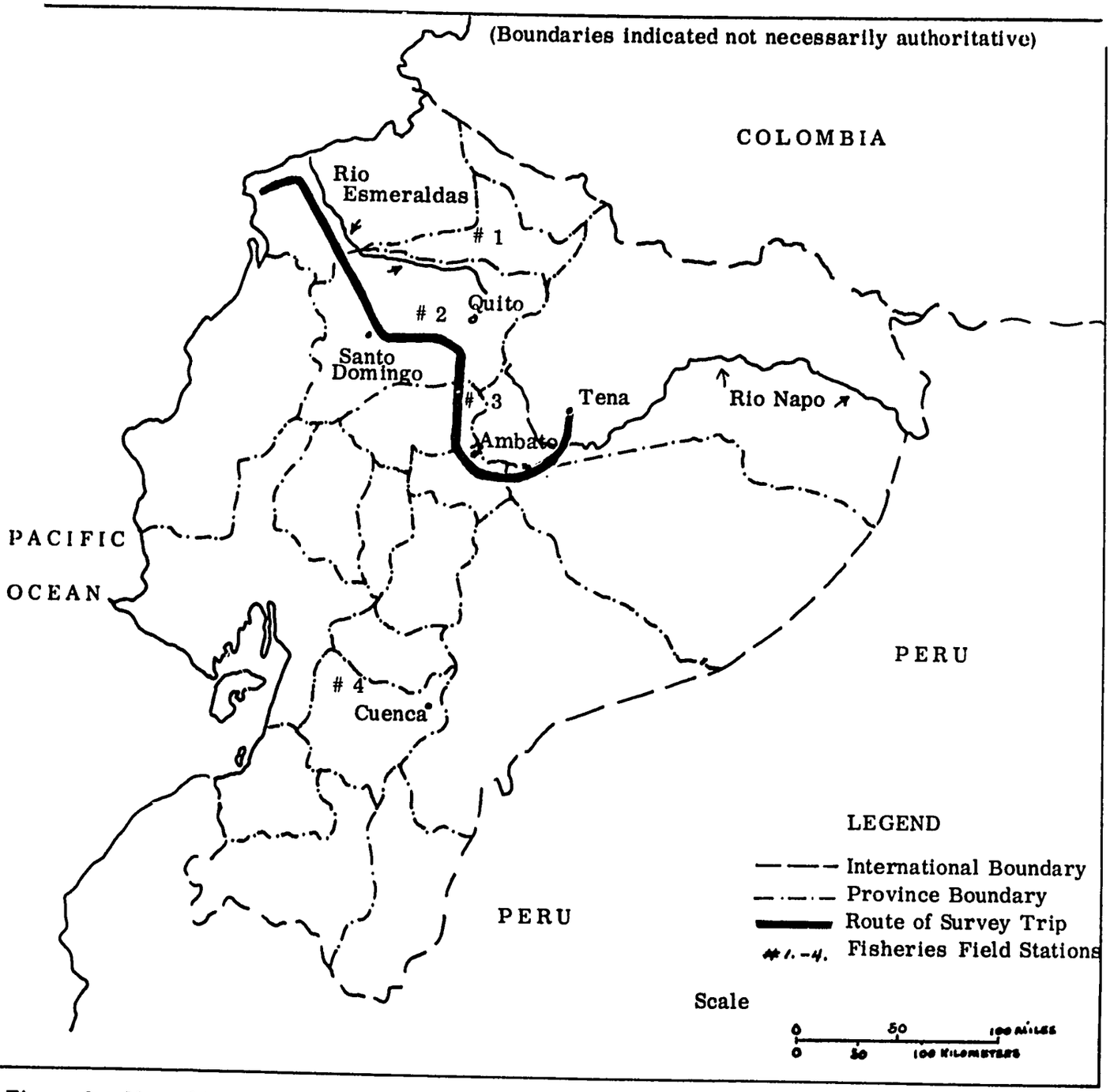


Figure 2. Map of Ecuador showing Route of Survey Trip and Fisheries Field Stations: 1. Punyaru - Imbabura Province; 2. Chillogallo - Pichincha Province; 3. Cotopaxi - Cotopaxi Province; and, 4. Chirimachay - Azuay Province.

FISHERIES REPORT ON ECUADOR
March 23 through April 2, 1971

H. S. Swingle
International Center for Aquaculture
Auburn University
Auburn, Alabama 36830

1.0 INTRODUCTION

A previous survey of inland fisheries in Ecuador was made by a team from the International Center for Aquaculture, Auburn University, during the period October 18 through October 28, 1969, and reported in "Fish culture Survey Report for Ecuador", by H. S. Swingle and F. A. Pagan, dated December 20, 1969. This report was made available to U. S. A. I. D./ Washington, U. S. A. I. D./ Ecuador, the Government of Ecuador and to the Food and Agriculture Organization of the United Nations (FAO).

In the above report, thirteen recommendations were made. To date, one of these, recommending that Sr. Fausto Silva, Head of the Departamento de Piscicultura, be sent to Auburn University for short-term training, has been carried out. Sr. Silva learned methods used in pond construction, experimental pond operation, keeping of scientific records and fisheries extension operations while at Auburn during the period October 13-19, 1970.

The present survey was made at the request of the U. S. A. I. D. Mission in Ecuador to accomplish another recommendation, which suggested that FAO and U. S. A. I. D. coordinate their programs in fisheries to provide joint assistance of most benefit to the host country.

It was noted in the report dated December 20, 1969, that FAO had approved a fishculture survey in Ecuador. The project was initiated October 15, 1970, when Dr. Arno Meschkat, FAO fisheries specialist, was sent for 6 months with the directive in part to:

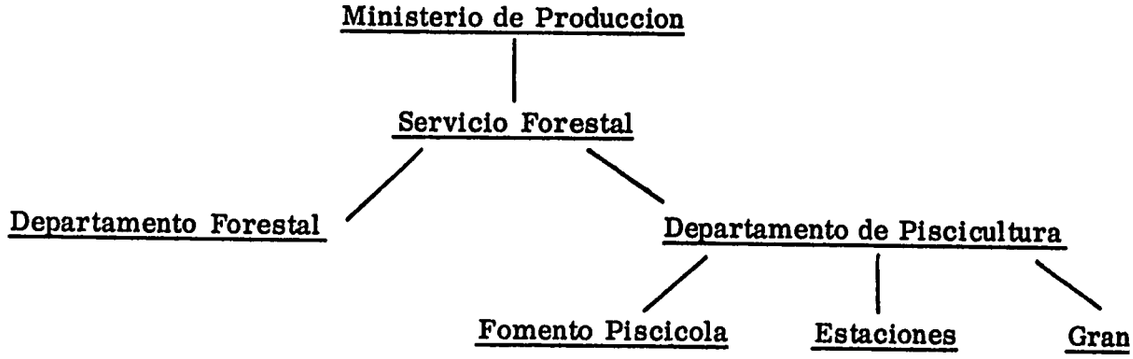
1. Survey all natural waters to determine best usage.
2. Compile a list of fish species of commercial importance, and study their biology, ecology and suitability for culture.
3. Assist in reorganization of the Departamento de Piscicultura and establish a center for fisheries investigations.
4. Make an economic study of fishculture on farms.

Within the short period of 6 months, very few of these objectives could be accomplished, except to gain a better idea of what should be done. Dr. Meschkat had drawn upon this experience to propose a program of further work, if FAO could extend his time in Ecuador. This program of work will be discussed in Section 7.0 of this report.

2.0 REORGANIZATION OF THE DEPARTAMENTO DE PISCICULTURA

Fisheries comes under two organizations in Ecuador. One is the Instituto Nacional de Pesca, which deals with marine and estuarine fisheries. The other is the Departamento de Piscicultura, which manages the inland fisheries in rivers, lakes and reservoirs. This department has been reorganized under the Ministerio of Produccion, whereas it was previously under the Ministerio de Industrias y Comercio.

The organizational structure is shown in the following diagram.



The estaciones are the 3 trout and 1 warmwater hatchery stations. The granjas are pilot fish farms, yet to be constructed. Sr. Mario Ordonez, who is trai in conservation and engineering,is head of the Departamento de Piscicultura, and Sr. Fausto Silva Montenegro is Chief Fisheries Officer.

2.01 Divisions and Personnel

For administration purposes, the country is divided into four zones. The provinces in each and the Inspector in charge are given below for Zones 1, 2, and 4. Zone 3 is under the main office at Quito.

Zone 1 - Sr. Jorge Ayala

Provinces: Carchi, Imbabura, Norte del Napo

Zone 2 - Sr. Francisco Garcia

Provinces: Cotopaxi, Pichincha, Centro y Sur del Napo

Zone 3 - Central Office

Provinces: Bolivar, Chimborazo, Tungurahua, Pastazo

Zone 4 - Sr. Arturo Malo

Provinces: Azuay, Canar, Loja, Morona-Santiago, Zamora-Chinchipe

The personnel at the Quito central office are:

Sr. Fausto Silva M., Chief

Sr. Francisco Garcia, Inspector

Sr. Eduardo Velaseo ((presently undergoing fishery training in Japan)

The personnel at the trout hatchery stations are:

Sr. Manuel Rodriguez	Cotopaxi
Sr. Manuel Quinatoa	Cotopaxi
Sr. Gabriel Mejia	Punyaru
Sr. Julio Astudillo	Chirimachay
Sr. José Ramos	Chirimachay

Chillogallo is a small research station near Quito with 2 men; Arturo Meza and Luis Brito.

Inspectors located elsewhere are:

Sr. Gerinaldo Morales	Vinces
Sr. José Gonzales	Guaranda
Sr. Juan Espinoza	Pillaro
Sr. Ramon Maldonado	Esmeraldas

2.02 Plans for Expansion of the Departamento de Piscicultura

Along with the reorganization of the structure under which the Departamento operates, the Government has allocated a grant of 2,500,000 sucres[1] (U.S. $100,000) for its expansion and improvement. The amount is in dollar equivalents, so if the value of the sucre depreciates, an amount of sucres at the new rate equivalent to $100,000 will be made available. Also the money can be spent at least in part for equipment from abroad. Its best usage

1. $1.00 = 24.75 sucres

requires careful planning. The Departamento has made preliminary plans for its expenditure, but wished assistance in planning from U. S. A. I. D./ Ecuador and Auburn University.

The plans developed included establishment of 3 regional stations for research and management, one in the Andes, one in the coastal area, and one in the Oriente. These combined would take 50 per cent of the total allotment. Operation of the central office would require 8 per cent. Improvement and operation of the 3 trout stations would require 7 per cent and construction and operation of the granjas would take 26 per cent, with miscellaneous research rproblems requiring 4 per cent. The last item includes:

1) Determination of areas suitable for fishculture.

2) Determination of areas suitable for shrimp culture.

3) Study of biology and identification of important species.

These plans are being carefully studied and modified by the Departamento with advice from U. S. A. I. D. /Ecuador, the FAO fisheries specialist, and the the International Center for Aquaculture, Auburn University.

3.0 SOILS, WATERS AND FISH IN THE ORIENTE

Leaving the well-watered high mountains with rainfall of 3,000 to 4,000 mm, near Salcedo, and extending eastward was an area of low rainfall, 1,000mm (40 inches). The latter was in the rain-shadow valley east of the high Andes. Near

Pillaro in a valley was Lago de Yambo. The lake was at an elevation of 2,460 meters. Measurements made by Sr. Silva in the month of December indicated water temperatures of 19 C. The lake depth was 30 meters and the pH was 9.0. It had been stocked with Tilapia mossambica and the common carp, Cyprinus carpio. The latter is a mirror carp obtained from Mexico, and is probably the Israeli strain.

We traveled down the river valley of Rio Patate where rainfall had again increased, brought in by rain clouds from the east. The river was in a deep gorge, with streams from side valleys flowing over high falls into the river. With the steep slope of the river bed and rapid flow of water, it is doubtful that the river can support a large standing crop of fish. The Rio Patate joins the Rio Chambe above Baños to form the headwaters of the Rio Pastaza.

The road then passed over the divide into the headwaters of Rio Napo. The soils extending from the city of Mera for a distance of over 50 km, about 10 km beyond Santa Clara, were heavy, stiff clays. These clays are so impervious to water that despite heavy rainfall of 2,000 to 2,500 mm (80 to 100 inches), there were no permanent streams in the valleys between the hills. This type of soil has a permeability of approximately 30 cm (12 inches) per year. In such soils, ponds can be built with very small watersheds practically anywhere they are desired, because the pond will remain full from the water falling on the pond plus that coming from a watershed 1 to 2 times the area of the pond. In such areas of impervious clays, little water is available from shallow wells and it it necessary to drill into the underlying, more porous formations to obtain large amounts of water. Under such conditions, it is usually cheaper to impound water in a pond than to drill the well.

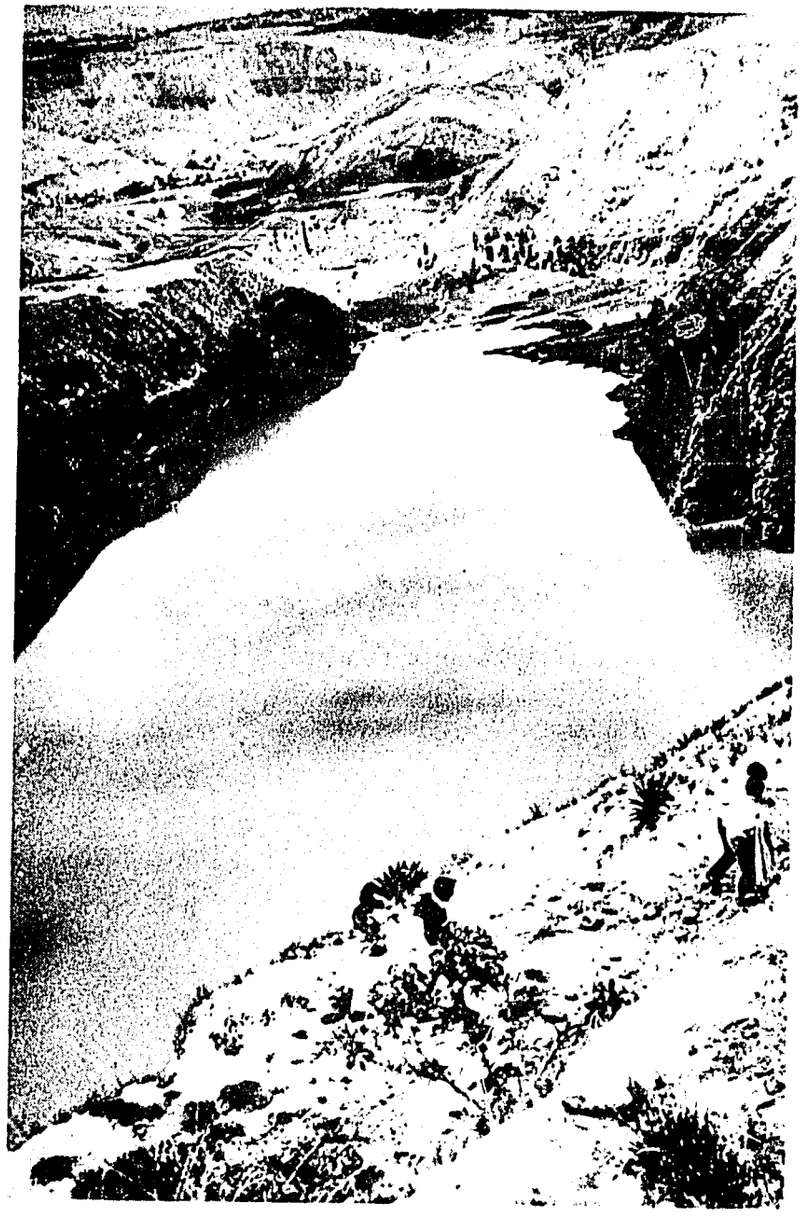


Figure 3. Lago de Yambo was constructed in an area of low rainfall east of the high Andes. At an elevation of 2,460 meters, water temperature was 19 C and pH 9.0. Both the common carp (Cyprinus carpio) and tilapia (Tilapia mossambica) had been stocked in previous years.

From 10 to 20 km beyond Santa Clara toward Tena, more porous soil formations occurred as could be seen in cuts along the road; in places, gravels from ancient river beds were on top of the hills. Soils in the valley of the Tena River were variable, and careful examination with a soil auger would be necessary to locate suitable areas for reservoirs or ponds. The river carries a heavy load of gravels, sand and boulders in times of flood.

Fishermen were interviewed to find the species caught in the Tena River system. Apparently only few fished the rivers on a commercial basis. In fact, the steep slope of the rivers and the large amounts of gravels and sand transported downstream should make them relatively unproductive. Best season for fishing was in February to March. The species caught were known only by local names: bagre; mota; pintarillo bagre; lechero; guacamayo bagre; plateano; sunjaro; bagre negro; sabalo; jandia; and bocachico.

Many of the common names were the same as those used for fish in rivers west of the Andes, although the species were undoubtedly different. Also, one common name was used for several species in the same genus and also for fishes of different genera. Four of the above common names do not appear in the preliminary list of common names of fishes of economic importance prepared by Sr. Fausto Silva (Section 6.0).

For effective management and research on fish populations it will be necessary to distinguish between species. Not to do so would be equivalent to the agriculturist not knowing if he were working with chickens or ducks. There is thus urgent need to determine the identity of the various important commercial species of both fishes and freshwater shrimps.

Figure 4. The Tena River, a tributary of the Rio Napo, is a source of sands and gravels for surfacing roads. The heavy load of eroded materials and the steep slope of the river bed make the river relatively unproductive for fish.

Ponds constructed by Sr. Segara at La Isla Hacienda in the outskirts of Tena were visited. He had constructed 5 ponds with surface areas from 200 to 270 m^2 each. The Departamento de Piscicultura had made available 6 mirror strain of the common carp and some Tilapia mossambica to stock the ponds in 1969. These small carp had grown from 0.7 to 1.0 kilo in this time but had never reproduced. Scales were examined and the fish appeared to be 2 1/2 years old, with fast growth the first and second year, but little growth during the third or current year. The pond owner had so far practically no return on his investment because he did not receive enough fish for proper stocking and he did not know how to get the carp to reproduce. If he had been supplied with approximately 25 carp fingerlings per pond per year, two usable crops of fish could have been produced.

For common carp to spawn, it is necessary to have both sexes present. When stocking with only 6 small fish that cannot be sexed at the time of stocking, there is no assurance that both males and females will be stocked.

Also, the common carp will not spawn in water that contains appreciable quantities of their own wastes. To obtain suitable broodstock, fish should be fed with waste grains or the pond containing the broodstock could be fertilized with manure to induce more rapid growth until eggs are formed.

Another pond should be left dry until grasses have grown to a height of 4 to 6 cm and the carp appear ready to spawn. It is then filled with fresh water, flooding the grasses. The brood carp should then be removed from the pond in which they have been grown and stocked at the rate of not over 2 pairs per 200 m of pond. The carps deposit their eggs on the leaves of grasses in the shallow

Figure 5. Privately constructed ponds at Tena in the Oriente. These were stocked with Tilapia mossambica and Cyprinus carpio, the common carp.

water, usually within 24 hours. This process of spawning the carp is too complicated to expect an untrained farmer to grow his own small fish for stocking. If one pair does spawn, he then has over 100,000 young fish. However, he only needs for all 5 ponds about 100 to 200.

An unknown number of tilapia was used to stock one pond. They had apparently grown to about 15 cm in length and appeared very thin. It was not known if they had reproduced as neither the farmer or the Departamento de Piscicultura owned a seine. The pond owner had fed small quantities of oats to the tilapia, but this was too expensive as it is not raised locally. No suitable local feeds were known, and no harvestable crops of fish were produced. However, when correct rates of stocking are used, with fertilization by manures or suitable leaves of crops, a harvestable crop of tilapia can be produced every 6 months.

These results emphasize the necessity of experimental testing before extension. A crash extension program often may discourage or destroy orderly development of an effective aquacultural program designed to substantially increase fish production. It is for this reason that we recommend establishment of an experimental fisheries research station so that efficient systems of fish culture can be developed and tested before being recommended to farmers and so that fisheries research and extension personnel may learn how to produce fish by doing it.

South America contains almost half of the total species of fish in the world, but despite this, the common carp and tilapia were introduced because nothing was known about the culture of native species. While carp and tilapia are widely

used in pond culture, it would appear quite probable that much better species occur locally, especially in the Amazon River system. It would be a function of the experimental station to test locally promising species to determine their efficiency in food conversion, ecological requirements and growth rate.

4.0 THE COASTAL AREA NEAR ESMERALDAS

After leaving the mountainous area, the flood plain of Rio Esmeraldas widens, and the slope of the river becomes less steep. However, the stream flow was quite rapid because of heavy rains in the mountains. The city of Esmeraldas has a good port at the mouth of the Esmeraldas River. The difference between high and low tide was approximately 2 meters, but even at high tide there was no back-flow upriver because of the tremendous quantities of water flowing downstream.

The inspector at this port city kept records of the fishermen and the number of fishing trips, but no record of their catch. However, the Instituto Nacional de Pesca has a report on the species and volume of landings (Technical Boletin Informativo, Volume 5, No. 1).

Shrimps are caught in large amounts, but are principally consumed locally where they sell at 2 sucres per kilo (about 5 cents per pound). Corvina, both the saltwater and river species, sells for 3.2 sucres per kilo at Esmeraldas, while they bring 8 sucres at Quito. Two species of catfish (marine) which were considered of high quality were Galeichthys sp. (bagre colorado) and Arius multiradiatus (cajeta). The mullets and marine catfishes are caught principally where fresh and salt waters meet, but also are caught considerable distances upstream.

Figure 6. Corvina from the sea and a riverine species bring highest price on the Quito market.

Figure 7. Large numbers of fishes and shrimps are caught in the estuary at Esmeraldas and offshore. Shrimp are principally consumed locally. Fish are transported by truck to the Quito market.

The desirable minimum harvestable sizes for coastal riverine fishes were proposed as follows:

Lenguada	20 cm	
Guana	20 cm	
Cagua	15 cm	
Mongalo	25 cm	
Tocano	20 cm	
Guanchiche	20 cm	Hoplias microlepis
Guabina	15 cm	
Ciego	20 cm	
Sabalo	15 cm	Brycon sp.
Savaleto	15 cm	
Bante	25 cm	

The difficulty here is that the scientific names of few of the above fishes are known, and the same common name may be used for entirely different species in different localities. Only two of the above species appear on the preliminary list of commercial species prepared by Sr. Silva (Section 6.0). Catch records and other data that are required for intelligent management are impossible under such handicaps. Ovchynnyk[1] has published a preliminary list of the freshwater fishes of Ecuador derived from published papers and from specimens in museums. While very helpful to taxonomists, it is of little value to the Departamento in management of the fishery resource. Easy to use keys with pictures and properly identified preserved specimens are needed for the fishery inspectors who must identify the fish in the commercial catch.

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[1]Ovchynnyk, Michael M. 1967. Freshwater Fishes of Ecuador. Michigan State University, Latin Amer. Studies Center, Monograph Series 1. 44 p.

Along the Pacific Coast near Atacama were several ponds in which the chame, Dormitator latifrons, was being raised. Two ponds with a total area of approximately 0.8 acre were stocked with 14,000 chame 2 years ago. This would be entirely too many fish for rapid growth and probably few survived. The owner had caught one weighing 480 grams and another taken by cast net weighed approximately 120 grams. No fish had been harvested for sale, and relatively few for private use. The owner did not consider the chame a high quality fish, but knew of no other more desirable species that he could raise. Another pond nearby, which was constructed about 70 meters from the Pacific Ocean, at high tide, contained brackishwater and shrimp (Penaeids) were grown in it, but without management of any kind. Near Atacama, extensive areas between high and low tide appeared suitable for development into shrimp ponds. However, the low price (10 cents per kg) that shrimp were bringing locally, does not make shrimp farming in this area feasible at the present time.

5.0 INTRODUCED SPECIES OF FISHES IN ECUADOR

Sr. Silva[1] lists the following introduced species:

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1 Silva Montenegro, Fausto. 1969. Finalidades, Objectives y Metas de la Piscicultura en el Ecuador. Ministerio de Industrias y Commercio. Direccion General de Pesca. Boletin de Difusion Piscicola No. 1. 41 p.

Scientific Name	Common Name	Spanish Name
Salmo gairdnerii	rainbow trout	trucha arco iris
Salmo trutta	brown trout	trucha parda
Salvelinus fontinalis	brook trout	trucha arroyo
Salvelinus namaycush	lake trout	
Micropterus salmoides	largemouth bass	lobina
Tilapia mossambica	tilapia	tilapia
Cyprinus carpio	common carp and Israeli strains	carpa

Tilapia were introduced in the provinces of Azuay, Imbabura, Pichincha, Cotopaxi and Napo. Carp were stocked into waters in all the above provinces and also in Bolivar. Trout had been stocked into practically all lakes in the Sierras.

6.0 PRELIMINARY LIST OF FISHES OF ECONOMIC IMPORTANCE IN FRESHWATERS

"List Preliminar de Peces de Agua Dulce de Importancia Economica"
by Fausto Silva
(Revision by Dr. J. S.Ramsey, International Center for Aquaculture, Auburn University, May, 1971)

ECUADOR OCCIDENTAL

Family	Scientific Name	Common Name
Characidae	Brycon atricaudatus	sabalo
	B. alburnus	sabalo
	B. dentex	dama
Erythrinidae	Hoplias microlepis	guanchinche
Lebiasinidae	Lebiasina bimaculata	guaija
	Piabucina astrigata	guaija
Prochilodontidae	Ichthyoelephas humeralis	bocachico
Curimatidae	Curimatus troscheli	dica
	C. boulengeri	dica
Anostomidae	Leporinus ecuadoriensis	raton
Gymnotidae	Gymnotus macrurus	bio
Ariidae	Bagre panamensis	bagre
	Netuma platypogon	bagre
Loricariidae	Plecostomus spinosissimus	raspabalsa
Carangidae	Hemicaranx atrimanus	dama
Sciaenidae	Menticirrhus elongatus	raton
Cichlidae	Aequidens rivulatus	vieja
	A. sapayensis	vieja
	Cichlasoma festae	vieja
	C. festivum	
Gobiidae	Dormitator latifrons	chame

Revision of list continued

ECUADOR ORIENTAL

Family	Scientific Name	Common Name
Osteoglossidae	Arapaima gigas	paiche
Characidae	Brycon capito	
	B. coxeyi	
	Colossoma sp.	paco
	Salminus affinis	
Erythrinidae	Hoplias malabaricus	quirosapa
Lebiasinidae	Piabucina unitaemata	
	P. elongata	
Prochilodontidae	Prochilodus nigricans	
	P. theraponura	
Curimatidae	Curimatus dobulus	
	C. nasus	
Anostomidae	Leporinus friderici	manguchalua
Pimelodidae	Brachyplatystoma sp.	puma bagre
	Megalonema platycephalum	
	Perrunichthys sp.	
	Pimelodus clarias	ichilla bolequique
	Phractocephalus hemiliopterus	guacamayo bagre
	Pseudoplatystoma fasciatum	pintarillo bagre
	Sorubimichthys planiceps	bagre arabi
	Zungaro zungaro	
Loricariidae	Plecostomus plecostomus	
Cichlidae	Aequidens mariae	umasapa
	A. tetramerus	umasapa
	Cichlasoma sp.	umasapa
	Crenicichla sp.	
	C. lucius	punisipqui
	Petenia myersi	umasapa

7.0 PROGRAM OF ASSISTANCE FOR THE ECUADOR DEPARTAMENTO DE PISICULTURA PROPOSED BY DR. MESCHKAT, FAO FISHERIES SPECIALIST

Dr. Meschkat has served for the past 6 months (October 15, 1970, through April 15, 1971) as FAO Fishery Advisor to Ecuador, and based on this experience, he has proposed an extended program of fisheries assistance by FAO. This includes extension of Dr. Meschkat's services in Ecuador by 1 or 2 years, and the request for his services has been submitted to FAO/Rome for consideration.

The program includes the following:

A. To teach river fishermen the use of more modern fishing gear in order to increase the catch per fisherman.

B. To initiate fish culture in ponds at Vinces and in the Andes in order to provide additional protein and to increase local incomes.

C. To continue on-the-job training of personnel in the department.

7.01 Increasing the Catch of Fish from Rivers

The goal, under A above, is to double the catch of fish by local fishermen from the riverine system near Vinces. Dr. Meschkat proposes to do this by teaching the commercial fishermen to use modern fishing gear, including the use of stationary and floating monofilament gill nets, other nets and traps made from various plastics similar to nylon. These nets are practically invisible underwater and can result in greatly increased catches of certain species of fishes.

The U. S. A. I. D. /Ecuador, Division of Rural Development, considers this a desirable program to increase protein for food and the income of local fishermen. They have proposed a supporting project that would make available limited funds for purchase of nets for preliminary tests and later for fishing gear through a Fishermen's Cooperative. It is expected that the demonstration at Vinces, if sufficiently successful, will encourage widespread use of modern fishing gear, and thus increase incomes among a very low income group.

7.02 Initiation of Pond Fishcultures

The goal under B above is to assist in the development of fishculture in the granjas, or pilot fish farms, proposed to be established under a 5-year plan of expansion by the Departamento de Piscicultura. These pilot fish farms would be placed on privately owned or community owned lands, utilizing money from the Government and labor from the land owners for their construction. Dr. Meschkat proposes to initiate culture of rainbow trout in cold water ponds (below 21 C) in the Andes and culture of common carp and tilapia in warmwater ponds (above 21 C) at the lower elevations. Advice would be given private land owners who wished to raise fish commercially.

Trout culture in ponds at higher elevations is quite feasible in certain areas of the Andes, but high production per acre can only be achieved if the fish are fed. Extensive methods of production with low returns of fish per acre are economically feasible in the many coldwater lakes in the mountain areas. However, low production per acre cannot be tolerated in inhabited small mountain valleys

because they often contain the only agricultural lands available.

Fishculture is valuable principally as a highly productive supplement to agriculture, not as a replacement. Where the acreage of arable land per person is very low, if fishcultures are to be initiated, they must be highly productive and use little or no agricultural land. Raceway trout culture requires little space and where suitable feeds for fish are available for daily feeding, production in excess of 30 tons rainbow trout per surface acre of raceway can be obtained. Suitable feeds are mixtures of ground meats, slaughterhouse wastes, and seed meals, or complete pelleted trout feeds can be made from plant and animal proteins plus necessary vitamins and minerals. These are not presently available in Ecuador. Also, trout eggs for production of the small fish needed for stocking are presently bought from Colombia and fry produced from these eggs have been found to have whirling disease. The Departamento de Pisciculture has plans for training personnel in methods of stripping eggs and milt from rainbow trout caught in the mountain lakes. It would appear that this is the appropriate time for development of sources of disease-free fish for stocking, for experimental testing of efficient trout cultural procedures, and the development of suitable feeds, but not for an extension program that would encourage many private or community land owners to invest in trout culture.

Similarly, the procedures necessary for high production of warmwater fish in ponds at low cost has not yet been worked out, using locally available materials. The species proposed for use are both foreign species and their acceptance on markets has not been tested. If they are considered low quality by the buying public, then their market price will be too low to make possible

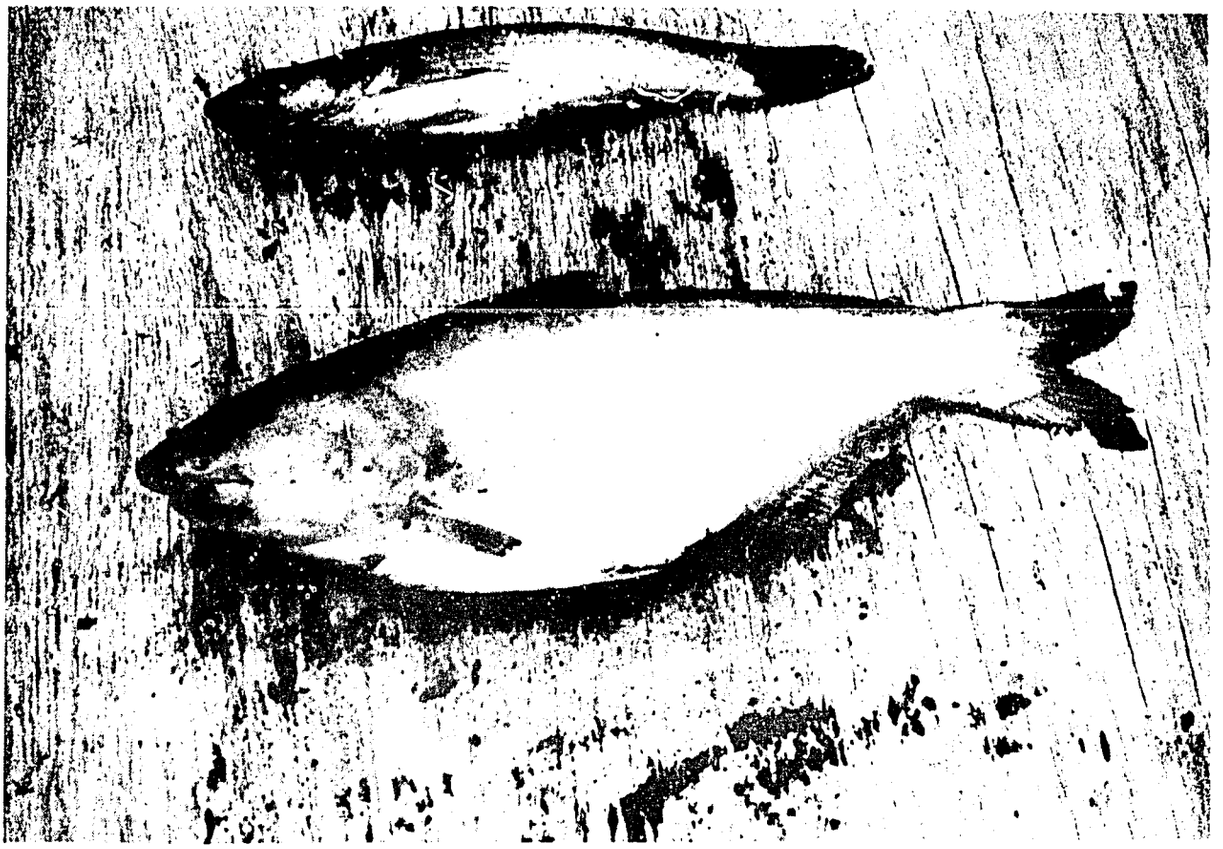

Figure 8. The guabina (top) and the bagre ciego (bottom), a blind catfish without pectoral or dorsal spines; the latter should be tried for pond culture.

Figure 9. The vieja -- there are many species with this common name, all in the Family Cichlidae -- would appear promising for culture.

culture at a profit to the pond owner. Suitable indigenous fishes for cultures are unknown. The common carp yields per year less than 200 kg/hectare in ponds without fertilization; up to 400 kg/hectare with fertilization, using inorganic phosphates, or decaying plants, or animal manures; and up to 2,000 kg/hectare with feeding. Where the pond is correctly stocked with carp, there will be no reproduction and all the carp grow to large size. The tilapia without fertilization yields up to 500 kg/hectare; with fertilization from 1,000 to 4,000 kg/hectare; and with feeding from 3,000 to 6,000 kg/hectare. However, the tilapia will reproduce and most of the weight will be small fish (5 to 8 cm) unless a suitable supplemental fish can be added that will eat the small fish. No suitable species is presently known in Ecuador. Efficient rates of stocking, suitable fertilizers and rates of application, and suitable feeds locally available for these fishes are unknown. Consequently, while this is the correct time to develop experimentally suitable species, fertilizers, feeds and cultural methods, extension of present knowledge only should be expected to result in failure to raise fish at a profit to the investor.

8.0 PROPOSED COORDINATED FISHERIES PROGRAM FAO-U. S. A. I. D. -AUBURN UNIVERSITY

The proposed coordinated fisheries program was planned in conferences between Dr. H. S. Swingle, Auburn University; Sr. Fausto Silva, Departamento de Piscicultura; Dr. Meschkat, FAO fisheries specialist; and Mr. Sam Haight, Mr. Ralph Van Dixhorn and and Mr. Richard Green, U. S. A. I. D. /Ecuador.

8.01 Introduction and Training in Use of Modern Fishing Gear in River System at Vinces

This plan, initiated by Dr. Meschkat with additional financial support by U. S. A. I. D./Ecuador as previously described, appears to have excellent possibilities of success. It is a logical place to start to upgrade not only the standard of living and the income of local fishermen, but also to upgrade the technical knowledge of personnel of the Departamento de Piscicultura.

8.02 Measuring the Effect of Increased Catch in the River Fish Population

If the changes in fishing gear achieve the goal of doubling fish production from the rivers, then it is essential for proper management of these resources by the Departamento, to determine if the fish populations are underfished, overfished or being fished at the most desirable rate for maximum continued yield. The new fishing gear is selective, taking large numbers of some species but few of others.

It is proposed that a sampling technique be planned to determine at appropriate intervals the percentage species composition of the catch, and the average lengths and weights of each species caught. From this simple data, changes in the relative abundance, average weights and sizes of species captured, and changes in their relative condition can be calculated. Also from these data, length-weight and standard condition tables can be developed.

It is proposed that the Departamento de Piscicultura will furnish inspectors and assistants to gather the catch statistics. It was suggested that college students in biology might be employed as assistants for this work. Assuming

that an FAO fisheries specialist (Dr. Meschkat or his successor) will be stationed in Ecuador, it is also proposed that he train the inspectors and the assistants in recognition of the species of fishes, and in methods to be used in the surveys for measurement of the catch.

8.03 Identification of Commercial Species of Fishes and Shrimps

To accomplish the above objectives, it is essential that species of fishes and shrimps in the catch be correctly identified. The problems involved have, in part, been discussed in previous sections of the report. Ovchynnyk does not give common names of fishes, which is the only name by which they are known by the fishermen or the Inspectors. In Section 6.0 of this report there is a partial list of important economic freshwater fishes giving the family, scientific and common names. However, common names vary from locality to locality. Confusion only can result in the collection of statistics on the catch until proper identification can be made. A partial collection of Ecuadorian fishes has been made by Dr. Orces of the Escuela Politecnica Nacional, and many are scattered in various museums in the U.S. It is proposed that a reference collection of properly identified commercial species with common names and descriptions be established that can be used by the Departamento de Piscicultura in training of their personnel. Ability to recognize the species is important to further development of the capabilities of the Departamento in management of their fisheries. This list of commercial species may include many indigenous species that could be cultured in ponds, and/or stocked into reservoirs in Ecuador and neighboring countries.

Consequently, the International Center for Aquaculture, Auburn University, considers it of sufficient importance to send a team to Ecuador composed of Dr. J. S. Ramsey, Ichthyologist, and several assistants for a 3-week period in August, 1971, to set up procedures for the surveys, make additional collections and assist in development of the reference collection. Collections would continue to be made by the Departamento de Piscicultura and the FAO fisheries specialist and sent to Auburn University by U. S. A. I. D. /Ecuador for identification. Finally, an illustrated leaflet of commercially important species would be prepared. The Departamento would furnish assistance and equipment for the preliminary survey and subsequent surveys mutually agreed upon: further, they would maintain the reference collection or arrange for it to be maintained by the college or university. It is proposed that U. S. A. I. D. /Ecuador cooperate by furnishing transportation in Ecuador for the Auburn Team, and send specimens, properly prepared by the Departamento, to Auburn for identification. The procedures for properly preparing the specimens for shipment are given in the Appendix of this report. It is proposed, subject to approval by U. S. A. I. D. /Washington, that international travel, per diem, and salaries of the Auburn Team by paid from 211(d) funds under the Auburn Project A. I. D. /csd-2780, because the information will be of value to other parts of South America.

The International Center for Aquaculture, Auburn University, with approval from U. S. A. I. D. /Washington would finance Dr. Ramsey's visits to various museums in the United States to clarify identifications of fishes and shrimps. This is necessary because many taxonomists visited Ecuador and brought back

collections of fishes which were named and placed in different museums, and the same species was sometimes given different scientific names by different taxonomists. This usually results in confusion in nomenclature which only comparisons of species with those in museums can clear up.

8.04 Food Habit Studies of Fishes and Shrimps to Determine their Usefulness in Pond Cultures or in Reservoirs

To determine the feeding habits of fishes taken in the proposed surveys, plus those obtained otherwise, analyses should be made of their stomach contents. Highest production of fish in any body of water comes from use of a combination of species with different feeding habits. In a reservoir, the principal groups of fish feeds are: 1) the plankton floating throughout the water, 2) the rooted plants in the marginal waters, 3) submersed or floating weeds, 4) insects, 5) crustacea, 6) mollusks, 7) small fishes, 8) periphyton growing over surfaces, 9) miscellaneous bottom organisms, 10) detritus, and, 11) decaying organic matter. A properly stocked reservoir should contain species of fishes and shrimps that feed upon each of these groups. Failure to include the correct species results in lower fish production. For example, in an unfertile 40,000-acre reservoir in Alabama, no plankton-feeding species of fish was originally present. This resulted in a standing crop of fish of approximately 30 kg/ha. The addition of threadfin shad, a plankton-feeding fish, increased the standing crop to 150 kg/ha, an increase of 400 per cent, caused by stocking one additional species. Fish that can be expected to give high production in cultures include plankton feeders, insectivores and omnivores.

At present, there are no personnel in the Departamento de Piscicultura qualified to make analyses of stomach contents of fishes. However, personnel with a good background in biology could be hired and then trained to do this work by the FAO fisheries specialist, or they could be sent to Auburn University for 3-months training. An alternate procedure could be to contract for the work with qualified biology teachers and their students in a university or college in Ecuador.

8.05 Determine Species of Fishes and Shrimps in Warmwater Lakes and Reservoirs in Ecuador

The purpose of this work is to find as rapidly as possible native species of fishes and shrimps that may be cultured in ponds or used in reservoirs. Many species of fishes in rivers required a running-water habitat and are not suited for culture in still waters. However, many of the species that have adapted to conditions in warmwater lakes should be suitable for pond culture or for stocking warmwater, man-made reservoirs.

The largest warmwater lake in the country is Lago de Sade in the Esmeraldas River basin. Since this is connected to the river system, fishes and shrimps that preferred quiet waters had access to it, and those making up large percentages of the population should be considered for use in aquacultures and in reservoirs.

Another area where the fish population should be surveyed is Poza Honda, a large reservoir recently completed on the Rio Porto Viejo. The gates in the dam were closed and the reservoir began to fill February 20, 1971. The river was reported to contain the following commercial species:

Scientific Name	Common Name
	bante
Ichthyoelephas humeralis	bocachico
	odola
	guabina
	roncador
	guaya
Aequidens rivulatus	vieja
A. sapayensis	vieja
Cichlasoma festae	vieja
C. festivum	vieja

The species that become important in the reservoir should be considered for culture in ponds and for use in other reservoirs. The vieja are in the Family Cichlidae, the same family to which the tilapias belong.

It is proposed that the Auburn Team would obtain information on the relative abundance of fishes and shrimps in the warmwater lakes and the reservoirs during the process of the survey described in Section 8.03.

8.06 Initiate Fish Cultures in Warmwater Ponds and in the Andes

This would be carried out on a small test scale by the FAO fisheries specialist with U.S.A.I.D./Ecuador supporting part of the costs for equipment and the Departamento de Piscicultura furnishing additional personnel and expenses. Extension activities should increase after suitable species, fertilizers, feeds, and cultural methods have been worked out, preferably in a fishery research station.

8.07 Establish Regional Fishery Stations in the Andes, the Western Coastal Regio and in the Oriente

In the program of 5-year expansion to be financed by the Ecuadorian Government, the Departamento de Piscicultura plans to establish three regional stations for research and management. One for cold waters in the Andes is presently proposed at Chillogallo, which is a small research station near Quito. Two for warmwaters is proposed, one in the Coastal region and one in the Oriente.

The establishment of such stations was recommended in the "Fishculture Survey Report for Ecuador", by H. S. Swingle and F. A. Pagan, December 20, 1969, where it was recommended that each station be located on an area of 20 to 25 hectares, with suitable soils for constructing experimental ponds, and with sufficient water to maintain 10 hectares of ponds (about 900 liters water flow per minute).

Chillogallo has a very great advantage in that the Government owns the land and it is very near Quito. Its disadvantages are that the area is only 2 hectares and water supplies are not adequate (only 60 liters per minute). Also, layers of sand occur below 1.7 meters that would increase the rate of seepage from the ponds.

A possible warmwater site in the Coastal area was suggested to be below the Poza Honda Reservoir, where the experimental station could get water by gravity from the reservoir or from its irrigation canals. It would be necessary to make soil borings to locate areas suitable for experimental ponds.

Since areas for construction of these stations must be on lands owned by the Government, it was also suggested that land-grant colleges and universities be contacted to see if they had suitable areas available. Also, the Agricultural Experiment Stations operated by the Ministerio de Produccion might provide suitable sites. It was proposed that Auburn University could assist in checking sites and in planning experimental ponds areas, with the FAO fisheries specialist and U. S. A. I. D. /Ecuador acting as advisors.

8.08 Training at the International Center for Aquaculture

Auburn University will provide special short-term and regular academic training in fisheries to qualified students that receive fellowships from U. S. A. I. D. or FAO.

9.0 APPENDIX

9.01 Guide for International Shipment of Fish Specimens

Preservation. Specimens should be maintained in about 15% formalin for at least two weeks before shipment. Those over seven inches (18 cm) should be slit longitudinally along the entire right side of the body cavity.

Labelling. Complete locality data should accompany each collection. Labels can be written on fabric or on high rag content paper (formalin dissolves other papers). India ink or pencil may be used to record the following:

(1) Country

(2) State or other political division

(3) Name of body of water where collection was made

(4) Distance and direction from an important nearby town

(5) Date of collection

(6) Name of collectors

Wrapping. Because formalin has unpleasant fumes, it is best to work outdoors or in a well-ventilated room. Use rubber gloves if possible. Remove specimens from the formalin and discard formalin. Loosely wrap specimens with label in several thicknesses of moist cheesecloth, muslin, or other absorbent fabric. Fish spines should not pierce the material. Secure loosely with rubber bands or cord.

Bagging. Place wrapped specimens (one or several bundles) in a plastic bag. Do not add fluid. Partially inflate each bag with air if many are to be sent together. Twist the mouth of the bag, double it back, and secure tightly with a rubber band. Often is is desirable to use two bags in case one leaks during shipment.

Packing. Place smaller bags in a large plastic bag (size dependent on shipping containers). Pack in stout cardboard boxes or in metal containers such as cans or small oil drums. Use lightweight packing material to surround the entire bag surface. It is important to include two things inside the container before sealing:

(1) Address of sender and recipient

(2) A bilingual request to customs inspectors, such as "CUSTOMS INSPECTOR: THIS SHIPMENT CONTAINS PRESERVED FISHES FOR MUSEUM USE. NO COMMERCIAL VALUE. PLEASE REPACK IF IT IS NECESSARY TO OPEN WATERPROOF CONTAINERS. THE SPECIMENS ARE RUINED BY DRYING. THANK YOU."

Secure boxes with strong tape, and with stout cord. Metal containers may be sealed with solder or wax.

Clearly label the outside of the container in two places with the following information:

(1) Name and address of sender

(2) Name and address of recipient

(3) Statement: "Contains preserved fish specimens for museum use. No Commercial Value."