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FISHCULTURE SURVEY REPORT

FOR COLOMBIA

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by Improved Fishcultures

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Map indicating places visited by the Auburn Team during the survey of Colombian fisheries, October 7 - October 18, 1969.

2.0 RECOMMENDATIONS

Provide short-term training trip of 2 weeks to United States, at Auburn University, Auburn, Alabama, at the Fish Farming Experiment Station, Stuttgart, Arkansas, and at trout farms in Utah for the Chiefs of Fisheries Divisions between April 1 and October 1.

Provide 2-year graduate level training in the United States for 6 persons over a 4-year period in inland fisheries and aquacultures.

Two alternate plans are proposed, with the first plan considered the more desirable.

A. Provide a fisheries advisor for a 2-year period to be located in Bogota, plus one visit per year by a team of 2 fisheries specialists from Auburn University for a one-month period to assist in organizing research, management and extension in fisheries and to participate in an on-the-job training program for Colombian fisheries personnel.

B. No full-time fisheries advisor, but two visits annually by an Auburn Fisheries Team approximately 6 months apart, one with 2 fisheries specialists and the second with 3 fisheries specialists. Specialists would be varied depending on what was considered most useful to the program. Specialists are available in pond design and construction, fisheries biology, aquaculture, fertilization, fish nutrition and feeding, fish diseases and parasites, limnology, water chemistry, fish population dynamics, fish taxonomy, aquatic plant

utilization and control, and hatchery management.

Locate suitable areas for construction of experimental stations for warm-water aquacultures first in the coastal areas and later in the Llanos. These stations should have a total area of 25 hectares, with at least 10 hectares in ponds. The ponds should be constructed to fill and drain by gravity, with pond sizes 500 to 1,000 square meters in surface area. Approximately 30 ponds should be constructed during the first year, with a minimum of 70 additional ponds constructed in succeeding years. Areas selected must have an adequate water supply during the driest period of the year to replace daily water loss by seepage and evaporation from 10 hectares of water surface. This will require a minimum of 250 gallons (950 liters) per minute, if the soils hold water well. Before purchase of an area, soils should be carefully examined with a soil auger to determine suitability for pond construction.

A survey should be made of the coastal regions to determine specific areas available for culture of shrimps, molluscs and fishes. If sufficient area is available, a research station dealing with these cultures should be planned. A possible site might be at Cienaga Grande, or along the Pacific Coast.

Research on management for fish production in large reservoirs constructed for electric power, water supplies or irrigation should aim at determination of the most suitable combinations of species to achieve highest annual sustained yields. This would consist in part of the study of the composition of the fish populations and of the catch from existing reservoirs, and in part from the testing of promising native species in experimental ponds, followed by further

testing in reservoirs. To achieve highest production, species must be stocked to utilize all types of fish foods and habitats present in the reservoirs. Stomach analyses on native fishes should be made to determine types of foods consumed. For each species of fish, measurements and weights should be taken to determine length-weight relationships and condition, which subsequently will form the basis for evaluation of management procedures. Seasonal changes in water temperature and dissolved oxygen should be determine for reservoirs located at different elevations.

For development of pond aquaculture, it will be necessary to determine food habits of various species, their ecological requirements, and effective methods for their reproduction. Promising species should be evaluated to determine their relative efficiencies individually and in combination with other species in ponds, without fertilization, with fertilization and with feeding. This information will then be utilized to develop systems of pond management for highest production and highest profit to the fish farmer.

The rivers of Colombia provide a very valuable fishery resource. Research should be designed to develop regulations and rates of fishing that will give the maximum sustained annual yields that are economically feasible. This requires accurate statistics on the catch, man-days of fishing, length-weight relationships of species caught, costs of capture, costs of processing and transportation, and wholesale and retail price structures. Fishery inspectors and biologists responsible for securing this information should undergo a one-week program of training annually, where they could be instructed in fish

identification, biological principles, and standardization of methods for obtaining and recording data.

Lake management is similar in many ways to reservoir management. Much can be learned regarding suitability of species by determining the percentage of the total weight of each species in the standing crop of the lake and in the catch. Periodic length-weight measurements on fishes are needed to properly evaluate management procedures, including restocking, closed seasons and other fishing regulations. Limnological studies of lakes at various elevations should be made to evaluate ecological conditions and to develop plans for improved management.

A survey of species of fishes present in different watersheds and in isolated lakes should be made. Specimens should be sent to Auburn University for identification and a reference collection of at least the commercially important species should be established in INDERENA at Bogota or at a university for use in training fishery inspectors and biologists.

To improve utilization and management of Cienaga Grande for oyster production, a survey is needed to determine the salinity gradient in the estuary during the wet and dry seasons. This will provide information necessary for evaluating the desirability of reopening a channel from the bay to the Caribbean, both for more rapid disposal of freshwaters during the rainy season and to provide, through water currents, wider distribution of larval oysters throughout the bay area. A survey is also needed to locate areas where the bottoms of the bay are sufficiently firm to establish new oyster reefs by planting oyster shells and spat. Expanded research is needed to develop more productive methods for

commercial culture of oysters and other molluscs. Information is also needed on the prevalence of oyster diseases and the extent of losses to predators in areas of different salinity. Records are needed on an annual basis for the amounts and sizes of oysters harvested to develop methods for improved management of natural oyster reefs.

3.0 SUMMARY

The government agencies responsible for fisheries development and management in Colombia are INDERENA (Instituto de Desarrollo de Recursos Naturales Renovables) and the CVC (Corporacion Autonoma Regional del Valle del Cauca). The former is responsible for inland, coastal and marine fisheries in all parts of the country except the Cauca River Valley, and the latter is responsible only for fisheries in the Cauca River Valley.

The population of Colombia is 20.5 million with an annual 3.2 per cent rate of increase. At this rate, the population will double in 23 years. The total protein available per capita per day was 54.9 grams in 1956-58 and 53.0 grams in 1960-61, both below the 57.3 grams average requirement. The rate of population growth indicates that protein production must be doubled within approximately 20 years. Coastal and inland aquacultures are economical and rapid methods for increasing protein supplies.

The annual catch of fishes and marine organisms totaled 57,300,000 kg in 1966, with 28,000,000 kg or 48.9 per cent of the total coming from freshwaters. The most productive of the freshwater areas was the Magdalena River system. Records for the first 6 months of 1969 indicated a total catch from all freshwaters

of 17,286,400 kg: of the 19 commercial species, 3 composed over 83 per cent of the catch. These were the bocachico (Prochilodus reticulatus magdalenae), and the catfishes, bagre (Pseudoplatystoma fasciatum), and nicuro (Pimelodus clarias). The catch of shrimp between 1958 and 1968 varied from 439,060 to 1,043,885 kg. Maximum catches of over 1 million kg were made in 1960 and 1967. The catch in 1968 dropped to approximately 600,000 kg. Material increase in shrimp harvest would appear possible only through discovery of new fishing grounds or through their culture in coastal ponds. The total catch of fishes and marine organisms averaged approximately 2.8 kg per capita. Adequate increases from marine fisheries appear improbable without development of an efficient and expensive fishing fleet together with discovery of new fishing grounds. Coastal and inland aquacultures can be developed to supply much of the protein needed in Colombia.

INDERENA operates marine research stations at Cartagena and Buenaventura and a small freshwater research station at Soplaviento. In addition, it conducts oyster research at Cienaga Grande; trout fingerling production and management research at Lake Tota with substations at El Cedral, Berlin and La Cocha; reservoir research in the mountains near Medellin. INDERENA is also responsible for collecting catch statistics on the riverine fisheries.

The marine research station at Cartagena serves as headquarters for marine, coastal and freshwater fisheries in northwest Colombia. It has an excellent building, modern laboratory equipment and a trawler for exploratory fishing. Presently there is a staff of 5 trained biologists, but it is expected that

5 more biologists will be added soon. Later, another laboratory building is to be constructed with space for staff and students.

The freshwater station at Soplaviento has a small, but well-equipped laboratory building, a set of 12 well-constructed concrete ponds and a building housing concrete tanks and other facilities for spawning fish. It is handicapped by lack of an adequate number of experimental ponds. At this location, earthen ponds cannot be built to fill and drain by gravity. If ponds are constructed across the old Spanish canal on one side of the station, the ponds must be drained by pumping and they would be subject to periodic flooding during years of heavy rainfall. If ponds are built on the uplands, they must be filled by pumping and excessive seepage may be a problem. A new site for a warm-water pond fish-cultural research station should be selected with a minimum area of 20 hectares. There should be 100 experimental ponds of 500 or 1,000 square meters in size, totaling approximately 10 hectares of water. The ponds should be constructed so that they can be filled and drained by gravity, and the water supply must be sufficient to replace evaporation plus seepage losses from 10 hectares of ponds. This will require a minimum of 250 gallons (950 liters) per minute if the ponds are well constructed in good soils. A suitable site probably can be found below an existing reservoir.

Research on production and management of oysters is conducted at Cienaga Grande de Santa Marta. This estuary has an area of 44,000 hectares, with 700 hectares of oyster beds from which is harvested 26,400 kg oysters, including shells, daily. Oyster meats make up approximately 8 per cent of the

total weight of oysters (with shells) harvested. Approximately 10,000 pounds (4,550 kg) oysters in cans are shipped to the United States weekly. It is believed that the oysters are being overharvested as their average size has declined in recent years. Present research deals with surveys of the oyster beds, methods of oyster culture and catch statistics. Various sections of Cienaga Grande are being leased to commercial companies for oyster production.

The trout station at Lake Tota is operated efficiently for production of fingerling trout. Catch statistics on Lake Tota are being obtained by sportsmen's clubs to evaluate effects of annual restocking on native fish populations, the rate of fishing and other management methods. The fee or charge made for fishing effectively limits use of the lake principally to sportfishing. Other coldwater lakes are stocked annually with trout fingerlings produced at the Lake Tota hatchery. Also, some private trout farms obtain fingerlings from this source. Several groups contacted INDERENA and the Auburn Team to obtain information on operation of commercial trout farms to supply fish to the Bogota market.

The area available in Colombia along the Pacific and Caribbean for culturing shrimps, fishes and molluscs could not be determine within the short time available for this survey. If sufficient area could be developed into coastal aquacultures, a productive export market should result.

The riverine fisheries appear to be quite productive. Landings at Honda on the Magdalena River total 2,472,000 kg per year. Standard forms are being prepared for recording catch data that may be used in evaluating the need for various regulations to protect the fishery. Data are being collected at 7 landings

on the Magdalena River. In addition, length-weight statistics and average conditions for each riverine species in the catch should be obtained. Periodically, samples of fish should be taken by seines, electricity or other means, and food habits determined by analysis of the stomach contents. Personnel collecting the data should have an annual, one-week training period in fish taxonomy, methods of collecting data, proper use of these data, and the biological relationships in riverine fish populations.

CVC operates a small freshwater fisheries research station at Buga. This station is too small to become an important research center for warm-water fisheries and has insufficient space for expansion. Some additional land can be made available for pond construction approximately 10 km from the station; however, this area is also of insufficient size for a good station.

The Food and Agriculture Organization of the United Nations is presently conducting a 2-year study on the marine fisheries of Colombia. The study is primarily concerned with a survey of marine fishes available for harvest.

Three universities are involved in fisheries research and training. The Universidad de Bogota provides training in marine fisheries and related disciplines. The training consists of 3 years of study at the University followed by two years of on-the-job training at the Cartagena marine fisheries station. The Universidad de Caldas has established a Fish Cultural Experimental Center at Manizales under the direction of Dr. Alonso Ramos-Henao. The station has approximately 20 experimental ponds. Three extension courses in fishculture have been offered at the Center. The Universidad del Valle at Cali has shown some interest in fisheries and aquaculture, but does not offer courses in these fields.

4.0 FISHCULTURE SURVEY REPORT FOR COLOMBIA

4.01 INTRODUCTION

The Republic of Colombia lies in the northwest tip of South America, adjoining the Isthmus of Panama. It has an area of 1,139,600 square km, and is the fourth largest nation in South America. It is the only South American country with both Caribbean and Pacific coastlines; the former coastline is about 1,560 km in length, whereas the latter is 1,392 km. Colombia is bordered on the west by the Pacific Ocean, on the northwest by Panama, on the north by the Caribbean Sea, on the east by Venezuela and Brazil, and on the south by Peru and Ecuador.

Because of the Equator, which crosses the southern portion of the country and the Andes Mountains which dominate the topography, Colombia is characterized by wide variation in temperature and rainfall. The country does not have a seasonal summer and winter, but all seasons can be experienced at any time of the year by traveling from one altitude to another. In the tropical lowlands, summer prevails the year round; in the intermediate Andean valleys to an elevation of 1,800 meters, one finds perpetual springtime; in the highlands above 1,800 meters, autumn prevails; still higher, in the paramos (wilderness) on the snowline, winter reigns.

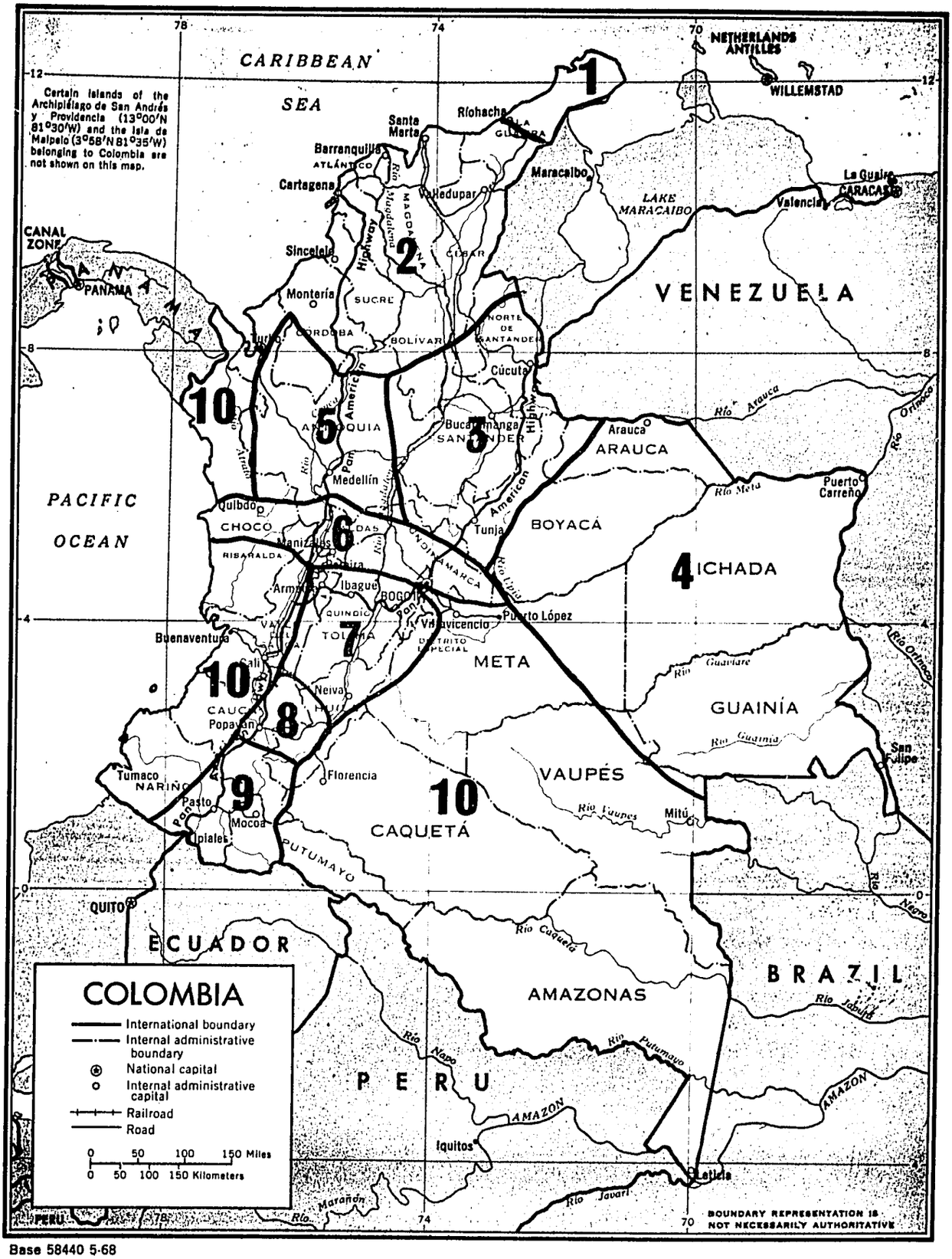
Rainfall fluctuates enormously depending on the geographical region of the country. In the Guajira region, the annual mean precipitation is less than 10 inches. On the Caribbean plains, rainfall ranges between 20 and 80 inches yearly, and in the Sierra Nevada, precipitation is more than 80 inches annually.

Along the Pacific Coast, annual rainfall amounts to at least 400 inches. On the Western, Central and Eastern mountain ranges, yearly precipitation ranges from 40 to approximately 470 inches (mainly on the Eastern range). The following map and diagram indicate the annual rainfall cycle for different regions in Colombia and the location of each region.

Colombia may be divided into two different regions: 1) a vast wilderness of plains, forests, and jungles east of the Andes, the Llanos Orientales; and, 2) the region of high mountains, high plateaus, and deep river valleys, which together with the narrow coastal strips have the farms, factories, mines, and commercial centers of the nation.

The Oriente, or Llanos Orientales (Eastern region), which contains two-thirds of the country, has scarcely 2 per cent of the population and is presently undeveloped. The Llanos has large areas of fertile soil and grassland and tropical jungles (rain forests) which extend south to the Peruvian border. The streams of eastern and southeastern Colombia flow eastwardly, and are tributaries of the Orinoco and Amazon Rivers. The Amazon River touches Colombia for a short distance in the extreme southeastern tip of the country. Some of the principal tributaries of the Amazon system in Colombia are the Vaupes, Negro, Apoporis, Caqueta, and Putumayo Rivers. Major tributaries of the Orinoco River are the Arauca, Casanare, Meta, Vichada, and Guaviare Rivers. The Orinoco forms a part of the Venezuela-Colombia boundary.

The mountains, with the exception of the Sierra Nevada, belong to the Andes, which disperse into three principal ranges north of the Colombia-Ecuador



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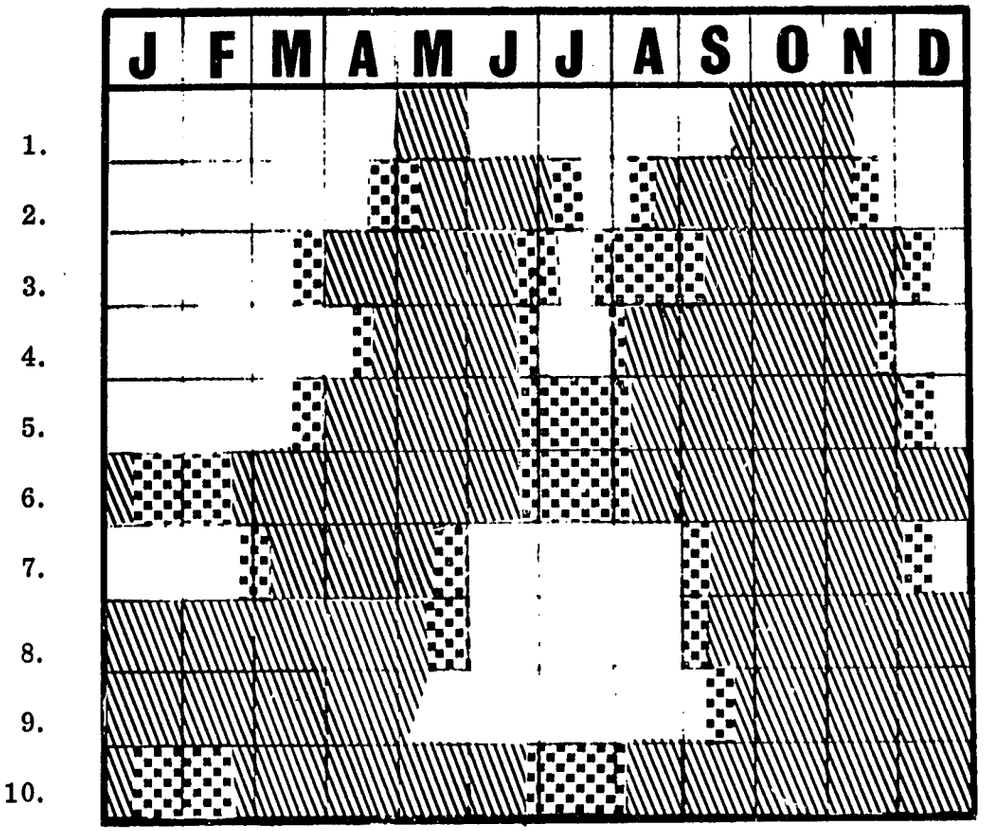
Map indicating locations of various regions of Colombia. Numbers 1 - 10 correspond to numbers shown in the following diagram.



1. Guajira
2. Llanuras Del Caribe
3. Cordillera Oriental
4. Llanos Orientales
5. Montanas De Antioquia Y Caldas
6. Zona Andina Central Y Ecuador Climatico
7. Valles Del Cauca Y Alto Magdalena
8. Altiplanicie De Popayan
9. Montanas Del Sur
10. Costa Del Pacifico Y Hoya

Legend

Rainy season

Rainy season with dry periods

Dry Season

Diagram showing the annual precipitation cycle for the various regions of Colombia.

border to form the Western, Central and Eastern ranges. A lower range, the Serrania de Baudo, runs along the Pacific Coast toward Panama. The isolated Sierra Nevada of Santa Marta rises to heights greater than 19,000 feet (5,793 m) along the Caribbean in the north. The Central range is the highest and extends some 500 miles (800 km) across the country. The Central and Western ranges are separated by the valley of the Cauca River, whereas the Eastern range is separated from the Central by the valley of the Magdalena River. The Magdalena River flows northward more than 1,000 miles (1,600 km) into the Caribbean.

The Caribbean coastal lowlands, formed in part by the alluvial deposits of the Magdalena and Cauca Rivers, occupy a triangular area between the Sierra Nevada de Santa Marta and the spurs of the Central and Western ranges of the Andes. The Pacific coastal lowlands are a narrow strip of marsh stretching from the border of Ecuador to Panama. The following principal rivers empty into the Caribbean: Magdalena, Cauca, Atrato, Sinu, San Jorge, and Cesar. The San Juan, Bando, Patia, and a number of smaller streams flow into the Pacific Ocean. The large number of rivers give Colombia approximately 3,000 miles of inland waterways.

Colombia is divided into different departments, districts, or municipalities. Bogota, the capital of Colombia, is located in the Department of Cundinamarca. The national economy is chiefly based on coffee, livestock, petroleum, and industries. The annual average per capital income is $288. Cost of labor on the average is 20 pesos ($1.13 U.S.) per day.

4.02 NUTRITIONAL STATUS OF COLOMBIA

The population of Colombia is 20.5 million with an annual rate of increase of 3.2 per cent. At this rate, the country will double its population in 23 years. Therefore, the importance of initiating prompt action toward the quantitative and qualitative improvement of the diets of the people can be immediately seen.

Increasing the number of calories and supplies of good quality protein are the most urgent nutritional needs in developing countries. The supply of food available in Colombia is theoretically adequate, but the supply of food protein does not reach all segments of the population in an equitable manner. It has been estimated that the worldwide average protein requirement is 57.3 grams per capita per day; of this, 19.1 grams should be animal protein. In the following table, the amounts of protein from various sources available in Colombia during the years 1959-61[1] are given:

Product	Grams of protein per capita per day
Cereals	18.3
Sugar, bananas, potatoes, pulses, cacao	12.2
Meat	11.2
Fish	0.5
Milk and cheese	9.5
Eggs	1.3
Total	53.0

The total average protein available was 53.0 grams per capita per day; animal protein amounted to 22.5 grams per capita per day; and only 0.5 grams were from fish protein. The total average protein for this period represents a

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

reduction of 1.9 grams per capita per day from that estimated available for the years 1956-1958 (54.9 grams per capita per day). The 1959-61 value was 4.3 grams lower than the figure given for the worldwide average protein requirement. Projections made by USDA indicate that the total average protein available for food in Colombia may increase by 1970 to 58.6 grams per capita per day of which 26.6 grams would be animal protein. This projection was based on an estimated population of 19.5 million by 1970. However, the population reached 20.5 million in 1969. The projected increase from 22.5 grams per capita per day of animal protein in 1959-61 to 26.6 grams by 1970 would have required a 64 per cent increase in total available animal protein within a 10-year period. This does not appear to have occurred. However, even this amount would be insufficient to provide adequate protein because of unequal distribution of protein-rich foods.

The present catch of fish is equivalent to 2.8 kg per capita per year. An FAO projection estimated the annual per capita consumption of fish for 1985 as 4.4 kg. This figure is quite low, but even this low consumption figure would require at least a 60 per cent increase over the present catch. Statistics from 1966 to 1969, however, appear to indicate a reduction in the marine fishery catch, rather than an increase.

4.03 FISHERIES STATISTICS

Most of the aspects of the fisheries of Colombia have not been investigated. However, exploitation of the various resources by traditional methods have been taking place for a long time. The fisheries are divided into marine, brackish-water, and freshwater; with the latter consisting of the river, the lowland and

upland lakes, and the reservoir fisheries. Marine fisheries have received the most attention. Brackishwater and freshwater fisheries have been only cursorily investigated. For these reasons, statistics on marine fisheries are more complete and reliable, whereas those from brackishwater and freshwater, with only a few exceptions, are fragmentary and not dependable. The catch resulting from the subsistence fishery, especially from freshwaters, is not included in the statistics.

The total catch for the year 1966 was reported as 57.3 thousand metric tons estimated at a value of 143,706 pesos ($8,622,000 U.S.).[1] This includes brackishwater, freshwater and marine organisms (fish, crustaceans, and molluscs). The following table itemizes the 1966 catch by species or groups of organisms:

Composition of catch	Weight (thousand metric tons)	Value in thousands of U.S. dollars	
Freshwater			
Bagre (catfish)	3.5		
Bocachico (Prochilodus)	19.2		
Various freshwater fishes	5.3		
			$3,913.00
Marine Organisms			
Redfishes, basses, congers	16.1	1,683.0	
Jacks, mullets	4.6	521.0	
Herrings, sardines, anchovies	3.3	342.0	
Scombrids (tunas, skipjack, bonitos)	.9	147.0	
Sharks, rays, chimaeras	.2	25.0	
Unsorted fishes	1.5	147.0	
Molluscs	.6	44.0	
Crustaceans	2.1	1,800.0	
			4,709.00
		Total	$8,622.00

1. FAO (1968). Yearbook Fish. Statis., (24): b-55.

The catch from freshwater is 48.9 per cent of the total catch, and the following tables give statistics and data on various aspects of Colombian fisheries. The number of commercial and subsistence fishermen in Colombia as estimated for the year 1968[1] was:

Type of fishermen	Number
Permanent	89,500
Occasional	35,000
Total	124,500

The following table lists total landings of fish (marine and freshwater), lobster, and shrimp for the years 1966, 1967, and 1968 at the ports of Barranquilla, Cartagena, and Santa Marta.[2]

Common name	Weight in kilograms		
	1966	1967	1968
Anchova		396	37,974
Bocachico	1,784,862	1,929,192	2,514,095
Bagre de Mar		42,691	147,468
Bagre de Rio	136,854	31,536	29,193
Bonito	94,967	170,732	8,473
Camaron		7,172	11,559
Caballeta			
Carito	14,262	9,877	48,391
Coroncoro			22,805
Cojinua	48,159	122,007	81,192
Chivo verde	575,282	70,349	33,263
Chino	3,640	36,013	68,906
Cherna	2,451	8,500	4,908
Dorado		11,359	4,568
Doncella			4,850
Jurel	83,525	133,862	172,406

1. Source of Information: Division de Economia Pesquera, Ministerio de Agricultu
2. Source of Information: Ibid.

(Table continued)

Common name	Weight in kilograms 1966	1967	1968
Langosta			1,871
Lebranche	994,137	278,132	154,663
Lisa	2,648,257	1,148,462	1,018,107
Macabi	12,218	64,820	30,215
Machuelo	85,760		245
Mero	356	19,578	27,364
Mojarra	797,931	923,744	773,269
Medregal	646	34,209	5,818
Roncholo			16,549
Pargo	94,489	432,942	285,259
Pacora			8,065
Picuda	4,553	11,926	28,820
Robalo	442,499	313,409	421,699
Ronco	109,155	182,440	77,195
Rubia	81	154	610
Sabalo	681,395	241,838	243,679
Saltona		38,457	125,186
Sierra	128,907	279,922	119,551
Salmon			12,534
Viscaina			39,500
Totals	8,744,386	6,543,719	6,580,254

The landings at these ports are characterized by a reduction of approximately 2 million kg during 1967 and 1968.

The landings of marine seafoods on the Pacific Coast from January through June, 1969, were:

Species	Weight in kilograms	Value in pesos
Abundancia	21,100	105,500*
Atun	90,773	354,577
Ambulu	1,200	8,400
Bagre	11,358	69,918
Berrugate	4,620	22,910
Bravo	221	630
Calamar	11,312	77,682

(Table continued)

Species	Weight in kilograms	Value in pesos
Camarones	916,099	21,225,969
Canchimalo	22,470	112,350*
Chimbilaco	23,020	115,100*
Corvina	25,573	204,310
Cherna	80,782	532,287
Dorado	575	2,355
Guabina	19,499	38,999
Jaivas	2,852	21,943
Jurel	245	1,075
Langosta	4,140	**
Lenguado	24,355	49,282
Lisa	50,360	251,800*
Machetajo	436	3,040
Merluza	8,324	51,024
Nato	19,499	38,399
Pargo	20,347	123,960
Pelada	224,499	448,979
Plumada	12,030	66,150*
Robalo	18,959	163,034
Sierra	35,459	102,550
Sardinas	260,030	260,030*
Tiburon	43,378	214,217
Zafiro	3,552	20,757
Totals	1,957,067	24,687,227

Following is the total landings of marine shrimp on the Pacific zone from the year 1960 through March, 1969.[1]

Year	Weight in kilograms
1960	1,017,299.5
1961	999,809.1
1962	979,384.5
1963	780,478.6
1964	951,086.8
1965	908,016.4
1966	984,086.4
1967	1,043,885.0

1. Source of Information: Zona Agropecuaria de Buenaventura.
* Estimated values.
**Value of langosta was unknown.

(Table continued)

Year	Weight in kilograms
1968	599,285.0
1969	209,078.5

The wholesale price of fish at the ports of landing averaged 4 pesos per kg (10.4 cents per pound) for both freshwater and marine fishes. It is estimated that one-half or more of the fish spoiled if not sold on the day of landing.[1] This acts to depress the price paid to fishermen, and makes transportation to inland markets difficult. The retail price of fish at Bogota ranged from 13 to 22 pesos per kg (34 to 57 cents per pound) for bagre, 49 pesos per kg ($1.25 per pound) for snapper, while dried fish sold for 18 to 31 pesos per kg (45 to 80 cents per pound), red meats for 20 pesos per kg (51 cents per pound) and chicken for 26 pesos per kg (68 cents per pound). Landings of freshwater fishes for the first six months of 1969 are given on the following page.

Fish at the Bogota market were usually scarce and of poor quality. Refrigeration and more rapid means of transportation are needed if significant amounts of fish are to be sold at cities distant from the ports of landing. Pond [illegible]cultures located near the centers of fish consumption could be developed to eliminate the need for transportation over long distances.

Fishing in freshwater is done with a variety of gear. The cast net is considered the standard gear. Also, hook and line, short drag seines, spears and arrows are used. Gill or trammel nets, fyke nets and fish traps are not used to

1. USDA Market News Leaflet 87, May, 1964, page 5.

Landings of freshwater fishes for all of Colombia from January through June, 1969

Species	Scientific name	Number of individuals	Weight in kilograms	Thousands of pesos
Bocachico	Prochilodus reticulatus	21,200,200	5,945,600	31,800,300
Bagre	Pseudoplatystoma fasciatum	2,642,600	5,792,500	23,170,000
Doncella	Ageneiosus caucanus	620,700	744,800	1,241,400
Pacora	Plagioscion surinamensis	172,100	120,400	378,600
Dorada	Brycon moorei moorei	87,300	113,800	218,200
Moncholo	Hoplias malabaricus	16,500	4,600	14,800
Vizcaina	Curimata mivartii	42,800	10,700	34,200
Nicuro	Pimelodus clarias	13,200,000	2,640,000	7,920,000
Conelon	Leporinus muyscorum	4,230	1,200	2,900
Arenca	Triportheus magdalenae	18,700	3,700	12,400
Capaz	unidentified	12,300	3,000	9,800
Mojarra	Petenia sp.	7,300	1,400	6,500
Blanquillo	Sorubin lima	722,700	518,800	1,815,800
Yalenton	unidentified		462,800	1,388,400
Amarillo	unidentified		676,000	2,095,000
Cachama	unidentified		186,900	467,200
Paleton	unidentified		17,000	44,300
Yamu	unidentified		13,700	36,900
Cherna	unidentified		29,500	94,400
Totals			17,286,400	70,751,100 ($4,199,494 U.S.)

Source of Information: INDERENA

Landings: Regional Atlantic - Maganque, Monteria, El Banco, Ayapel, Marralus, Puerto Cordoba, Lorica, Caimito, Montelibano, Planeto Rico, and San Marcos. Middle Regional - Girardot, Hondo, Leticia, Puerto Lopez, Villavicencio. Western Regional - La Dorada.

any great extent. Actually, in certain areas gill nets and fish traps have been outlawed in the belief that use of these types of gear endangers or eliminates the young individuals of commercially important species. However, there is no evidence supporting this assumption at the present time.

4.031 Problems in Colombian Fisheries

Several factors have retarded and hindered development of fisheries of the country. The main difficulties still in existence and requiring corrective measures or adjustments are:

1. Lack or insufficient knowledge of the resources--fishes, shrimps, oysters, clams, mussels, lobsters, and algae.
2. Limitations of trained scientific personnel.
3. Lack of suitable research stations to carry out the necessary investigations in fisheries and aquacultures.
4. Insufficient funds to cope with the demands of a scientific program in the country.
5. Lack of suitable fish marketing facilities and absence of modern marketing techniques.
6. Inadequate facilities for transportation, distribution and refrigeration of fish and other seafoods.

4.04 GOVERNMENT AGENCIES RESPONSIBLE FOR FISHERIES MANAGEMENT

The fisheries of Colombia are under the supervision and control of two agencies: INDERENA (Instituto de Desarrollo de Recursos Naturales Renovables) and the CVC (Corporacion Autonoma Regional del Valle del Cauca).

4.041 INDERENA

INDERENA was created by the government in 1969 to protect and develop the natural resources of the country. It replaced CVM (Corporacion de Desarrollo del Valle del Rio Magdalena). All fisheries operations in Colombia, with the exception of those in the Cauca Valley, are under the control and management of this agency. INDERENA is divided into a Technical Section and Administrative Services. Under the Technical Section are the divisions of Soils and Waters, Fisheries, Forests, Parks and Wildlife, Social Development and Engineering. The Fisheries Division is organized as follows:

Jefe: Capt. Max Rodriguez

Seccion Investigacion y Tecnologia - Jefe: Alfredo Acero-Sanchez

Seccion Pesca Continental - Jefe: Fernando Pereira-Velasquez

Seccion Pesca Maritima - Jefe: Gabriel de J. Acevedo-Rojas

The offices of the above sections are located in Bogota. The Fisheries Division also has regional offices and personnel stationed throughout the country: Medellin, Cartagena, Buenaventura, Honda and in the Llanos.

INDERENA has six hatchery and research stations in operation, and plans to build two additional stations; one at Leticia on the southern tip of Colombia and the other on the Llanos Orientales. The location of each of the proposed stations as well as the stations already in operation is shown on the following map.

4.0411 Research Stations

4.04111 Centro de Investigacion de Ciencias Marinas

This Center is located in Cartagena on the Caribbean coastline. This zone

Map showing localities of INDERENA'S marine and freshwater fisheries stations.

offers the greatest variety of fish habitats in Colombia. The coast is low with alternating sandy beaches and mangrove swamps, and has several bays and brackishwater lagoons. This facility, which is part of INDERENA, is not yet in full operation as it has only been in existence for less than a year. Most of the marine and coastal fisheries investigations being conducted on the Caribbean side of Colombia are under the supervision of this Center. The director is Mr. Enrique Diaz. Other members of the staff are: Mr. Alejandro Ciardelli (principal investigator working on the oyster project); Miss Judith Catano (a microbiologist working on the oyster project); Mr. Jorge Mercado (working on the biology of fish); and Mr. Lisandro Lopez (working on the population dynamics research on turtles and the tarpon).

The main building is built completely of concrete except the roof. It is a very good facility for research. There are also plans to build a ten-story building which will eventually house up to 18 professional personnel and students, coming to the station for training from the University of Bogota. Presently, there are only 5 biologists and the main building has room for ten. They expect to add a chemist, a planktologist, a fish taxonomist, and a technologist. The fifth position was undecided.

The Center has a large amount of extremely good equipment already at the building, however, some equipment is still in customs and has not been released. A 52-foot trawler, constructed in Mexico, is available for work offshore in locating shrimping grounds.

The remainder of the INDERENA stations visited by the Auburn Team will be discussed under section 4.07.

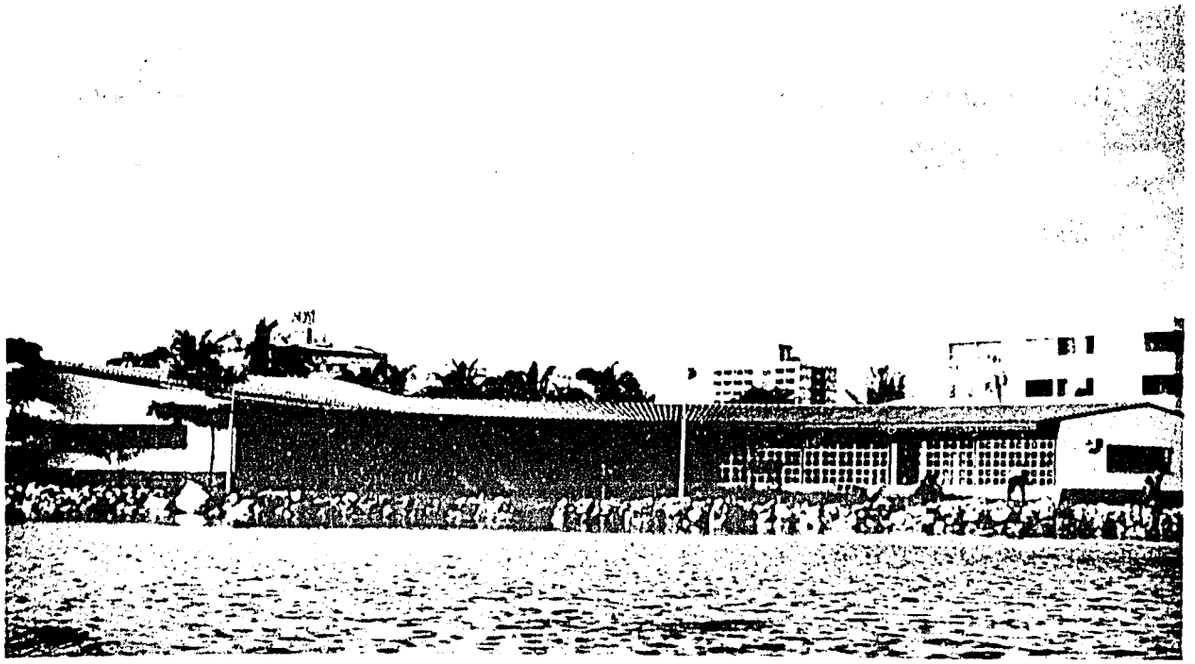
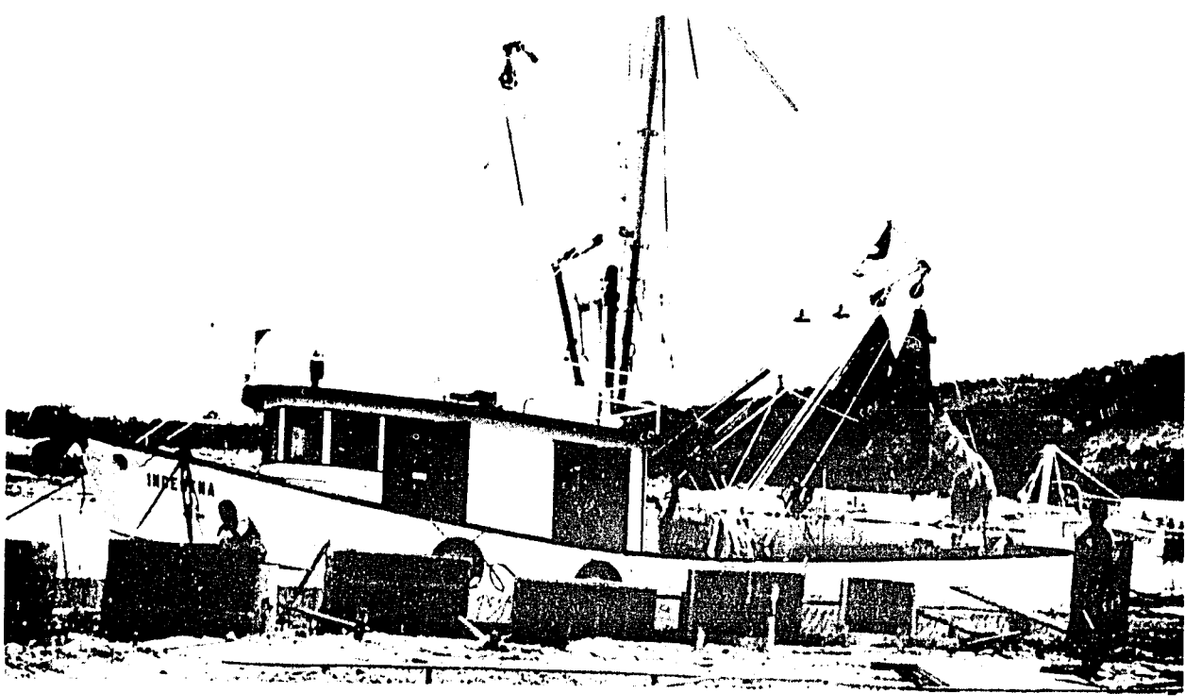


Fig. 1. Well-equipped, new laboratory building at the Cartagena Center for Marine Sciences.

Fig. 2. Trawler used for marine research at the Cartagena Center for Marine Sciences.



4.042 CVC

The CVC has the responsibility of protecting, developing, and utilizing the natural resources of the Cauca Valley. The fisheries are specifically under the supervision of the Departamento Agropecuario of the CVC. The director of the department is Dr. Jose Maria Lombana. The Instituto Nacional de Piscicultura de Buga is under the supervision of the CVC and it appears to be the only CVC fisheries research facility. To insure better administrative, technical, and scientific control of all fisheries operations in Colombia, active cooperation should be established between all groups involved in fisheries.

4.0421 Research Stations

4.04211 Instituto Nacional de Piscicultura de Buga

In 1959, the Ministerio de Agricultura of Colombia created the Instituto Nacional de Piscicultura de Buga. In 1960, FAO of the United Nations inaugurated the facility by placing there its Latin American Inland Fisheries Training Center. Presently, the Institute is under the CVC. The Institute is located about 88 km north of the city of Buga (120,000 inhabitants). The Buga area has an elevation of approximately 1,100 meters above sea level and a mean annual temperature of 77^{o}F. Mr. Jorge San Clemente-Zapata is the director. The present staff of the Institute consists of one fish culture technician (who is also the director), one administrator, 4 laborers, and one advisor. The advisor is Professor Anibal Patino, Professor of Biology at the Universidad del Valle, Cali.

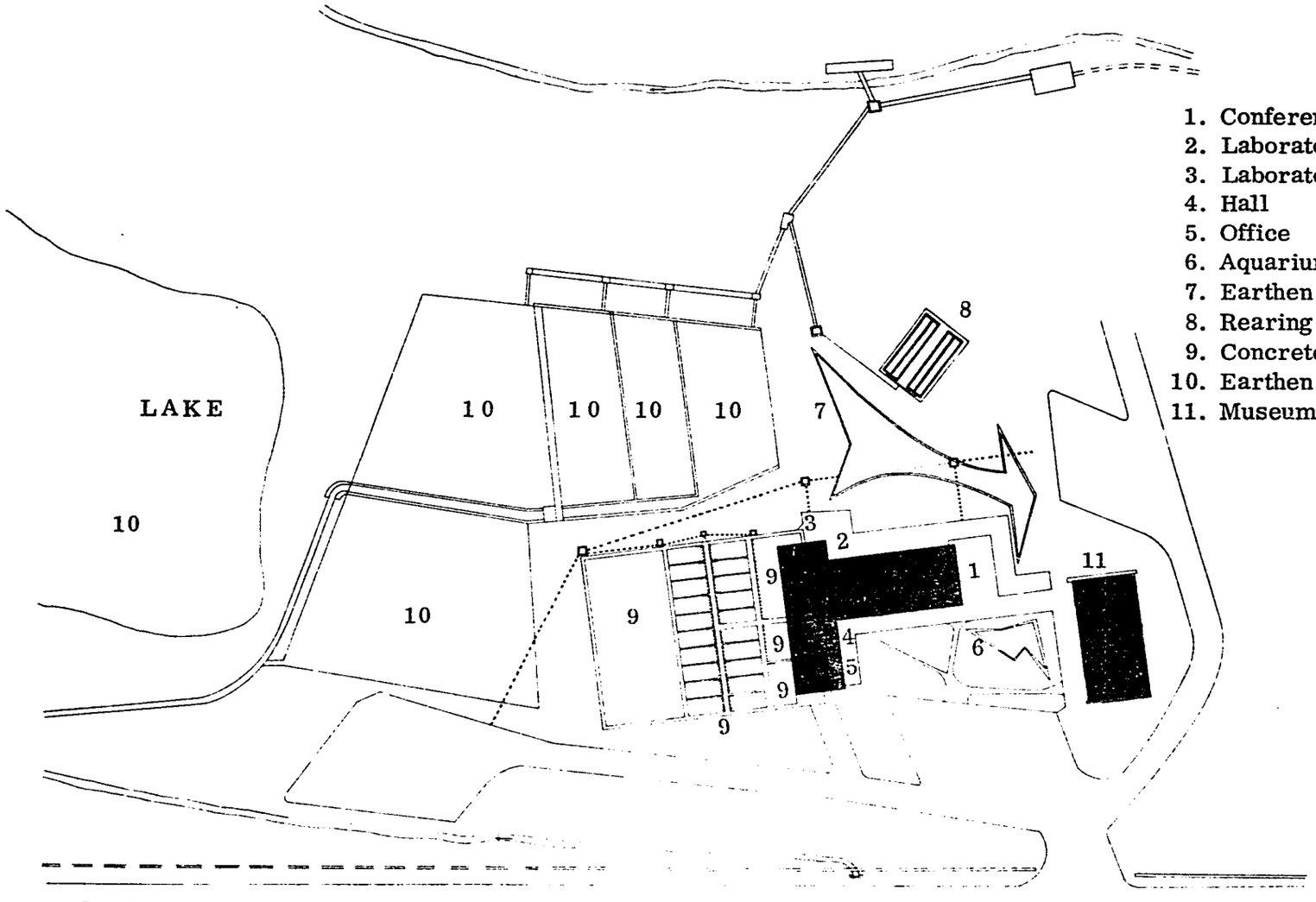
Due to lack of trained scientific personnel, research at the Institute is very limited. Investigations are being conducted on some aspects of the culture of

Tilapia mossambica, the culture of the piscivorous fish, Cichla ocellaris (tucunare), and on the culture of Prochilodus reticulatus (the bocachico). Incidentally, the tucunare does not have a good potential for intensive fish culture because of its piscivorous food habits; it might, however, be used in combination with forage species to control reproduction. At Buga, the tucunare was being used in combination with T. mossambica for reproduction control. Results were inconclusive.

The Institute has a land area of approximately 3 hectares. It was found that there were 6 hectares for expansion, but this land was 8 to 10 km from the Institute. The Institute has 2 very nice buildings. One is the museum and the other houses the laboratory. There are 24 concrete ponds and 6 earthen ponds. These are shown on the following map.

The water utilized at the Institute comes to the ponds by gravity through a pipe which originates at a canal operated by the city of Buga. The ponds also drain by gravity. Nonetheless, during dry weather, it was found that there was a scarcity of water, and, of course, as the city increases in size, it is very likely that less water will be available for use by the Institute.

The 6-hectare expansion area also was visited. The area was hill land and it was impossible to estimate how much of it could be used for ponds. The supply of water was to come through a diversion canal from a creek to the area, but no one was certain at what level on the hill the water could be carried by gravity. Soil borings were made on the land. The soil was a stiff, heavy clay resulting in very low seepage. However, it would pose a problem in that the pond bottom would be sticky mud making seining and harvesting operations difficult.



1. Conference room
2. Laboratory
3. Laboratory
4. Hall
5. Office
6. Aquarium
7. Earthen aquarium
8. Rearing tanks
9. Concrete ponds
10. Earthen ponds
11. Museum

BUGA STATION

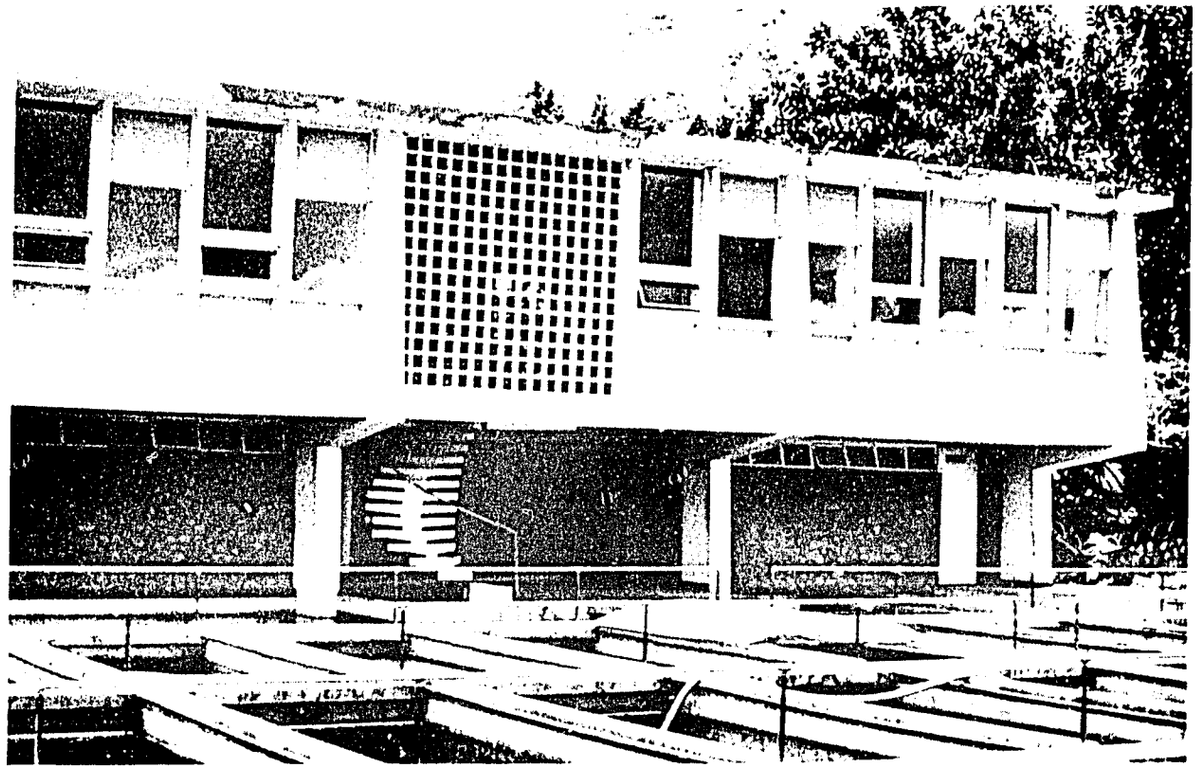


Fig. 3. The Buga Station of CVC has 2 good buildings, 24 concrete ponds and 6 earthen ponds of variable sizes, with little room for expansion. This is inadequate for a major aquacultural research station. Its best use could be as a hatchery to produce fingerlings.

Fig. 4. Lake Tota (5,500 ha) is one of the many natural lakes in Colombia. Lakes are found from the tropical lowlands up into the coldwater mountain areas. Little information is available on their limnology, fish populations or yield to fishing.

It appeared that not over 2 to 3 hectares of the expansion area would be level enough for ponds and sufficiently low in elevation to receive water by gravity.

4.05 FAO FISHERIES PROGRAM

Presently, INDERENA and the Food and Agriculture Organization of the United Nations are conducting a 2-year study on the marine fisheries of Colombia. The project is primarily concerned with a survey of the various kinds of marine fishes that are available for harvest. FAO has their research station located at Cartagena. A 107-foot research vessel is utilized in conducting surveys and other investigations.

4.06 UNIVERSITIES INVOLVED IN FISHERIES RESEARCH AND TRAINING

4.061 Fundacion Universidad de Bogota Jorge Tadeo Lozano

Training in marine fisheries and related disciplines at the university level in Colombia is presently limited to the Fundacion Universidad de Bogota Jorge Tadeo Lozano, which offers a program in marine sciences. In 1964, a Faculty of Marine Sciences was created at the University and offers degrees in Marine Sciences and Food Technology (equivalent to a Bachelor of Science). The program has been reorganized and the new one will go into effect in the 1970 academic year. More emphasis will be placed on fishery technology. No training is available in freshwater fisheries.

During the first three years of the curriculum in marine sciences, the students take courses at the University of Bogota. The last two years are spent at the Marine Center at Cartagena where the students receive field training in

fisheries.[1] At the end of their undergraduate work, the students receive a degree either in Marine Sciences or Food Technology. To date, the school has awarded 25 degrees. Those students showing the most potential are offered a scholarship (6,000 pesos per year or $340.00 U.S.) to continue their training. Generally, additional training is received in another country - the United States, Mexico, Venezuela, France, or Russia - when fellowships are available.

The Dean of the Faculty of Marine Sciences is Professor Luis Ortiz-Borda. None of the professors at the University has a Ph.D. Eight have the M.S. and the 4 remaining have a B.S. or its equivalent. Plans are underway to improve the staff of the University, both qualitatively and quantitatively.

In addition to the basic and general courses in the curriculum, training in marine sciences includes courses in invertebrate zoology, microbiology, statistics and biometry, biochemistry, general oceanography, phycology, ichthyology, marine plankton, chemical oceanography, marine ecology, population dynamics, fisheries biology, and an oceanographic cruise.

4.062 Universidad de Caldas

The Universidad de Caldas, through the School of Veterinary Medicine at Manizales, is developing a small program in aquaculture. The Fish Cultural Experiment Center at Manizales belongs to the University. Principally due to the efforts of one man, Dr. Alonso Ramos-Henao, the Center was created. Unfortunately, while Dr. Ramos was in the United States to receive further training

1. In 1970, France will supply 8 scientists who will conduct research at Cartagena and assist in the training of students in marine sciences for a 2-year period.

in aquaculture, no one replaced him. He returned to Colombia in December, 1969, and will continue to work on aquaculture at the Fish Cultural Experiment Center and at the University.

Three short courses in aquaculture have been offered at the Center. The facility has a small research area consisting of 20 earthen ponds ranging in size from 80 to 1,000 square meters. The Center is located 20 miles west of Manizales, 1,100 meters above sea level. Little research has yet been accomplished because of lack of funds for investment in construction and for hiring personnel. The Center does not have laboratories or any other facility besides the earthen ponds.

4.063 Universidad del Valle

A third university that has shown some interest in fisheries and aquaculture is the Universidad del Valle at Cali. Here again, all efforts appear to originate from one man, Professor Anibal Patino, Professor of Biology at the University and advisor to the Buga Station for the CVC.

Limitations of trained personnel, lack of funds, and insufficient facilities are again roadblocks, at this time, to the academic and research phases of the fisheries at the university level.

4.07 FRESHWATER FISHERIES

The freshwater fisheries of Colombia may be divided into those of rivers, reservoirs, lowland and upland lakes, and coastal and inland aquaculture. All of these are at different stages of development and utilization, although in most cases, proper management has been the exception rather than the rule.

At the present time, most inland waters (with the exception of those in the Llanos, which are chiefly undisturbed) are variously used for recreation, sportfishing, subsistence fishing, commercial fishing, agricultural irrigation, hydroelectric power and city water supplies.

4.071 Coldwater Lakes

In the upland or highland lakes, the fisheries are primarily oriented toward the production of rainbow trout for sportfishing. The Auburn Team visited Lake Tota which is a 55-square km lake located approximately 187 km northeast of Bogota. INDERENA has a rainbow trout station near the lake. The station is called the Centro Biologico Pesquero del Lago de Tota. The director is Mr. Carlos Eduardo Angarita. The station is relatively small and has no land for further expansion unless some land below the station is acquired. It is mainly operated as a hatchery for the production of trout fingerlings.

The station was constructed on the side of a mountain about 1 to 2 km from the western shore of the lake. Water is supplied through stream diversion. The water is aerated by passing over "cascade-type" aerators. Fry are raised to fingerlings in concrete tanks. Each tank has a capacity of 1,800 liters. The water entering the tanks has a rate of flow of 1,800 liters per hour, thus there is a complete change of water every hour. The hatchery produces 800,000 trout fry per month. Fifty-thousand of these per month are used to stock Lake Tota. The rest are used to stock other lakes in the country. Since Lake Tota has a number of streams flowing into it, in which trout spawn naturally, no one knows whether or not there is any need for restocking the lake on an annual basis.

Futhermore, since no estimates have been made on the trout population in the lake, there is no way to determine whether or not hatchery stocked fish survive.

The station has available for study two of the small streams flowing into the lake. One is apparently operated to supply ripe spawners for the hatchery and the other acts as a natural spawning ground for the trout. The trout migrate upstream in very large numbers to spawn in these streams.

Lake Tota is presently operated for sportfishing. A fisherman can either obtain a license for one day of fishing for 10 pesos ($0.57 U.S.) or a 1-year fishing license for 50 pesos ($2.84 U.S.). This probably excludes most of the native inhabitants living around the lake from fishing. The fishing license may be obtained at a private sportsmen's lodge which has facilities located on the lakeside. The club is the Asociacion Colombiana de Piscicultura y Pesca. The association has approximately 400 registered members. Apparently, most of them come from Bogota and other large cities. There is a limit of five trout with a minimum size of 30 cm per license per fisherman per day. It appears that these regulations were established before any attempt to manage the lake was made. The Sportsmen's Association is responsible for recording the date, hours fished, catch of fish, the total length, and weight. Apparently, some of these fish are being aged and it is expected to use those data as a basis for determining whether the lake is over- or understocked with trout and also if it is being over- or underfished. Subsequently, the INDERENA biologists are hopeful that these records will provide the necessary information allowing for better management of the lake.

Fig. 5. Rainbow trout (Salmo gairdneri) migrate upstream in large numbers from Lake Tota for spawning.

Fig. 6. Trout collected from streams are stripped of eggs and sperms for production of fry. Approximately 800,000 fry are produced per month at Lake Tota.

Because of the large size of the lake and the limited number of guards or inspectors to patrol it, poaching has become a common occurrence in Tota. A peculiar situation at the lake at the time of the visit by the Auburn Team was that only catch records or statistics were available based on fish confiscated from poachers. From this catch, the weight of trout ranged between 84 and 2,000 grams, and averaged approximately 700 grams. The highest monthly catch by poachers was 30 kg. However, it must be pointed out that INDERENA has been in existence for only three months and they are now arranging to obtain adequate records on the sizes and numbers of fish removed from the lake.

The production of fingerling trout is under the direction of Mr. Angarita. He uses a number of diets for fish of different sizes, which he prepares himself. The cost was 8.5 pesos per kg (21 cents per pound).

INDERENA officials at Tota expressed their interest and intent to construct ponds on the land between the lake and the station. Consequently, soil borings were made on the area. Apparently, some time in the past, the lake filled the valley almost to the foot of the mountain.

The first boring was made by the road to the station, approximately 1/4 mile (0.4 km) from it, in a field of onions.

A. Soil Profile

Feet	Material
0	
	sand
4.5	
	clay--sand

(Soil Profile continued)

6.0	
	sand--clay
6.5	
	sand--rocks--clay
7.0	
	sand--clay
7.5	
	clay--organic matter
9.5	
	organic matter--clay
11.0	

The boring was made along a small stream and it was felt that the sample might be somewhat affected by the shifting stream.

The second sample was taken across the same field slightly up the valley near the road at the edge of the onion field.

B. Soil Profile

Feet	Material
0	
	clay
1.5	
	sandy clay
2.0	
	clay--organic matter--sand
2.5	
	clay
3.0	
	sand--clay--organic matter
3.5	
	organic matter--clay
4.0	
5.0	
	organic matter
6.0	
	organic matter
8.5	

The third sample was taken in the onion field just above where the second sample was obtained.

C. Soil Profile

Feet	Material
0	
	clay
1.0	
	clay--sand
2.0	
	sand--clay
2.5	
	sand
3.0	
	sandy clay
5.0	
	clay--sandy clay
6.0	
	sand--clay
6.5	
	heavy clay
7.5	
	clay--organic matter
8.5	
	clay
10.0	
	organic matter--clay
11.0	

The next boring was made at a terrace above the field where the third sample was taken, just below the houses of the natives and apparently at the edge of the old lake, which presumably covered most of the valley some time ago.

D. Soil Profile

Feet	Material
	sand
4.0	
	sand--clay
4.5	
	clay--sand

(Soil Profile continued)

5.5	
	sand below clay
6.0	
	sand--clay
6.5	
	sand
7.0	
	sand--clay
7.5	
	sand mixed with some clay
8.0	
	sand--organic matter
8.5	
	sandy clay
9.0	
	clay--sand
9.5	
	yellow sand--clay--rock
10.0	
	rocks--clay--iron in rocks
10.5	

Since a constant stream of water is usually passed through the trout ponds, it was considered that the land between points C and D would be suitable for construction of such ponds. However, the area would not be very good unless the lower part of the field could also be used, and the soil at point B was undesirable because of the organic deposits.

Lakes Cocha and Otun are other large upland lakes operated for sportfishing of rainbow trout. Three additional substations are also conducting research on trout. These are: El Cedral at Caldas, Berlin at Santander, and La Cocha at Narino.

4.072 Warmwater Lakes

The warmwater lakes and the upland lakes are primarily utilized for

sportfishing, although some subsistence and commercial fishing are done. Two of these lakes, Luruaco and Guarinocito were visited by the Auburn Team. Lake Luruaco has an area of approximately 4,000 hectares. It is located about 80 km northeast of Cartagena. Biologists under the previous CVM (Corporacion de Desarrollo del Valle del Rio Magdalena) stocked the lake with Atlantic tarpon (Megalops atlanticus) and were hoping to produce large enough fish to develop the area as a tourist attraction.

Several aspects of fisheries management, however, were not taken into consideration when the lake was stocked with tarpon. A survey to determine the presence of other species of fish in the lake and to determine what effect, if any, the tarpon might have on these native fishes was not conducted. Periodic samplings of tarpon to estimate their relative abundance, rate of growth and condition were not made. Additionally, the lake was closed to public fishing under the impression that the closed season would allow the tarpon to reach fantastic sizes. However, together with the closing of the lake for fishing, annual stocking of tarpon fingerlings into the lake was continued. It is highly possible that continuous stocking under the above conditions may result in crowding of the population of tarpon. This would be followed by a reduction of their food supply, an inevitable decrease in the rate of growth of the fish, and a subsequent natural check in the population of tarpon.

Lake Guarinocito, a smaller lake than Luruaco, is located northwest of Honda. There is a small fishermen's village at the edge of the lake. The fishermen here are organized into a cooperative. The most common fishes in the

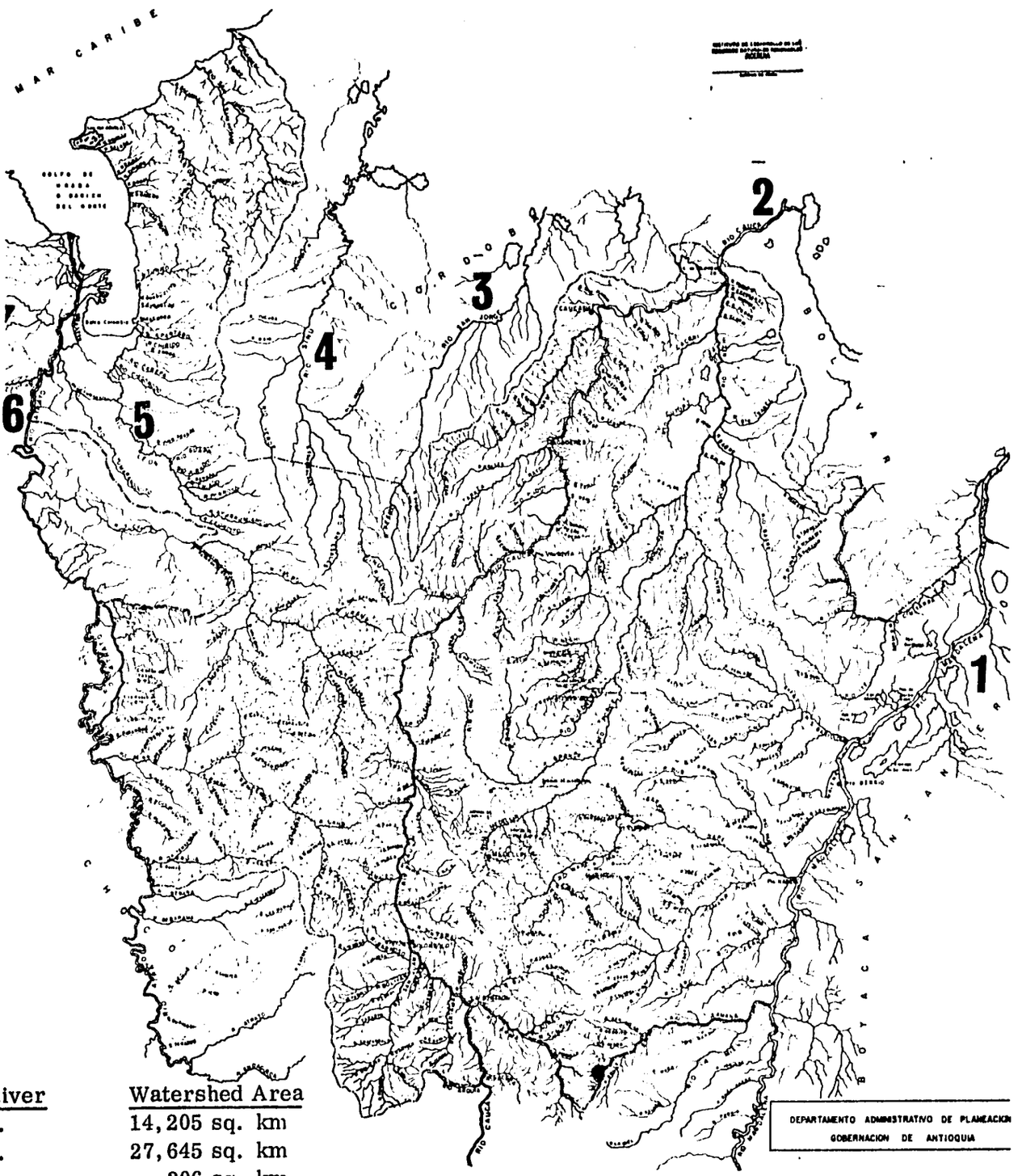
lake are the bocachico, tolomba, and bizcaino. At the time of the visit by the Auburn Team, a group of fishermen was fishing from canoes with cast nets. Fishing at Guarinocito is principally at the subsistence level, only a small portion of the catch is utilized commercially.

An inventory of the Colombian lakes, their areas, together with pH, hardness, temperature variation, and the oxygen profile of the waters should be made since this information is essential in planning the development of more productive fisheries.

4.073 Reservoirs

Several reservoirs are already in existence in Colombia and some others are either being constructed or are in the planning stage. These reservoirs are mainly used to produce electric power, for water supplies, and for irrigation. There appears to be serious interest in utilizing these waters more fully by incorporating various fisheries practices into the reservoir program.

The Auburn Team visited Medellin (Department of Antioquia) and adjacent areas where many such reservoirs are in operation and others are being constructed. There is a large number of rivers and streams located within the province and this undoubtedly will result in continued construction of reservoirs in the area. The Empresas Publicas de Medellin, a private enterprise, is in charge of constructing and developing, in part the reservoirs for the department. Apparently, INDERENA and the Empresas, in cooperation, are attempting to coordinate plans to incorporate fisheries (aquaculture, subsistence fishing, sportfishing, and commercial fishing) into the reservoir development program.



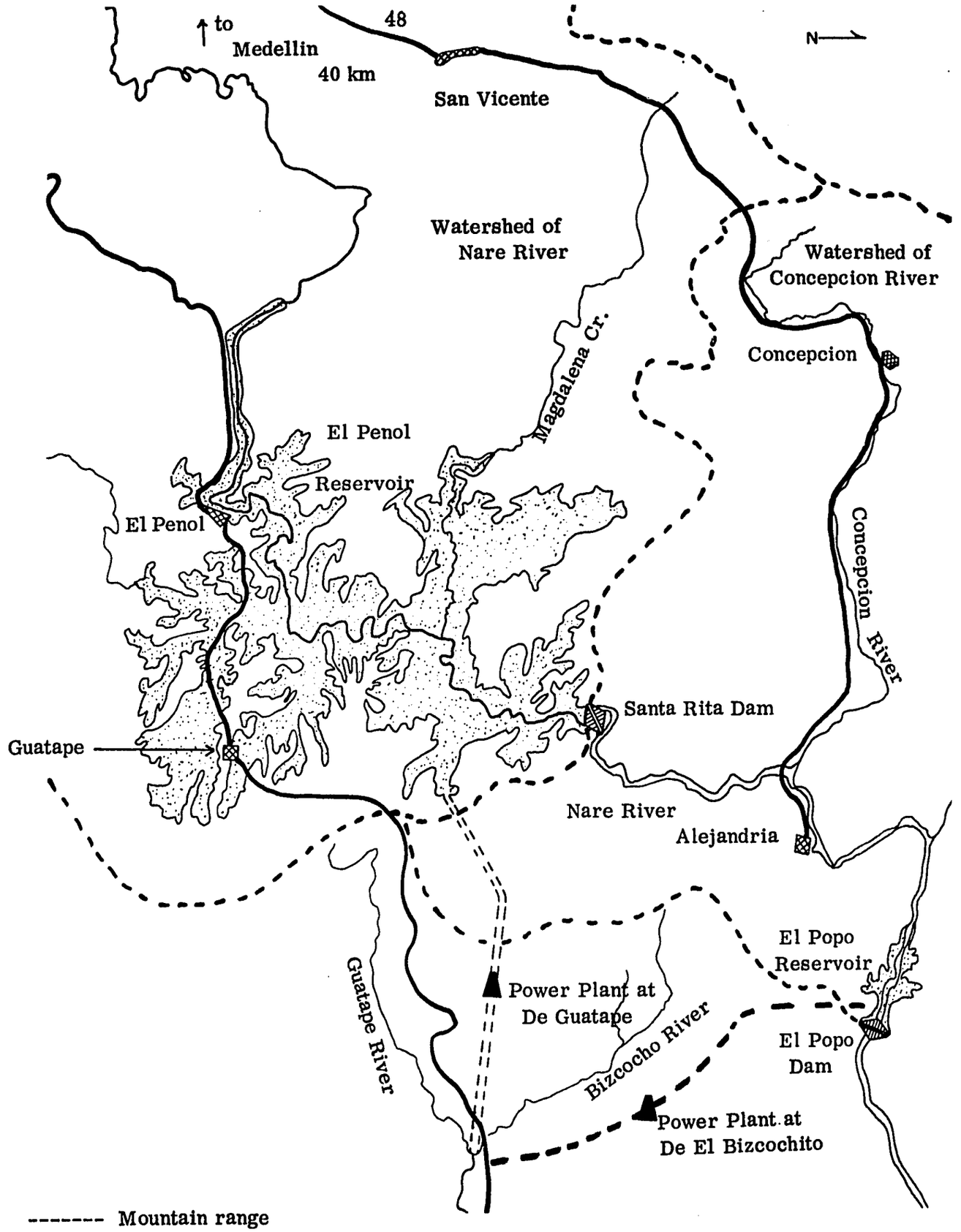
River	Watershed Area
1.	14,205 sq. km
2.	27,645 sq. km
3.	306 sq. km
4.	1,505 sq. km
5.	2,970 sq. km
6.	11,246 sq. km

Map showing river systems and large number of tributaries in the Department of Antioquia, where several reservoirs are located and others will be constructed. The principal river systems are the: Magdalena, Cauca, San Jorge, Sinu, Leon, and Atrato. Only the portions of the watershed areas of these rivers within the Department of Antioquia are indicated in the legend.

El Penol Reservoir, in its preliminary construction stage, was visited because it appeared to be the most representative reservoir in the development program. It is also the largest. The reservoir is located approximately 40 km east of Medellin. It is being constructed on the Nare River and will have a maximum depth of 20 meters and a drawdown of 5 meters. El Penol will be built in two stages; first stage construction will inundate about half the area. There are plans to build eight reservoirs in the department and of these, six are already completed. These are: Piedras Blancas, La Fe or Rionegro, Troneras, Miraflores, La Garcia and Quebradona. Those being constructed or planned are: El Penol and El Popo. The first 4 are hydroelectric reservoirs and the remainder are presumably for irrigation. All are to be operated for fisheries. El Penol Reservoir will flood one small village (about 10,000 inhabitants) and the people will be relocated. These people will be allowed to fish in the reservoir to partially repay them for losing their land.

Although El Penol Reservoir is on the Nare River, its discharge water is run through a conduit into another river system, the Atrato River. When filled, El Penol will have a surface area of approximately 60 square km. The temperature of the river water ranges from 7^{o} to 16^{o}C. The temperature in one of the existing reservoirs in the area was given as ranging between 19^{o} and 22^{o}C. No reliable information was available on the amount of runoff from the area, flow of the various rivers, or the area of the watershed above El Penol.

The INDERENA-Empresas personnel had selected several sites that they felt might be suitable for pond research stations. One site was on the San


to
Medellin
40 km
48
San Vicente
N
Watershed of
Nare River
Watershed of
Concepcion River
Concepcion
Magdalena Cr.
El Penol
Reservoir
El Penol
Concepcion River
Santa Rita Dam
Guatape
Nare River
Alejandria
El Popo
Reservoir
Power Plant at
De Guatape
Guatape River
Bizcocho River
El Popo
Dam
Power Plant at
De El Bizcochito
Mountain range
Towns
Power Plants

Gertrudiz River. Personnel from the Empresas had made a soil profile of the area and it was largely sand underlain with gravel. Unfortunately, this site is totally unsuitable for pond construction. In another site, nearby, there was practically no area for ponds as the area consisted of a rather steep stream valley with sand and gravel along the stream banks with a little amount of clay. Several recommendations were made to the group regarding factors that must be carefully considered when examining a site for possible development into a pond research station. Efforts to locate suitable sites for pond research stations will be continued in the future.

4.074 Riverine Fisheries

There are numerous rivers in the country. Much attention has been given to the fishery of the Magdalena River which is very rich in fish fauna and is a highly preferred fishing ground, both for commercial and sportfishing. Inadequate records are available from most of the other rivers to evaluate the fisheries.

The Magdalena River is approximately 1,600 km in length from its origin at the paramo El Buey on the southern portion of the Central mountain range. Most of the fishing in the river is done on the lower and middle Magdalena. It has been estimated by fisheries officials in Colombia that the rivers provide 80 per cent of the total freshwater fish production in the country. The 1966 catch statistics indicate that at least 50 per cent of the total catch of fishes comes from freshwaters. Although the catch records are reasonably accurate for the Magdalena River fishery, one must also consider that few records are available from

Fig. 7. Rapid runoff from steep mountain areas has caused severe flooding downstream. Many large reservoirs are being constructed to reduce flood damage and to impound water for electric power, irrigation and fisheries.

Fig. 8. The bocachico (Prochilodus reticulatus) is one of the most important riverine fishes, making up 34 per cent of the total catch in freshwaters.

other rivers.

The most important commercial species in the river are: bocachico (Prochilodus reticulatus); the catfish, bagre tigre (Pseudoplatystoma fasciatum); and nicuro (Pimelodus clarias), in that order. Other fishes of lesser importance in the catch are: the cichlids, chiefly of the genus Pete..a; the catfish, bagre sapo (Pseudoplatystoma bufonius); capaz (Pimelodus grosskipfi); the sardinata (Brycon moorei); and the sabalo or tarpon (Megalops atlanticus).

The zone of the middle Magdalena, near Honda, was visited. Unfortunately, the visit did not coincide with the fishing season, but rather with one of the river's flood stages. Thus, no fishing was taking place at this time. The Auburn Team had opportunity to look over the records that were being kept on the commercial fisheries of the river. INDERENA personnel had set up 7 catch reporting points up and down the river. The location of the catch points, from north to south is: Barranquilla, Monpos, El Banco, Gamarra, Puerto Wilches, Barranca Bermeja, and Honda, as shown on the following map. Records are kept on the lengths and weights of fish caught, number of fishermen and the type and amount of fishing gear. Additional records are maintained on fish transported to the market, by species, number, weight, length, and value of each fish. Boats and type of fishing gear to be utilized in the river must be registered at the various reporting points. Four different types of gear are commonly used in the river: short drag seines, cast nets, hand lines and "congolos" (dip or hand nets). Fish traps and gill nets are outlawed in the zone of Honda.

The total catch for the section of the river corresponding to the Honda zone

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Map showing catch reporting points along the lower and middle Magdalena River.

(25 km in length) for the one-year period between December, 1967, and December, 1968, was given as 2,472,376 kg with an estimated value of approximately 6.6 million pesos ($375,000 U.S.). Records from other rivers in the country were either fragmentary or lacking. Attempts are being made to obtain more complete and reliable records from the Atrato, San Jorge, Cauca, Sinu, Orinoco, and Amazon Rivers.

The data gathered at the various catch reporting points go to the Department of Statistics at Bogota where they are processed. The completed records are then returned to the biologists in charge for subsequent application to the management of the fisheries.

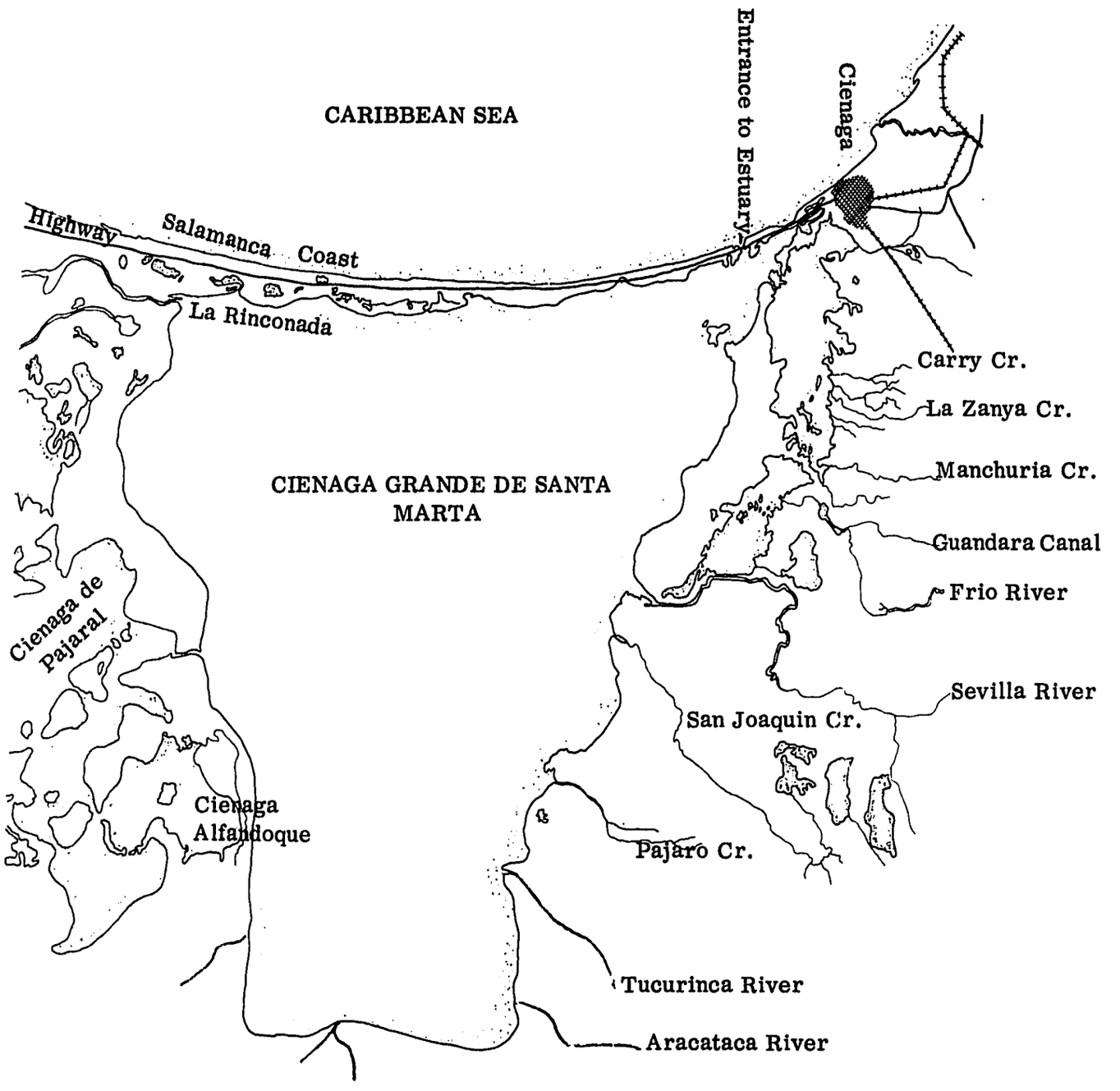
4.075 Coastal Fisheries

It appears that the best potential for development of the coastal fisheries in Colombia is in areas similar to those found near Santa Marta along the northern coast of the Caribbean. There, the coast is low and swampy and is characterized by a series of channels and cienagas (marshes and estuaries) which are connected to rivers. The largest of these is the Cienaga Grande de Santa Marta. The cienaga is an estuary of approximately 44,000 hectares. Here several types of fisheries, including shrimp, snook mullet, tarpon, and oyster, are important. The most important, however, is the oyster fishery. The species of oyster present is the Crassostrea rhizophorae.

INDERENA and the Instituto de Fomento Industrial are cooperating on an oyster research project in this area. INDERENA reports that Colombia exports approximately 10,000 pounds of canned oysters per week to the United States.

The canned oysters are being sold for $0.25 per can of 4.6 oz. This would represent a gross income per week of $8,929.57 U.S. The INDERENA biologist in charge of research in the cienaga reported that in previous years there were 35 oysters per 4.6 oz. However, with the heavy exploitation, present size is much smaller and it now takes 60 to 70 oysters to make the 4.6 oz. Approximately 8,500 sacks of oysters are harvested each month from approximately 700 hectares of oyster beds. Each sack contains between 600 and 1,000 oysters. Daily harvest of oysters is approximately 378,000 oysters. The accuracy of the estimates of sacks of oysters per day and number of oysters harvested daily is questionable. The daily catch is reported to be 26,400 kg and of these, only about 8 per cent would be oyster meats, or approximately 2,100 kg of oyster meats per day. The annual exploitation was estimated in total gross weight with shells at about 9,800 kg per hectare. The price paid to the fishermen per sack ranges between 8 and 12 pesos ($0.45 and $0.68 U.S., respectively). The price per sack in Bogota is 100 pesos ($5.70 U.S.).

Although not much research has been conducted, some oysters were raised experimentally on strings hanging from wooden frames. Unfortunately, no personnel remained at the locality while the experiment was being conducted and most of the frames were stolen. So far, some of the oyster beds have been mapped, measurements made of size and abundance of oysters on selected reefs, and harvest statistics are being accumulated. At the present time, no study of the salinity gradient in the estuary has been conducted; consequently, it is not known which areas of the cienaga would be suitable for oyster culture and which would not.



Map showing Cienaga Grande de Santa Marta and adjacent areas.

There are several rivers which flow into the lower end and eastern side of the cienaga, and there is only one outlet at present into the Caribbean. Formerly there were two outlets, but one of them (30 m in width) was closed when a road was built across the entrance toward a national park which INDERENA operates. There is now under consideration a proposal to re-establish an outlet by cutting a ditch through the road. It would be more feasible to make salinity measurements over the entire estuarine area during the wet and dry periods to determine whether another entrance to the Caribbean is necessary. The investigation should be completed within one year.

Plans have already been developed to lease sections of the estuary to five or six private companies who would operate them for commercial oyster production. The companies leasing the area will be responsible for planting their own shells on their zones. Another thing that needs to be done in the estuary, since most of the oysters are being raised on the bottom and oysters can live only where there is a firm substrate, is to conduct a study and subsequently map bottom-types in the estuary. It could then be determined what areas of the estuary could be used to expand oyster production by planting either empty shells or seed oysters.

Undoubtedly, there must be other areas similar to Santa Marta in Colombia. For instance, the Guajira on the Caribbean coast has areas where several rivers form an estuarine environment and a system of brackishwater lagoons. Also, the zone of Cartagena on the Caribbean offers a variety of mangrove swamps, bays, and brackishwater lagoons. On the Pacific Coast, areas near Buenaventura and Tumaco exhibit some estuarine and bay systems. All of these areas

should be investigated to determine their potential in development of coastal aquaculture and fisheries in Colombia. The areas along the Pacific coastline should also be considered carefully to determine if aquaculture could be developed in the intertidal zones. The tide change of the area is semi-daily, having a spring tide of 4.8 meters.

4.076 Freshwater Aquaculture

Although there exists many natural ponds, small lakes, and a good number of artificial ponds, aquaculture of warm-water fishes is practiced only to a very limited extent in the freshwaters of Colombia. It seems that the Centro de Investigaciones Limnologicas de San Cristobal at Soplaviento is the only experimental station presently conducting research directly related to aquaculture, and this station does not have the experimental ponds necessary to develop systems of aquaculture.

The Soplaviento station, located about 45 km east of Cartagena, has an area of approximately 25 to 30 hectares. There are only two biologists working full time at the facility. The director is Mr. Jose Miguel Solano and the other biologist is Mr. Guillermo Quinones. The staff is actually attached to the Centro de Investigacion de Ciencias Marinas at Cartagena.

The station has 12 concrete ponds, which have sides and bottoms lined with glazed tiles. There are five 22.7 sq meter tanks used to raise fingerlings, five 106 sq meter experimental tanks, one 42 sq meter storage tank, and one incubator tank. The total cost of these ponds was given as 500,000 pesos ($ 28,409 U.S.). There are three different buildings on the station: one houses

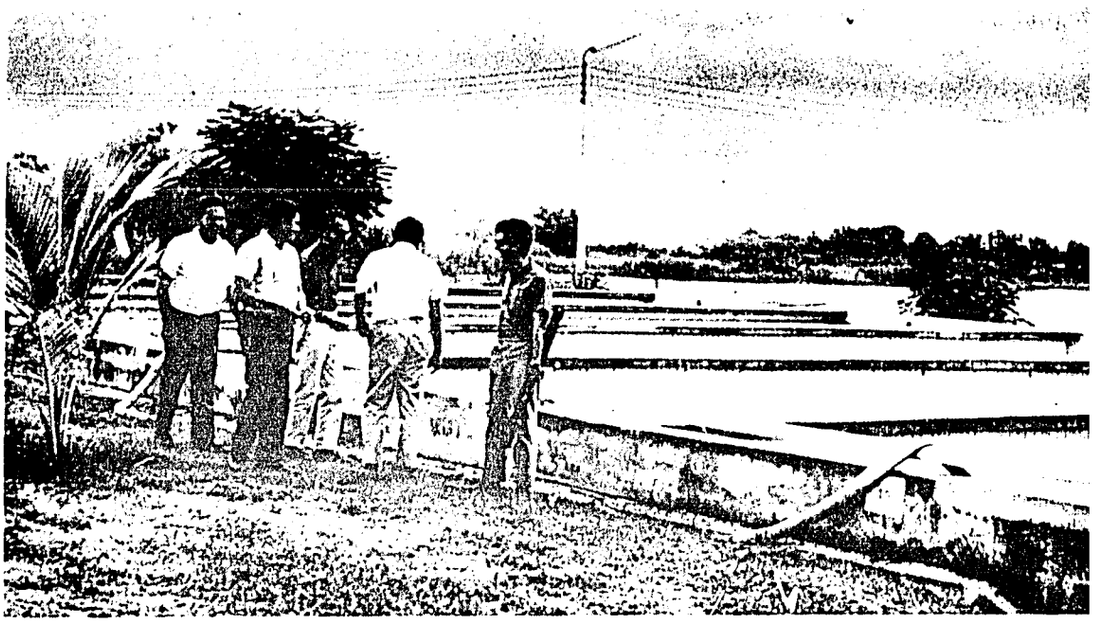
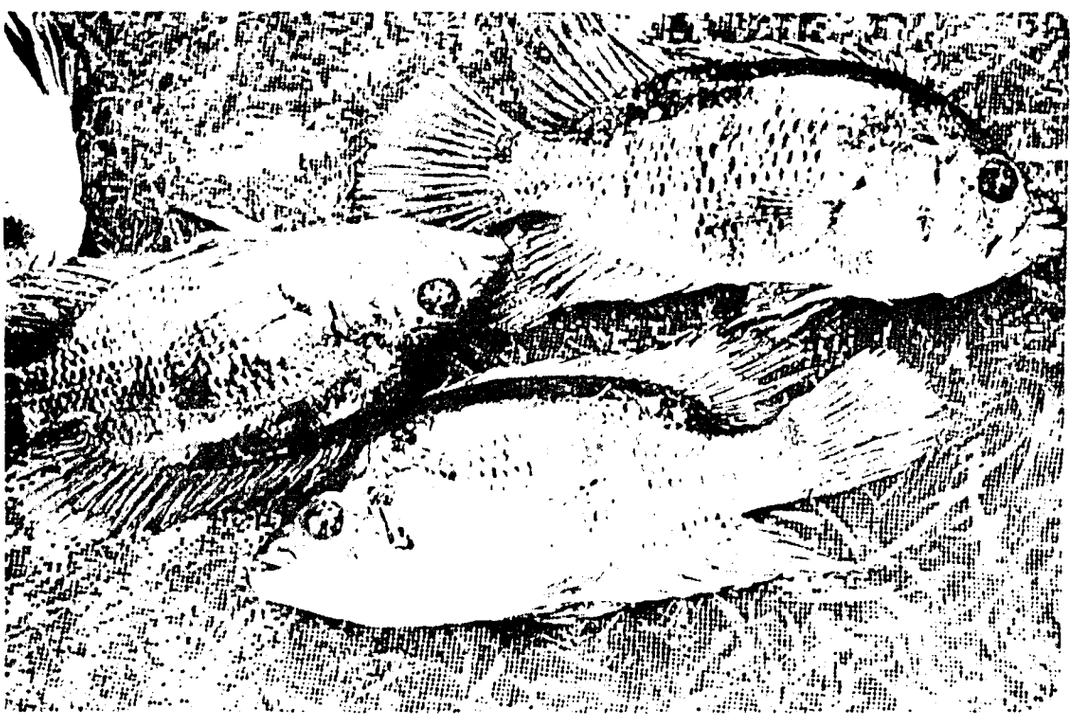


Fig. 9. The Soplaviento Station of INDERENA has a good hatchery building, a reservoir pond and 12 concrete ponds. It has no experimental earthen ponds and little space suitable for their construction.

Fig. 10. Research at the Soplaviento Station deals in part with spawning and culture of the yellow mojarra, Petenia kroussii. There are over 700 spec of freshwater fishes in Colombia, but practically nothing is known of th biology, food habits, or their potential for culture.



the director; one the administrative offices, a laboratory, a library; and one the employee's quarters. Additionally, the station has a nice hatchery building with concrete tanks. A number of these tanks have observation ports or glass windows similar to the type used in aquaria.

Water comes from a canal located along one side of the station. Since the ponds are at a slightly higher elevation, water must be pumped from the canal to the ponds. Pumping could be quite an expensive operation if large numbers of ponds were constructed. The station has a small artificial lake, which can be partly filled by gravity from the canal when the lake level is down. Usually during wet periods, the lake is partly filled by gravity and partly by pumping. There is also a small water filtration plant to supply potable water for the station personnel.

Investigations are being conducted on four species of fish: the bocachico; the yellow mojarra (Petenia kroussii); the black mojarra (P. umbrifera); and the bagre tigre.

Research on the bocachico deals principally with induced spawning. Brood fish are maintained in the artificial lake on the station. When the fish are removed from the lake for spawning, they are usually in a rather exhausted condition, presumably from struggling in the nets. Immediately, the adult fish are injected with pituitary extract. Later, they are placed in aquaria and as soon as the fish appear to have recovered, a second injection is made. Generally, spawning takes place within 24 to 48 hours. The eggs hatch within 15 to 20 hours, at temperatures of 27° to 29°C. The young fish are fed within 24 to 48 hours after hatching with

natural fish-food organisms obtained from the nearby lake. They grow to approximately 26 grams (15 cm) in 4 months.

Research on yellow mojarra consists chiefly of studies on reproductive behavior in concrete ponds. INDERENA biologists were able to spawn and raise this fish. Since the yellow mojarra appears to have other favorable characteristics for pond culture, it would be desirable to conduct further research to determine its food habits, rate of growth, relative efficiency, behavior under intensive culture, and adaptability to feeding on artificial feeds.

The only area on the station that the INDERENA personnel thought might be suitable for building ponds was in an old canal (Canal del Dique), which was constructed several centuries ago by the Spanish. The canal was dug to a depth of about 4 to 5 m below the surrounding countryside and brought water apparently from the Magdalena River to the bay at Cartagena. A soil boring was made at this location and a stiff, heavy clay was found to a depth of 11 feet. Another boring was made approximately 250 meters farther down the side of the canal where good clay also was found. This soil would hold water very well. The ponds could be filled by gravity but would have to be drained by pumping water out into a canal or ditch built beside the ponds. Since the area is 4 to 5 m below the surrounding land and heavy rainfall occurs here, the ponds would probably be subjected to damaging floods. Without more information, the area cannot be considered suitable for experimental ponds.

A third boring was made on the upland area. This was found to be a sandy loam with very little clay to a depth of 4 feet. Seepage here would be excessive

unless the top soils were removed and excavations made into the underlying clay. Time was not available to make a detailed study of the area. The disadvantages of building ponds on such a site are that water would have to be pumped to fill the ponds and the ponds would need to have relatively tight clay to hold water that high above the canal. It was suggested that it would be better to locate another site, possibly near a reservoir where the ponds could be constructed to fill and drain by gravity.

4.08 MARINE FISHERIES

The marine fisheries of Colombia have been investigated more fully than the freshwater fisheries, but in most cases, the fisheries operations are still in very primitive stages. Marine fisheries enterprises, to have at least moderate success, should have vessels with refrigeration facilities, capable of performing efficiently in open waters off the coast. This would mean an additional financial burden on the fishermen and fishing companies of the country without a guarantee that the operation would succeed.

A major obstacle seriously hampering development of marine fisheries (and coastal and freshwater fisheries to some degree) is the high concentration of people living on the Sierras. Communication with the coast from these centers, unless by air, is not easy and the transport of fresh fish is both difficult and costly. Because of the lack of suitable cold storage facilities, there is a high rate of spoilage of fishery products.

The principal marine fisheries resources of Colombia are: the tunas (skipjack and yellowfin), shrimp, lobster, and several species of demersal fishes

(e.g., redfishes, basses). Of these, the demersal and shrimp fisheries appear to have the best potential. Yellowfin tuna appears to be overfished. Although the skipjack tuna is not yet fully fished, exploitation of the resource might be too costly and with low financial reward because of two main reasons. First, there would be a stiff competition with other nations possessing facilities and marketing outlets. Secondly, even if Colombia were willing to face this competition, costly fishing vessels and equipment and well-trained crews would be necessary.

Some of the problems of the demersal fisheries are the lack of knowledge of the species of fish available in commercial quantities, lack of adequate refrigeration facilities on boats, and the lack of boats with sufficient speed to expediently travel to and from the fishing grounds.

The shrimp fishery appears to be highly successful, but this industry contributes indirectly to the domestic food supply as almost the entire catch is exported. However, because of the contribution of this resource to the national economy, it must be considered a highly desirable product. The lobster resource is also being exploited, although this fishery does not represent a significant contribution to the domestic food supply.

Investigation and research to improve and expand the marine fisheries should be continued. Careful evaluation of the resources should be made to determine at what level of operation increased exploitation becomes economically undesirable. When dealing with natural populations of animals and plants, one must bear in mind that these are not inexhaustible resources and that if too heavily exploited, continued harvest no longer is economical.

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