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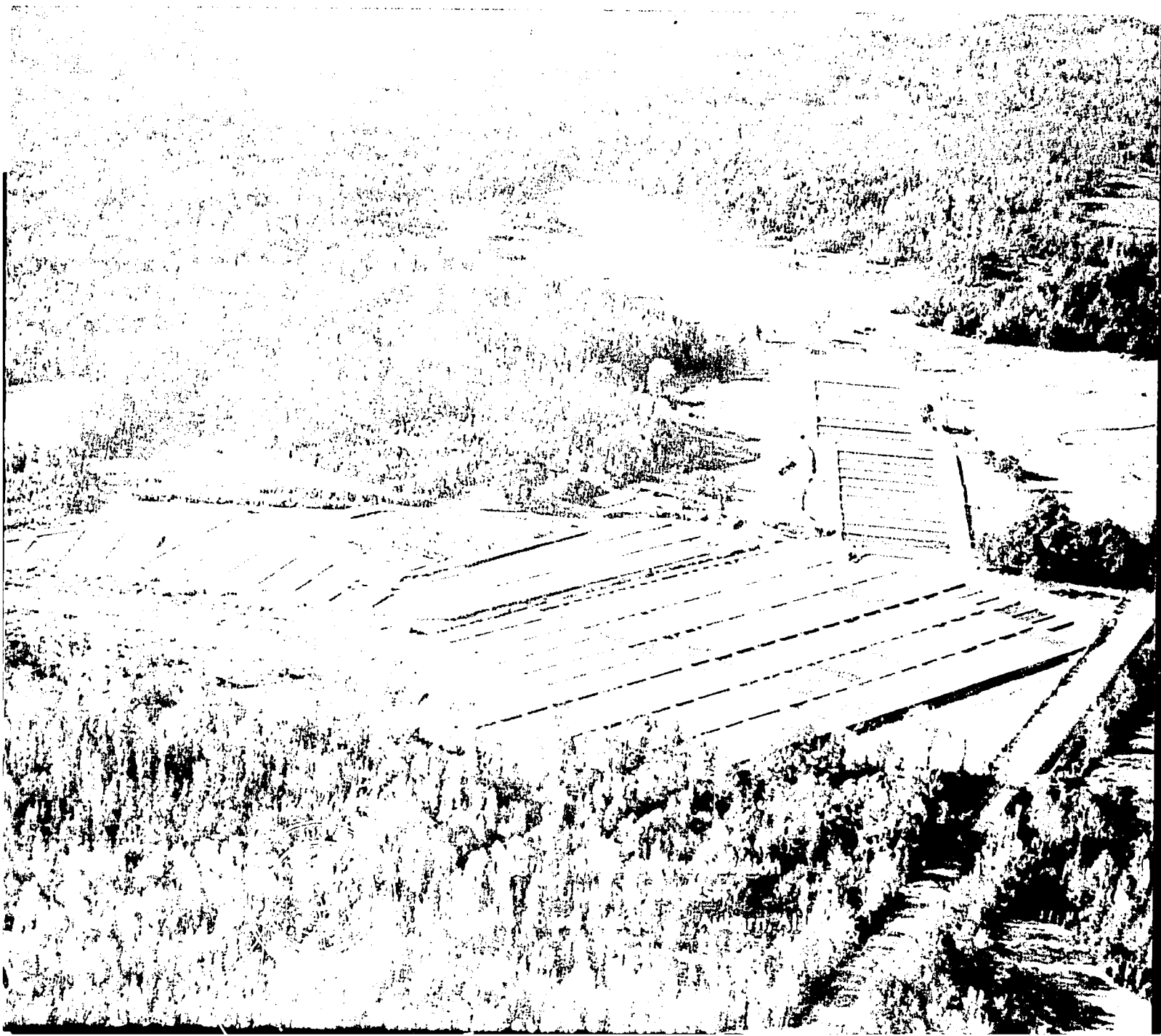

Upper Meta River Fisheries Investigations

Part 3

THE UPPER META RIVER SYSTEM

ORNAMENTAL FISHERY

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Seining for Tigrito (Pimelodus pictus) in the Meta River. Pieces of fish, as bait, are staked to the sandy river bottom near a beach. At 15-20 minute intervals, the site is seined.

Percando Tigritos (Pimelodus pictus) en el rio Meta. Pedazos de pescado son usados como carnada y son estacados en el fondo arenoso del Rio cerca de la playa. Cada 15 o 20 minutos el sitio es chinchorreado.

Temporary storage facility for Tigrito on a Meta River Beach.
Almacenamiento temporal para Tigrito, sobre la playa del Rio Meta.

Dip-netting Brillantes (Hemigrammus armstrongi) in flooded pasture near Villavicencio

Nasas hondas para la captura de "Brillantes" (Hemigrammus armstrongi) en potreros inundudos cevca se Villavicencio.

Ornamental fish warehouse in Villavicercio. Fish are transferred from cement tanks to insulated plastic boxes, lined with form-fitted plastic bags in preparation for trucking to Bogota.

Bodega para peces ornamentales en Villavicencio. Los peces son transferidos de estanques de cemento a bolsas plasticas para ser transportados a Bogota.

TABLE OF CONTENTS

Summary 1

1.0 Introduction 1

1.1 Background 1

1.2 Area Description 3

2.0 Methods 4

3.0 Results and Discussion 6

3.1 The Piedmont fishery 6

3.2 The Savanna fishery 19

3.3 Analyses of catch trends in INDERENA marketing statistics 30

4.0 Recommendations 32

5.0 Literature Cited 38

6.0 Appendices 39

Summary

We estimate that annual harvest of ornamental fish from the upper Meta River system, generally between Villavicencio and Orocue (figure 1), including some catch from head waters of the Muco and Ariari Rivers which are near the Meta River fishing area, is 18,223,700 ornamental fish. These fish provided a gross income to the fishermen of 16,911,032 pesos[1], and an average annual income for the estimated 382 fishermen of 44,270 pesos. Average value per fish was 0.93 pesos.[2]

The 702,192 fish recorded on interview forms (4% of the total estimated annual catch), included 57 species. The most numerous species were Rojitos, Cardenales, Tigrito, Brillantes, Rodostomos and Monedas from the Savanna and Cuch Albina, Corredoras Verde, Brillante, Cucha Negra and Cucha Pina from the Piedmont region.[3] In general, characids dominate the Savanna catch, while loricariids and callichthyids dominate the Piedmont catch.

Of the 57 species of ornamental fish, only three species, the Sapuara, Agujon and Mataguaro could be considered as food fish. The Sapuara is occasionally found in the commercial market, but the Agujon and Mataguaro are not. The Sapuara, because of its small size relative to the majority of Meta River food fish, and because it does not take a baited hook, is very lightly exploited as a food fish. As an ornamental, it is also lightly exploited, contributing only 0.6% of the Savanna catch where its fishery exists. However, because of its great demand and difficulty of capture, unit price is high. Thus the Sapuara contributes 14% to the savanna catch

[1] During 1978, U. S. $1.00 had an average value of 41 pesos.

[2] We noticed no consistent increase in price during the 18 month study, but, during times of scarcity, price increased.

[3] Common and scientific names are given in Appendix I.

economically. There appears to be very little direct competition between the food and ornamental fish industries.

INDERENA's records of ornamental fish marketed from the Meta River indicate that 8 of 52 species listed accounted for 71% of the total number. Four of these showed signs of declines in annual catches through the years 1975-1978. These are Cardenal and Neon Tetras, Apistogramma ramiresi and Cucha, the latter being a general name for Hypostomus (formerly Plecostomus) and similar appearing genera of loricariids.

Local over-exploitation of tetras and Apistogramma may have occurred. Fishermen have shifted their effort to more profitable species and a Tetra fishery near the Inirida River is presently satifying demand for Tetras. The Cucha fishery expanded rapidly in 1974. Popular fishing areas may have been over-fished. Investigations into the condition of stocks of these species are recommended.

The Ornamental Fishery of the Upper Meta River System

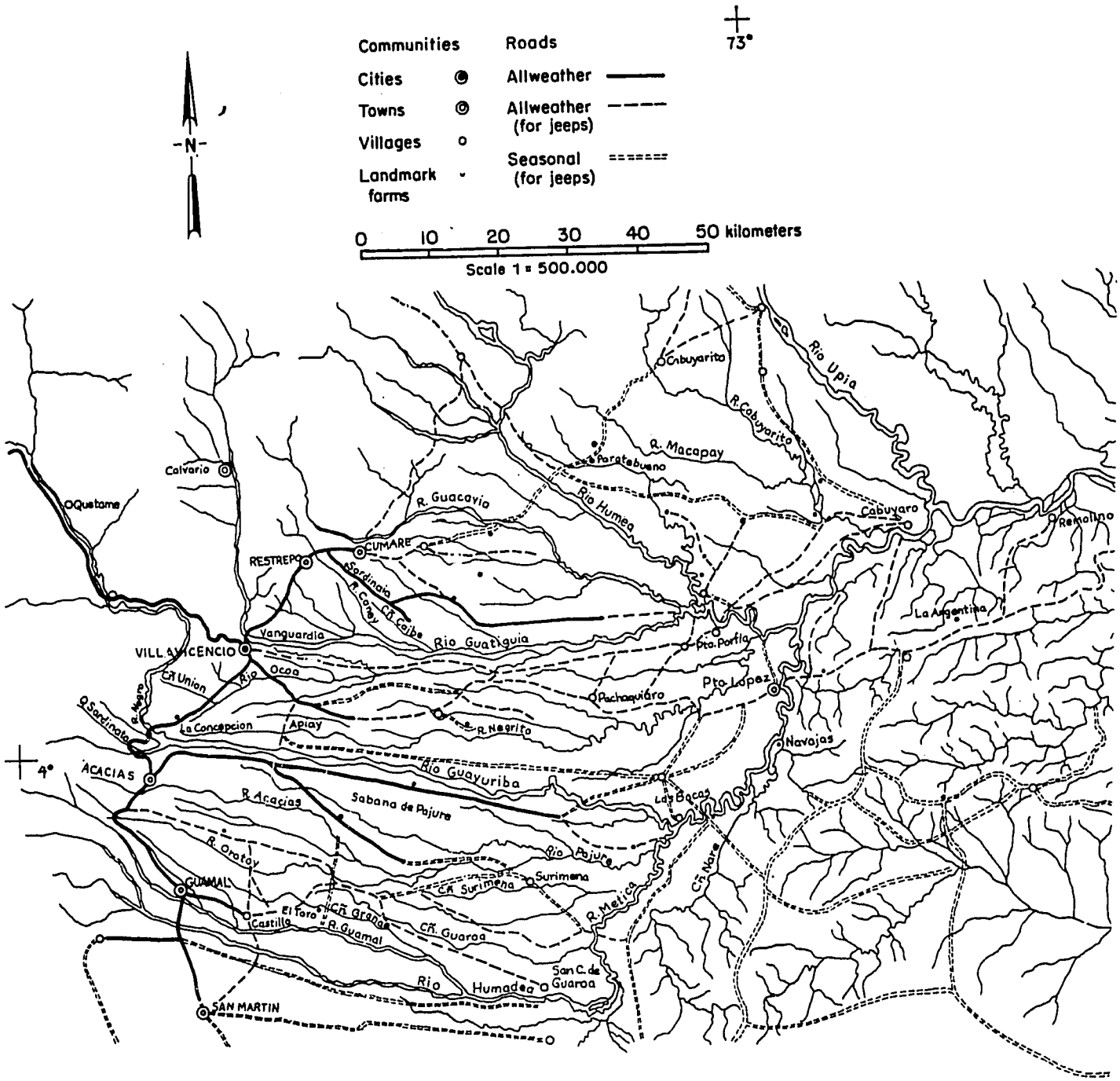
By Richard J. Scully, Maria Cristina Blanco
Fernando Garzan and Marco A. Torres

1.0 Introduction

1.1 Background

Colombia has been harvesting and exploiting ornamental fish for more than 25 years. Although this business begain in the Amazon basin with fish marketed at Leticia, in 1955-56 exploitation also began in the Orinoco basin near Puerto Gaitan in the Upper Meta River area (figure 1). Since then, the Meta River ornamental fishery has developed rapidly, such that 88% of the 34 million ornamentals captured in 1975 came from the Meta River (Borrero, in Morales et al., 1979) and it is generally believed that the Meta River system is Colombia's most abundant source of ornamental fish (Thomerson (1976) and Morales et al., ibid.).

Concern about the effects on tropical fish communities of harvesting millions of ornamental fish (Conference on Exotic Fish and Related Problems, Washington D. C., Feb. 1969) led to a survey of ornamental fishing sites in major exporting countries by Thomerson (ibid.). Concerning Colombia's Orinocian fishery, Thomerson believed that only one percent of water present during the dry season was regularly fished, with perhaps another percent or two being fished occasionally. The fishery was considered conservative in that only a few species from a few localities were exploited. It is worth quoting Thomerson concerning the effects of agricultural development in the


Communities
Cities
Towns
Villages
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Cabuyarito
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Paratebueno
Rio Humea
Cabuyaro
Remolino
Calvario
Quetame
R. Guacavia
CUMARE
RESTREPO
Sardinata
R. Carey
Ca. Caibe
Rio Guatiguia
La Argentina
Pto. Porfia
Vanguardia
VILLAVICENCIO
Ca. Union
Rio Ocoa
Pachaquiaro
Pto. Lopez
R. Negro
Q. Sardinata
La Concepcion
Apiay
R. Negrito
Navajas
ACACIAS
Rio Guayuriba
R. Acacias
Sabana de Pajure
Las Bocas
R. Orotoy
Rio Pajure
Ca. Mare
GUAMAL
Ca. Surimena
Surimena
R. Metica
El Toro
Ca. Grande
Castillo
R. Guamal
Ca. Guaroa
San C. de Guaroa
Rio Humadea
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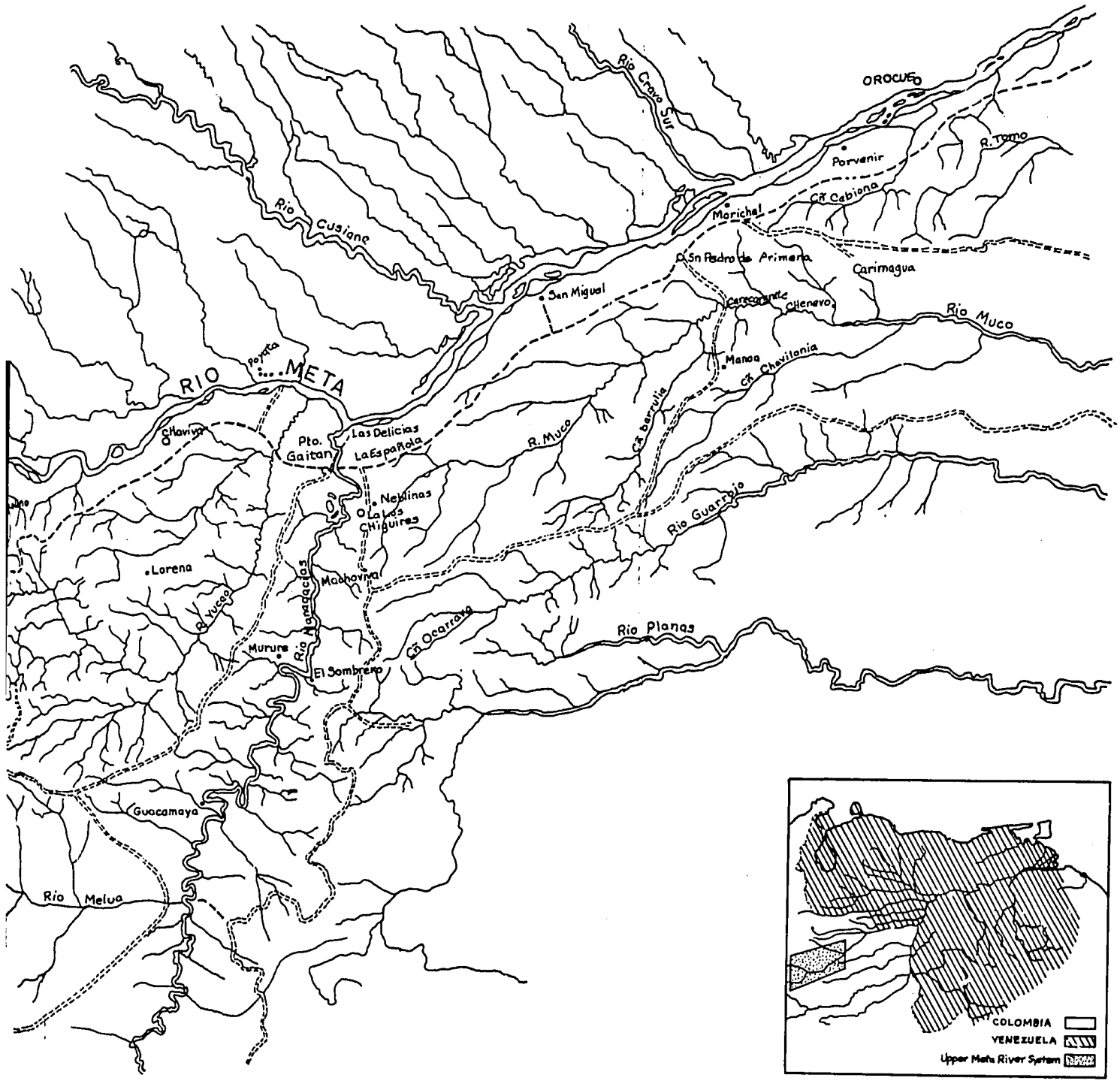
OROCUE
Rio Cravo Sur
R. Tomo
Porvenir
Cª Cabiona
Morichal
Rio Cusiana
Sn Pedro de Primera
Carimagua
San Miguel
Carecarante
Ollenevo
Rio Muco
Manoa
Cª Chavitonia
RIO META
Pto. Gaitan
Las Delicias
La Española
R. Muco
Cª barrulia
Nebilinas
La Las Chiguires
Rio Guarrojo
Lorena
Machovina
R. Yucao
Rio Agua Claras
Cª Ocarrava
Rio Planas
Murure
El Sombrero
Guacamaya
Rio Melua
COLOMBIA
VENEZUELA
Upper Meta River System

piedmont zone near Villavicencio on the ornamental fisheries.

> "The major factor which will determine future development of ornamental fish operations is agricultural development which is proceeding very rapidly in this area. Square miles, which were untouched savanna a few years ago, are now rice fields. There has been extensive ditching and diversion of water into rice field use. There are ten sprayplanes operating out of a small airport between Villavicencio and Pto. Lopez. The stench of spray is strong within a three-mile radius of this airport. A wide array of agricultural pesticides is used in the area and I suspect this as the major reason for any decline in fisheries or fish abundance in the area.
>
> Local people report that extensive fish kills are common in rivers draining the rice fields. Some human deaths have been attributed to drinking of spray-contaminated water. Roads in the area are often flooded and eroded by poorly planned and constucted rice field canals and ditches. Fishermen took us to several supposedly prime fishing spots and shook their heads in amazement to find the stream converted to a rice field ditch.

Available data indicate that land in rice production in the Upper Meta River watershed increased from 16,000 hectares in 1960 to 100,000 hectares in 1975. This trend seems to have continued, and several airports for pesticide sprayplanes were located along the road between Villaricencio and Puerto Lopez in 1978. The authors, as well as the majority of interviewed piedmont fishermen witnessed pesticide induced fish mortalites in 1977 and 1978.

The magnitude of the harvest and value of the industry which employes fishermen, transporters, warehouse operators, biologists and exporters warranted investigation, if for no other reason than to understand its dynamics. Besides this, however, recent trends in INDERENA's annual

records for marketed ornamental fish indicated decreasing catches in the Meta River fishery of some of the more important species.

Thus in 1977, an investigation of the Upper Meta River ornamental fishery was begun by INDERENA as part of a fisheries development plan assisted by a loan from USAID.

The investigations have produced estimates of (1) numerical harvest, (2) species composition and their relative abundance in the catch, (3) spatical (Piedmont verses the Savanna) and seasonal (high water verses low water) characteristics of the fishery. (4) methods of capture, and (5) net economic value of the fishery to individual fishermen and to the fishing community as a whole. Recommendations were made concerning research and management of possibly overfished species.

1.2 Area description

The Upper Meta River ornamental fishery (figure 1) is located in the western 300 km of Colombia's Eastern Plains and is centered around the Meta River, a major tributary of the Orinoco River system. The area is tropical (4° latitude and 400-200 m elevation). Climate is charaterized by wet (April-November) and dry (December-March) seasons and very little temperature change with daily fluctuations exceeding the mean monthly range of 25-28°C. The area can be divided into the piedmont and savanna portions each being unique in species composition, fishing community and collection points.

The Piedmont fishery is located in a west-east band 80-90 kms wide, between the eastern range of the Andes mountains near Villavicencio (population 150,000) and Puerto Lopez, the upper navigable port on the Meta

River. Typical streams are rocky bottomed with moderate to swift current and most originate in the mountains. Such streams are "white water", carrying large quantities of sediment from the mountains to the plains and are cool, 20-24°C. Rainfall, from two to four meters falls annually with amounts increasing near the mountains.

The Savanna fishery is centered around Puerto Gaitan on the Manacacias River, 200 km east of Villavicencio. Puerto Gaitan has 3,000-4,000 inhabitants, most of who are directly or indirectly dependent on the ornamental fishery. The Savanna is generally flat grass-land used primarily for grazing cattle. However, one is seldom out of view of narrow bands of "gallery forest" which line springs, lagoons, streams, and rivers. Nearly all small streams originate from ground water and could be considered "black-water" environments; they are slow moving, clear, but tannic stained from decomposing allochthonous organic matter. They are generally acid (ph = 5.5-6.5 at mid-day) and some contain dense stands of submerged aquatic vegetation. Seasonal rains cause rivers and streams to flood their banks forming the "esteros"[1] habitat which exists during the months of May to October. Water temperature in the Savanna is generally between 24° to 30°C. The Meta River, as it passes through the Savanna, supports an ornamental fishery mainly downstream from its confluence with the Manacacias River. However, only three species are significantly exploited there.

2.0 Methods

Ornamental fishing is done in small streams, flooded grasslands, lagoons, and rivers. Very few species are captured in rivers, however, and

[1]Esteros are referred to as Varzea in Amazon River literature.

most ornamental fishing is carried on in isolated areas such that it would be difficult for an interviewer to find fishermen at fishing sites. However all the ornamental catch must be brought to warehouses in towns where they are sold, and at these points we interviewed fishermen concerning their catch, fishing effort, expenses and income.

We calculated an annual estimate of catch including data from October 1977 until March of 1979, an interval of 18 months, based on estimates of fishing effort (E) and catch per unit of fishing effort (CPE)[5] from two seasons comprising a hydrological year (the high water 214-day season from 10 April to 9 November and the 151-day low water season from 10 November to 9 April). Catch was calculated separately for the two unique fisheries of the Piedmont and Savanna.

During the time interval November 1977 to June 1978 we recorded 59 names of ornamental fishermen from interviews at fish-recieving warehouses in Puerto Gaitan and Villavicencio. Eleven of 38 interviewed fishermen in Puerto Gaitan were licensed as evidenced by their names on a list of license holders examined at INDERENA offices. Five of 21 interviewed

[5]Variance of the ratio CPE was calculated according to Cochran (1963), see appendix II. We used this method since it allows us to use total catch/total effort rather than mean CPE calculated from individual interviews. The former calculation weights each interview proportional to effort. This was desirable since two general types of fishing trips occur ie, those which are of short duration to local fishing sites and have low catch per unit efforts and those of long duration to distant sites having high CPE. The former type is by far the most numerous and therefore the most frequently encountered in interviews, while the latter type are rarely interviewed but make a large contribution to the total catch estimate.

fishermen from the Villavicencio area were licensed. There were 52 licensed fishermen in Puerto Gaitan and 48 in Villavicencio.

By proportion, we estimate that there are 38/11 times 52 or 180 fishermen in the Puerto Gaitan region and 21/5 times 48 or 202 fishermen in the Villavicencio area. Three hundred eighty-two ornamental fishermen within the upper Meta River study area is probably a minimum estimate since some fishermen do not come to the towns but send their fish in with one or two members of their fishing party. Those not transporting fish are the least likely to purchase licenses or to be interviewed.

3.0 Results and Discussion

3.1 The Piedmont Fishery

Annual catch from the Piedmont was estimated at 7,353,790 fish of which 74 and 26 percent were captured during the high water and low water seasons, respectively. However, due to the high price of one species, the Cucha Real, which is captured almost entirely during low water, 51% of the 8,837,060 pesos annual gross value was obtained from the low water catch (Table 1).

Two hundred and two fishermen fished the Piedmont waters and had an average daily catch of 172 fish (136 pesos) during high water and 116 fish (270 pesos) during low water. Fishermen fished 73% of days during high water and 55% during low water (Table 1). During low water, transportation to fishing areas is easier, weather is more accommodating to field work and fish are more concentrated and easier to catch. Fishermen fish less in this season, possibly because the larger daily income from catches results in less need to work.

In the Piedmont fishery the average fishermen supports five people, is 33 years old and has been fishing for ornamentals 8 years. Eighty percent of fishermen said they fished throughout the year, sixty-nine percent said they had other sources of income, the most common source being farming.

Eighty percent of fishermen traveled to fishing sites by public bus while 12% used bicycles and 8% walked. Weekly transportation costs averaged 247.5 pesos during the rainy season and 221.25 pesos in the dry season. Weekly costs for tranporting fish (at 4 pesos per plas ic bag) were 61 pesos in the wet season and 50 pesos in the dry season. Total annual transportation cost is estimated at 15,395 pesos. Estimated annual material costs for fishing gear (seines, 311 pesos; dip nets, 262 pesos; diving face mask, 158 pesos; cast nets, 60 pesos; and 200 pesos for plastic bags) was 791 pesos, for an annual total cost of 16,386 pesos. Total annual income of 43,748 pesos minus costs leaves a net annual income of 27,362 pesos. This can be considered a low annual salary, similar to what one would earn as a day-laborer in the Villavicencio area.

Common fishing equipment are the seine, dip net, and diving mask. The latter gear is used by fishermen who dive for Loricariids and pull them by hand from rocks and submerged logs. This gear is not used in the Savanna fishery.

In 1973 Tomerson (ibid) found that the Piedmont fishery was mainly in areas 60-100 miles (100-170 kms) from Villavicencio and that little fishing

[6] Annual costs for materials was based on the average useable life of the materials.

took place near the city.

At the time of the present study, a significant number of fishermen traveled daily from Villavicencio to fishing areas by foot or bicycle. Fishing, especially in the wet season, is mostly done in waters near Villavicencio, such as the Rivers Ccoa, Guatiquia, Guacavia, their tributaries and adjacent lagoons. During low water (the dry season), more distant fishing trips and of longer duration (3 to 5 days) are made. This latter system is more common during the dry season as weather is better for transport and camping. Also, the valuable Cucha Real, which lives in the larger rivers more distant from the mountains, is captured by skin diving among sunken tree trunks. This can be accomplished only when water current is reduced and visibility is greatest, i.e., the dry season.

Eighteen ornamental species were captured in the Piedmont during the present study (Table 2). Seven species were loricariids, three gymnotoids, three cichlids, two callichthyids, two characids and one pimelodid.

Numerically the loricariids are the most important group; being 44% of the total in both high and low water catches. Monetarily, the two corresponding percentages for the loricariid family are 50.7% and 87.2% for high and low water fisheries, respectively.

The species compositions in the catch are distinct for each of the high and low water seasons (Table 3 and 4). The most important species during high water are Cucha Albina, Coryedora Verde, and Brillante, the former being the most important numerically and monetarily.

During low water, the Brillante, Cucho Negra and Cucha Pina are captured in the greatest numbers. However, the Cucha Real, due to an

exceptionally high unit price is the most important species economically (57.9%). This species and the Cucha Pina are not marketed during the high water season.

Considering the available water sources in the Piedmont, only a small percentage of the area included fishing sites identified by fishermen responding to interviews. During high water, the Ocoa, Humadea, Guatiquia, Guacavia and Negro Rivers were mentioned as fishing sites. Relative catch compositions are listed for these areas (Table 5). There is much similarity in the composition of species found in the Rivers Ocoa, Negro, Guatiquia and Guacavia. During low water, an additional fishing area, the Pajure River, was mentioned. Catch from there was entirely Cucha Real (Table 6).

Table 1. Catch and fishing effort in the Piedmont ornamental fishery. Standard error (SE), relative standard error (RSE) and sample size (n) are given where applicable.

Number of Fishermen - 202

	Estimate	SE	RSE	N
Number of days/season				
High water	214			
Low water	151			
Number of fishing days/fisherman				
High water	156	7.0	4.5%	15
Low water	83	21.4	25.8%	13
Number of fish captured daily/fisherman				
High water	171.7	22.7	13.2%	22
Low water	115.9	51.3	44.3%	13
Daily income/fishermen in pesos				
High water	136.60	21.9	16.0%	22
Low water	270.34	71.6	26.5%	13
Total catch (Numbers)				
High water	5,410,610	711,541	13%	
Low water	1,943,179	860,599	44%	
Annual	7,353,789	1,572,140	21.4%	
Total value in pesos to the fishermen				
High water	4,304,539	690,743	16.0%	
Low water	4,532,520	1,200,278	26.0%	
Annual	8,837,059	1,891,021	21.4%	

*The RSE expresses the SE as a percentage of the estimate and is a measure of the estimate's precision.

Table 2. Ornamental fish species caught in the upper Meta River system in the Piedmont and Savanna fisheries

Species	Savanna Low Water	Savanna High Water	Piedmont Low Water	Piedmont High Water
Rodostomo	X	X		
Sapuara	X	X		
Juan viejo	X	X		
Moneda	X	X		
Cuchillo carapo	X	X		
Rubi	X			
Corunta	X			
Lisa	X	X		
Luchillo caballo	X			X
Leporino	X	X		
R.R. rayado	X			
Ramiresis	X	X	X	
R.R. negro	X			
Torito	X	X		
Satena	X	X		
Catalina	X			
Mataguaro	X	X		X
Corredora	X	X	X	X
	X			
Sierra	X	X		
Cuchillo	X	X	X	X
Cucha	X		X	X
Coli rojo	X	X		
Rojito	X	X	X	
Mojarra	X	X		
Cardenal	X	X		
Chilodus	X	X		
Arari	X	X		
Festivum	X	X		
Tigrito	X	X		
Pico rojo	X	X		
Cuatro lineas	X	X		
Dos puntos	X	X		
Tijero	X	X		
Agujon	X	X		
Copeina	X	X		
Cuchillo "7"	X	X		
Brillante	X	X	X	X
Estrigata	X			
Estrifaciata	X			

Table 2. (continued)

Species	Savanna Low Water	Savanna High Water	Piedmont Low Water	Piedmont High Water
Jiboso	X	X		
Neon	X	X		
R.R. comun	X			
R.R. de punto	X			
Guacamaya		X		
Cuchillo oso		X		
Rosita		X		
Cucha albina				X
Loricaria			X	X
Lapicero			X	X
Corroncho			X	X
Corr. metae			X	X
Cuchillo negro			X	X
Corredora verde			X	X
Cucha real			X	
Pacamu			X	
Cucha pina			X	

57 species.

Table 3. Relative abundance and nonetary value by species in the Piedmont fishery during the high water season. Data are from 24 interviews.

Species	Frequency in Interviews	Number	Average Value Pesos	Total Value Pesos	% by Number	%Monetary Value
Cucha albina	12	2934	1.00	2934	31.8	39.2
Loricaria	6	209	0.36	75	2.3	1.0
Lapicero	6	594	0.80	474	6.4	6.3
Cuchillo	1	43	1.50	65	0.5	0.9
Brillante	3	1300	0.60	780	14.1	10.4
Corredora	2	450	0.93	420	4.9	5.6
Corocoro	2	45	2.00	90	0.5	1.2
Cuchillo caballo	1	1	5.00	5	-	0.1
Cucha (negra)	5	324	0.69	223	3.5	3.0
Corr. metae	4	649	0.52	337	7.0	4.5
Cuchillo negro	1	14	1.50	21	0.2	0.3
Mojarra	1	30	0.40	1	0.3	-
Mataguaro	1	80	1.00	8	0.9	0.1
Corr. verde	4	2550		2040	27.6	27.3
Totals		9223		7477		

Table 4. Relative abundance and monetary value by species in the Piedmont fishery during the low water season. Data are from 13 interviews.

Species	Freq.	Number	Average Monetary Value in Pesos	Total Value in Pesos	% Nos.	% Economic Value
Cucha real	4	820	30.378	24910	4.4	57.9
Cucha (negro)	6	3090	0.842	2601	16.5	6.0
Brillante	3	7100	0.503	3570	38.0	8.3
Corr. verde	2	38	1.197	45	0.2	0.1
Loricaria	3	112	0.477	53	0.6	0.1
Lapicero	3	880	0.902	794	4.7	1.8
Corocoro (corroncho)	4	422	1.50	633	2.3	1.5
Corrodora	1	100	1.15	115	0.5	0.3
Pacamu	1	100	0.70	70	0.5	0.2
Apistograma, Ramiresis	1	100	0.60	60	0.5	0.2
Cuchillo	2	50	1.00	50	0.3	0.1
Corr. metae	4	870	0.80	696	4.7	1.6
Rojito	1	2000	0.40	800	10.7	1.9
Cucha pina	4	2980	2.887	8603	15.9	20.0
Itui (cuchillo negro)	1	35	1.50	53	0.2	0.1
Totals		18,697		43,053		

Table 5. Fishing sites and species captured during high water in the Piedmont fishery.

Ocoa River (la union, Apiay)

n = 2398 fish

	%
Brillante	33.4
Cucha albina	22.1
Corredora metae	19.3
Cucha negra	9.3
Corredora sp.	6.3
Loricaria	4.1
Mataguaro	3.3
Lapicero	1.6
Cuchillo negro	0.6

Negro River (Pachaquiaro)

n = 757 fish

	%
Corredoras supp.	39.6
Corredora verde	26.4
Loricaria	9.2
Cucha negra	7.9
Corroncho	5.9
Lapicero	5.9
Corredora meta	4.8
Cuchillo caballo	0.1

Guatiquia, Guacavia Rivers (La cuncia, Cumaral)

n = 1138 peces.

	&
Lapicero	43.9
Cucha albina	41.7
Corr. verde	4.4
Cuchillo	3.8
Loricaria	3.5
Mojarra	2.6

Humadea River

n = 500

	%
Cucha albina =	100.o

Table 6. Fishing sites and species captured during low water in the Piedmont fishery.

Ocoa River (Cano Sucio, San Carlos de Guaroa)

n = 1877

	%
Corredora meta	27.7
Cucha negra	20.8
Lapicero	16.0
Brillante	10.7
Corredora supp.	5.3
Pacamu	5.3
Ramiresis	5.3
Corocoro	2.8
Loricaria	2.7
Cuchillo	2.7

Humadea River

n = 5285

	%
Cucha negra	36.0
Brillante	36.0
Cucha pina	18.9
Corocoro	2.8
Corredora meta	2.8
Cucha real	2.8
Corredora verde	0.4
Loricaria	0.2

Guatiquia y Guacavia Rivers (Cumaral - Restrepo)

n = 8.335

	%
Brillante	60.0
Rojito	24.0
Cucha negra	9.6
Corrdora meta	2.4
Lapicero	1.8
Cucha pina	1.2
Loricaria	0.6
Cuchillo negro	0.4

Pajure River

n = 500

	%
Cucha real	100.0

3.2 The Savanna Fishery

Fishermen caught 10,868,580 fish for which they received 8,073,972 pesos, an average of 0.74 pesos per fish. The majority of the catch in both numerical (55%) and monetary (59%) terms was harvested during the high water season (Table 7).

On hundred and eighty ornamental fishermen fished the Savanna and had average daily catch per fisherman- day of 255 fish (204 pesos) during high water season and 307 fish (206 pesos) during the low water season. They fished 61% of the days during high water and 58% during low water.

In the Savanna, an average fisherman supports 5 family members, is 31 years old and has been fishing 6 years. Fifty-one percent said ornamental fishing was their only occupation. Eighteen percent also farmed, 9% fished for food-fish, 5% worked with cattle and 18% did various jobs in the Puerto Gaitan area.

Seventy-seven percent of fishermen said they fished the year round with the remaining 23% fishing only during low water. However, we found that 24% of interviewees who were actively fishing during high water said they only fished during low water. Therefore, it appears that even this group fishes during high water but possibly less frequently than during low water.

The average fishing group size was 3 or 4 ($\bar{x}$ = 3.38) fishermen. Seventy-eight percent of interviewees used canoes as a means of transport to and from the fishing sites. Fourteen percent went by foot and 8% rented jeeps or trucks. Most canoes, 85%, were not motorized. Annual expenses per fisherman for materials averaged 808 pesos (428 pesos for seines, 127 pesos for dip nets, and 253 pesos for the canoes). Those going by foot would have annual material expenses for 555 pesos. Plastic bags and cartons are usually provided by the buyers.

Fishermen using motorized transport had much larger expenses. However, much of these costs were paid by the fish buyers in Puerto Gaitan. For instance, a motorized canoe costing about 40,000 pesos and using 600 pesos per week in gasoline and oil, plus maintenance costs, would be assigned to a group of fishermen by a buyer who would direct them to fish in specific distant areas for certain species and to buy fish from other fishermen. This arrangement is especially common in the Meta River Tigrito fishery.

Fishermen who travel by car (usually to the Cardenal Tetra areas of the Muco River) are often sent by buyers who pay transport costs. Only 8% of fishing trips are done by car which indicates that the Tetra fishery may be economically marginal, possibly becuase land-transport is required. The average cost of a round trip in a rented Jeep to Cano Caracarate is $1,550 or the value of more than 5,000 Cardenal Tetra. Nearly all Cardenal Tetra are brought to Puerto Gaitan by car.

We consider the average annual cost of material as 808 pesos per fishermen, i.e., the cost estimated for those fishing from a non-motorized canoe. Savanna fishermen fish an average of 219 days per year. Considering 120 pesos per day as an income which could be earned in non-skilled jobs in the Puerto Gaitan area, the average fisherman invests about $26,280 in labor annually in the fishery. Therefore, his total cost of labor, materials and opportunitycost in materials (about 18% in Puerto Gaitan Caja Agraria) is 27,233 pesos.

Average gross annual income is 44,917 pesos which is 1.65 times the Hedmont fishermen income and can be considered adequate especially for the majority of fishermen who also earn income from other sources.

The most abundant species in the Savanna ornamental fish catch during the high and low water seasons were: Cardenal Tetra, 30% and 14%; Rodostomo, 15% and 7%; Tigrito, 14% and 9%; and the Rojito at 6% and 18% respectively (Tables 8 and 9).

Species of large value economically are the Tigrito 40% and 29%, the Sapuara 13% and 15%, and Cardenal Tetra 11% and 4%, from high and low water catches, respectively.

Economically and numerically there was a large difference in relative value since the unit value of the Sapuara (about 20 pesos each) is about 60 times that of the cardenal tetra.

Numerically, slightly over 50% of the catch marketed in Puerto Gaitan is from the Muco River, a head water tributary of the Vichada River, which has many small streams and lagoons near the Manacacias and Meta River vallies (Tables 10 and 11). However, the majority of the Muco River catch is of Cardenal, Neon, and Rojito, species for which a very small unit price is paid, about 0.30 pesos. In the Manacacias system the fishing is done mostly in streams and lagoons during the dry season, and in flooded savanna "esteros" in the rainy season. Almost no fishing is done in the Manacacias River itself. The system is rich in ornamental species, with 30 being recorded during the study. This area produced the majority of important species such as the Sapuara and Moneda.

The main Meta River fishery differs from others in the study in that most fishing is done in the river itself rather than in affluent streams or flooded back waters. The majority of the catch is "Tigrito" the valuable pimelodid catfish which is only fished in the main Meta River. Two additional species, Cuatro Lineas and Dos Puntos, are caught incidental to the Tigrito fishery but usually are less than 10 percent of the catch.

Table 7. Catch and Fishing Effort in the Savanna Ornamental Fishery. Standard error (SE), relative standard error (RSE), and sample size (n) are given where applicable.

Number of Fishermen = 180

	Estimate	SE	RSE*	n
Number of days/season				
High water	214			
Low water	151			
Number of fishing days/fisherman				
High water	130.5	5.0	3.8%	51
Low water	88.2	4.7	5.3%	30
Number of fish captured daily/fisherman				
High water	255.2	73.8	28.9%	58
Low water	307.0	120.7	39.3%	26
Daily income/fishermen in pesos				
High water	204.35	37.2	18.2%	58
Low water	206.21	32.1	15.6%	26
Total catch				
High water	5,994,648	1,733,562	28.9%	
Low water	4,873,932	1,916,233	39.3%	
Annual	10,868,570	3,649,795	33.6%	
Total value in pesos to the fishermen				
High water	4,800,182	873,828	18.2%	
Low water	3,273,790	509,620	15.6%	
Annual	8,073,972	1,383,448	17.1%	

*The RSE expresses the SE as a percentage of the estimate and is a measure of the estimate's precesein.

Table 8. Relative abundance and monetary value by species in the Savanna fishery during the high water season. Data are from 66 interviews.

Species	Frequency of Mention	Number	Average Value (Pesos)	Total Value (Pesos)	% Numbers	% Monetary Value
Chilodus	25	7,785	0.45	3466	2.5	1.3
Coli rojo	6	4,100	0.40	1648	1.3	0.6
Ramiresis	18	16,120	0.36	5819	5.1	2.2
Cuchillo carapo	5	620	1.60	372	0.2	0.1
Pico rojo	3	7,300	0.43	3117	2.3	1.2
Moneda	29	37,920	0.76	2893	12.1	10.9
Tijero	11	3,635	1.22	4427	1.2	1.7
Juan viejo	12	6,574	1,28	8448	2.1	3.2
Festivum	7	440	0.70	308	-	0.1
Leporino	3	290	1.69	490	0.1	0.2
Bocon (mataguaro)	5	1,124	0.87	981	4	0.4
Arari	7	768	2.10	1614	0.2	0.6
Lisa	2	103	1.02	105	-	-
Custro lineas	7	641	0.88	562	0.2	0.2
Sapuara	19	2,281	14.5	33136	0.7	12.5
Agujon	6	722	5.00	3610	0.2	1.4
Sierra	3	337	0.64	217	0.1	0.1
Rojito	11	18,420	0.335	6167	5.9	2.3
Rodestomo	14	46,455	0.36	16852	14.8	6.4
Guacamaya	1	1	4.00	4	-	-
Mojarra	10	7,071	0.37	2623	2.2	1.0
Cuchillo	9	6,220	0.49	3064	0.2	1.2
Tigrito	12	43,780	2,42	105825	13.9	40.0
Torito	1	20	1.00	20	-	-
Cardenal	7	93,900	0.31	29112	29.9	11.0
Brillante	2	3,120	0.40	1236	0.1	.5
Cachillo oso	2	20	0.63	13	-	-
Rosita	1	200	0.20	40	0.1	-
Cuchillo "7"	1	300	0.70	210	0.1	0.1
Dos puntos	3	380	1.15	436	0.1	0.2
Satena	2	1,100	1.00	1100	0.4	0.4
Corredora	2	1,800	0.28	510	0.6	0.2
Copeina	1	400	0.20	80	0.1	-
Neon	1	120	0.30	36	-	-
Jibose	1	200	0.30	60	0.1	-
Totals		314,267		264640		

Table 9. Relative abundance and monetary value by species in the savanna fishery during the low water season. Data are from 40 interviews.

Species	Frequency of Mention	Number	Average Value (Pesos)	Total Value (Pesos)	% Numbers	% Economic Value
Rodostomo	5	23.700	0.628	14.880	6.7	0.5
Sapuara	12	1.732	26.535	45.959	0.5	14.8
Juan viejo	3	400	1.50	600	0.1	0.2
Moneda	6	750	2.478	1.853	0.2	0.6
Cuchillo carapo	1	50	1.50	75	-	-
Rubi	2	7.000	0.186	1.300	1.9	0.4
Corunta	2	3.210	1.00	3.210	0.9	1.0
Lisa	2	130	0.677	88	-	-
Cuchillo caballo	1	8	0.8	6	-	-
Leporino	1	40	1.0	40	-	-
R.R. rayado	3	4.015	1.751	7.030	1.1	2.3
Ramiresis	8	4.830	0.398	1.922	1.3	0.6
R.R. negro	1	1.000	0.50	500	0.3	0.2
Torito	3	750	0.507	380	0.2	0.1
Satena	1	30	0.70	21	-	-
Catalina	3	5.502	0.582	3.201	1.5	1.0
Mataguaro	2	15	1.0	15	-	-
Correaora	6	5.654	0.487	2.754	1.6	0.9
Otocincol	4	4.800	0.454	2.180	1.3	0.7
Sierra	1	150	1.50	225	-	0.1
Cuchillo	8	18.400	0.241	4.433	5.1	1.4
Cucha	5	30.151	1.004	30.271	8.4	9.8
Coli rojo	2	6.000	0.3	1.800	1.7	0.6
Rojito	11	64.900	0.427	27.690	18.0	8.9
Mojarra	1	1.000	0.40	400	0.3	0.1
Gardenal	4	49.500	0.245	12.150	13.7	3.9
Chilodus	3	650	0.992	645	0.2	0.2
Arari	16	5.194	2.545	10.675	1.4	3.4
Festivum	3	740	1.284	950	0.2	0.3
Tigrito	11	32.705	2.723	89.072	9.1	28.8
Pico rojo	1	500	0.30	150	0.1	-
Cuatro lineas	11	2.274	1.048	2.384	0.6	1.8
Dos puntos	11	2.605	1.359	3.539	0.7	1.1
Tijero	5	720	0.990	713	0.2	0.2
Agujon	2	30	6.333	190	-	0.1
Copeina	3	5.750	0.370	2.125	1.6	0.7
Cuchillo "7"	1	20	0.50	10	-	-
Brillante	8	23.100	0.268	6.194	6.4	2.0
Estrigata	7	18.700	0.388	7.253	5.2	2.3
Estrifasciata	1	5.000	0.20	1.000	1.4	0.3
Jiboso	1	1.000	0.40	400	0.3	0.1
Neon	1	20.000	0.20	4.000	5.6	1.3
Rique-Raque Comun	1	6.000	2.50	15.000	1.7	4.8
Rique-Raque Comun	2	1.300	1.923	2.500	0.4	0.8
totals		360.005		309.788		

Table 10. Fishing sites during the low water season within the Savanna fishery and species compositions.

Muco River(Cn Caracarate, Cumaribo)

	%
Cardenal	40
Neon	18
Rojito	17
Rubi	7
Estrigata	7
Brillante	5
Estrifasciata	4
Ramiresi	1
Jiboso	1

Manacacias River(cano, lagunas, esteros)

	%		%
Rojito	22	Saguara	1
Rodostome	21	Festivum	1
Rubi	11	Chilodo	1
Otocinclo	7	Corredora spp.	1
Cardenal	7	Tijero	1
Arari	5	Copeina	1
Coli rojo	5	Cuatro lineas	1
Copeina	5	Cuchillo Transp.	1
Riqui Raque Comun	2	Agujon	1
Dos untos	2	Festivum	1
Mojarra	2	Juan Viejo	1
Riqui Raque Negro	2	Moneda	1
Torito	2	Lisa	1
Cuchillo carapo	1	Satena	1

Manacacias River (cano, lagunas, esteros)

	%		%
Catalina	1	Mataguaro	1
Cucha	1	Sierra	1

Table 11. Fishing sites during high water in the Savanna fishery and species compositions.

Muco River(Cn Caracarate, Chenevo, Hato Palito, Penal y Cholocolo)

	%
Cardenal	64
Rodostomo	19
Rojito	7
Juan viejo	4
Brillante	2
Mojarra	2
Satena	1
Bocon	1
Neon	1
Ramiresi	1

Manacaias River (lagunas, canos y esteros)

	%		%
Rodsetomo	27	Festivum	1
Moneda	24	Lisa	1
Coli rojo	9	Juan viejo	1
Pico rojo	7	Sierra	1
Mojarra	6	Leporino	1
Chilodo	5	Torito	1
Ramiresi	5	Cuchillo oso	1
Tijero	3	Rosita	1
Sapuara	3	Cuchillo "7"	1
Rojito	2	Corredora supp.	1
Cuchillo transp.	2	Dos puntos	1
Cuatro lineas	1	Jiboso	1
Agujon	1		

Table 11. (continued)

Meta River (Aqua Verde, Buramas, Orocue, San Miguel)

	%
Arari	1
Cuchillo carapo	1
Mataguaro	1
Copeina	1
Tigrito	79
Cuchillo	20
Dos puntos	1

Rio Meta - esteros

	%
Moneda	84
Chilodo	6
Sapuara	4
Tijero	3
Cuchillo Transp.	3
Cuchillo Oso	1

3.3 Analyses of catch trends in INDERENA marketing statistics

We examined the Meta River ornamental fish catches from INDERENA files for the years 1973-1977 (Table 12). There were 52 classes (common names) and a group of "various species" listed in the catch. Eight of the classes totaled 71% of the approxmiately twenty million fish which were caught annually. These were cuchas, 16%; Brillantes, 14%; Cardenal tetra, 10%; Corydoras, 10%; Tigrito, 9%; Rojito, 8%; Ramiresi, 2%; and neon, 2%. Of these important groups we found general trends of declining catch in four species (Figure 2).

The ornamental catch doubled from 1973 to 1974, from 10,381,000 to 21,271,000 fish, and from 1975 onward, catches for Cucha, Cardenal, Neon Tetras, and Ramiresi consistently declined. Linear regressions from 1974-77 data describe the annual decreases and can be used to predict future catches if trends remain the same.[7]

		r^2
Cucha	$Y = 14{,}961{,}542 - 147{,}054\ X$	0.56
Cardenal	$Y = 31{,}544{,}953 - 381{,}863\ X$	0.79
Ramiresi	$Y = 3{,}914{,}639 - 44{,}768\ X$	0.94
Neon	$Y = 11{,}900{,}000 - 150{,}000\ X$	0.74

Where Y = the annual numerical catch

and X = the year of the catch as a two digit number

i.e., 74 for the year 1974.

[7]Data used for 1978 values are questionable because of their sharp decrease from previous years. Possibly, data was incomplete where we recorded the values, hence 1978 values were not included in calculating the linear regression equations.

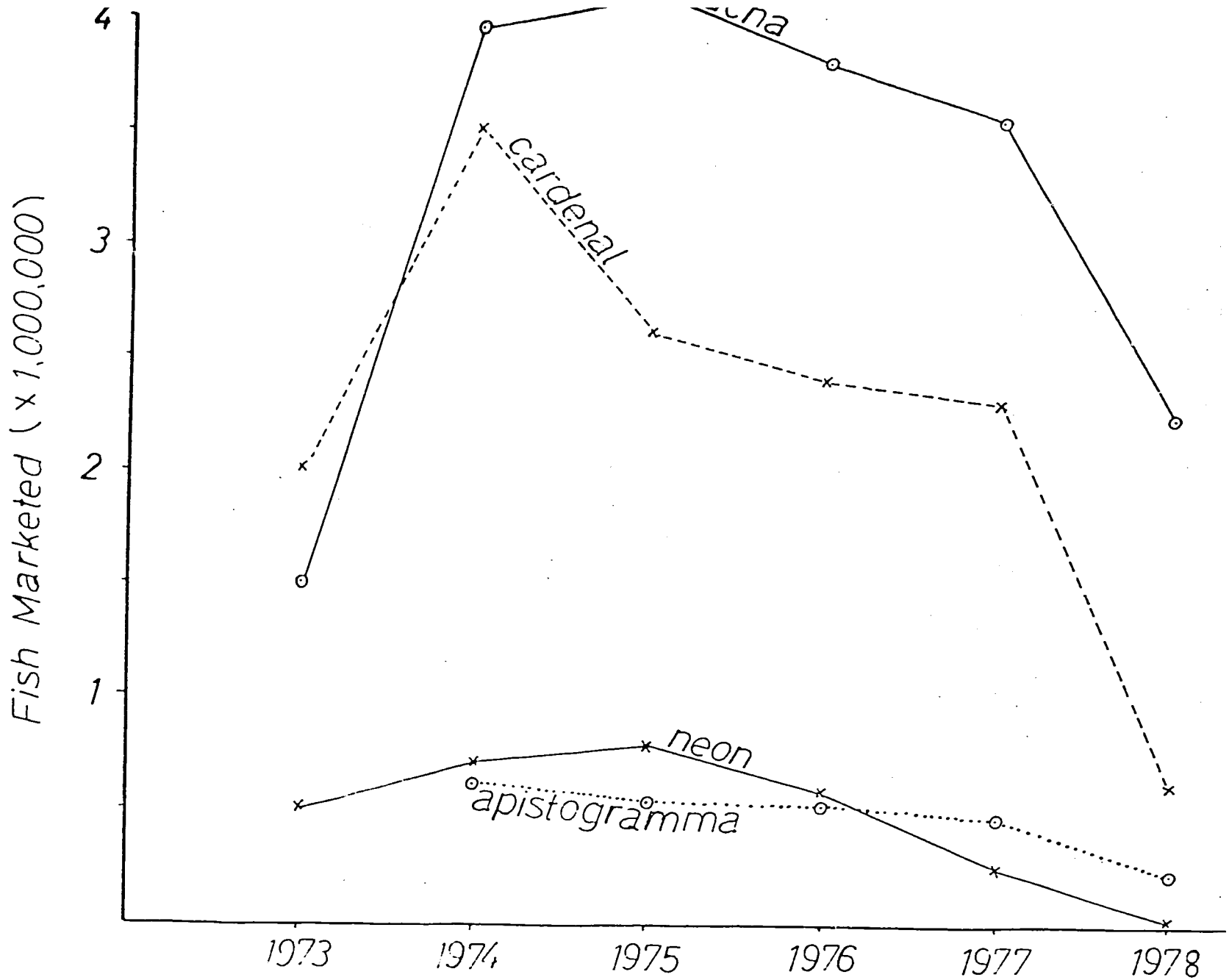

Figure 2. Number of four important ornamental fish species marketed annually from the Upper Meta River system. The 1978 values may be low since these data were extracted from monthly summary forms rather than from annual reports as were the previous years' values. Possibly the 1978 data were incomplete. Source: INDERENA statistics reports.

Catch of Cardenal Tetra declined most rapidly. Possibly, fishermen had begun shifting fishing effort towards more valuable species, since the Cardenal commands a very low unit price. Also the Cardenal fishing sites near Puerto Gaitan may have been heavily fished, and it may have been only marginally profitable to make distant trips by vehicle to fish for Cardenals. Also, other fisheries, centered around Puerto Carreno at the mouth of the Meta and Puerto Inirida of the lower Inirida River may have satisfied most of the demand for Cardenals at a lower price. Jorge Morales, a biologist and representative of Alcopeces, an organization of Colombian fish exporters, told us that this latter hypothesis has basis in fact. Addition of data for 1978 indicate even more dramatic declines in catch from the upper Meta fisheries. Part of this latter decline can be attributed to irregular data collection as no INDERENA inspector was present in Puerto Gaitan during most of November and December 1978. Stocks of the Cardenal Tetra and its less abundant twin, the Neon Tetra should, however, be investigated. Recommended investigations are described in Section 4.

The reported reduction in Cucha catches may in part be caused by the improved identification of species in recent years. For instance, fish which once were listed as Cuchas on salvoconductos may now be classified as Cucha Albina, Cucha Pina, Cucha Negra, Panaque, Corocora, Corroncho, Plescostomo, etc.

The Cucha fishery is generally located within 20-50 km of Villavicencio and several years of intense local fishing may have reduced stocks and catch per unit of effort. It is interesting to imagine, however, that the relative large number of Cuchas which continue to be caught (nearly 3 million annually) may be due to artifically high carrying capacities of the Guatiquia

and other Piedmont rivers which receive much organic enrichment from the sewage affluents of Villavicencio, Acacias, Restrepo, etc. Investigative fishing in some of the many unexploited streams of the Piedmont by experienced cucha fishermen may aid in determining if traditional fishing areas are overfished and may discover new fishing grounds. The decrease in Ramiresi, a Savanna species, is probably due to economic overfishing in the outskirts of Puerto Gaitan. It may be possible to study populations of Ramiresi and the Tetras simultaneously.

If, in the future, it is decided that reduction in fishing effort for certain species is warranted to allow populations to rebuild, restrictions by season on individ al species or size groups should be set. Catch restriction during the nursery stage would reduce the catch of small immature stages ,which generally receive low prices and suffer high mortality rates during the marketing process. Placing overfished areas into no-fishing zones until populations recover is another possible way to facilitate population recovery but, this would be difficult to enforce.

However, by comparing what appears to be an endless number of rivers, streams, and lagoons in the Upper Meta River system, to those reported in interviews, (Tables 4, 6, 10, and 11) it appears that only a very small fraction of the area is being exploited. This view coincides with Thomerson (ibid) who believed that "less than 1% of Colombia's Orinoquia waters during the dry season are regularly fished and perhaps another one or two percent are fished on an occasional or irregular basis." Morales et al. (ibid) describes stories from various fishermen of the Eastern Plains indicating that at distant locations i.e., farther away than fishermen usually travel to fish, probably because of financial limitation, or because an adequate

supply of fish exists closer, there are dense populations of exploitable ornamental fish.

It seems reasonable to assume that the only overfishing that exists is local, near the centers of Puerto Gaitan and possibly Villavicencio and that as nearby populations are reduced, it will become more economical to move to more distant areas. The price of fish may have to increase to pay for increased transportation costs.

It also seems logical that aquaculture schemes should develop in the plains to mass produce, at hopefully reduced cost, many of the sought after species such as the Sapuara, Cucha Real and Cardenal Tetra This would alleviate any real or imagined problem of over exploiting wild populations. Since the results of studies into aquaculture techniques would benefit only a few persons who own the facilities, it is hoped that reasearch will be funded by these private investors.

Recommendations

1. Relative stock density analysis in fished and unfished areas should be made to determine intensity of fishing at traditional fishing sites and the geographical extent of the resources in relation to the areas presently exploited.

   Two methods seem practical: (1) INDERENA biologists could take experienced ornamental fishermen to previously unexploited areas to see if CPE there is 2 times the CPE achieved in traditionally fished locations. (2) Rotenone, in standing or slow moving water and explosives in fast moving water could be applied to both traditional and previously unexploited locations to see if density of the ornamental species being investigated in the unexploited

areas is 2 times that in the traditional location. In both methods (1 and 2) the previously unexploited locations should be ones which are similar to traditional locations and thus likely to support similar communities of fish.

If it is found that CPE or density (from methods 1 and 2 respectively) in previously unexploited areas are greater than twice those in traditionally fished locations, the traditional areas can be considered biologically over-harvested. Such experiments may require several replications to produce statistically valid conclusions. Whether or not overfishing is determined, a better understanding of the extent of the fishery resources will be achieved, and possibly new fishing grounds discovered.

2. Laws for protection of aquatic environments should be reviewed and strengthened, including those regarding stream modification for agricultural or industrial use and for protection of a buffer zone between water ways and agricultural lands.
3. A thorough investigation of existing pesticide-application management should be initiated in order to find the minimum dosages required, which agents are the least toxic to aquatic organisms and which have the least residual effects.
4. The combined expertise of INDERENA and "Alcopeces" should prepare a manual of preferred methods for capture, holding, and transport of fish, designed to minimize mortalities and infections.
5. A rigorous effort should be made to insure the maximum validity of "salvoconducto" statistics as these statistics provide the best method to monitor the important aspects of catch, species composition and area of capture.

The Eastern Plains fisheries staff should be actively involved with improving the usefulness of salvoconductos. Accuracy could be improved by having the fish transporters complete the salvoconductos themselves when fish are loaded for transport. Also, as an example, we found 120,800 Cardenal Tetras in salvoconductos reported to have come from the Villavicencio area (where they do not exist) indicating that duplication in records are occurring, since these fish probably initiated near Puerto Gaitan or Puerto Inirida. Also, if INDERENA inspectors continue to be the only persons authorized to dispense salvoconductos, there should be an inspector available at all times, as the shipment of live fish must proceed without administrative delays.

6. Aquaculture experiments should begin on the most sought after Colombian ornamental species and those which have the most potential for successful culture such as the Sapuara. Successful aquaculture would alleviate future over-exploitation of wild stocks and in the case of the Sapuara, eliminate ornamental exploitation of a species which is also a food fish.

Table 12. INDERENA "Salvocenducto" statistics of ornamental fish (times 1000) marketed from the areas of Villavicencio and Puerto Gaiten from 1972-1978.

	1972	1973	1974	1975	1976	1977	
Ramirezi			612.4	536.1	522.4	467.8	2%
Arari			36.2	44.5	49.6	298.2	
Alcaldes		75.4	549.4			404.5	
Brillantes		695.7	2,685.7	2,101.7	2,062.7	3,153.3	(14%)
Cardenal		1,989.8	3,525.3	2,614.2	2,390.6	2,327.0	(10%)
Corredora		769.3	2,028.1	1,774.4	1,731.0	2,317.7	(10%)
Cuchas		1,499.3	3,948.2	4,111.0	3,822.1	3,554.4	(16%)
Cuatro lineas				38.6	91.3	39.4	
Falomestas			3.5				
Colirojo			165.8	203.5	55.0	73.6	
Catalina			134.1	143.0	177.3	284.1	
Cuchillo			146.9	237.6	298.5	303.1	
Cabecirrojo			175.4	178.3	149.5	152.2	
Crenicara			4.0			56.7	
Copeinas			3.0				
Chilodus		26.6	152.2	289.5	253.1	107.5	
Doras			5.1	7.4	62.2	69.6	
Tucunare			2.7				
Dos puntos			29.2	41.5	28.1	21.8	
Escalares			10.3	9.8	5.6	7.4	
Rosardinas			11.3				
Estrigata			385.4	269.7	295.6	239.1	
Hilo negro				20.3			
Festivum					11.0	10.0	
Gancho rojo						7.9	
Gibsos			14.5	24.8			

Table 12. (continued)

	1972	1973	1974	1975	1976	1977	
Gatos				14.1	27.3	7.1	
Tetras			277.8				
Hemiodos			42.6		19.5	37.2	
Anostomos					1.5		
Rubi					61.5		
Juan viejo			154.2	65.7	39.7	186.0	
Lapiceros				437.2	268.6	219.2	
Rositas			105.4	1.4	84.7		
Leporino			12.5	35.6	5.0	28.4	
Monedas		246.1	358.5	720.8	713.3	455.0	
Mojarra		280.6	542.6	335.1	94.3	182.0	
Neon		521.3	705.5	793.9	573.9	251.8	
Otocinclos			264.7	793.9	573.3	251.8	
Pencil			28.2	26.1	64.5	42.9	
Pacamu			345.6	314.9	350.7	431.0	
Rojito		222.3	1,474.6	1,578.9	1,332.6	1,707.9	(8%)
Riqui-raque			106.9	111.6	383.2	262.8	
Rodostomo		144.1	692.7	1,297.6	1,317.5	1,063.3	
Sapuara						27.1	
Agujon			0.9	0.1			
Sierra			7.2	14.5		10.9	
Tigritos		300.4	1,355.5	1,795.2	1,864.2	1,927.2	(9%)
Tijeros			112.9	128.0	103.4	46.0	
Toritos/curitos					20.6	17.9	
Cichlidos		130.0					
Ribolus				5.4			
Varias		3,480.2		70.7	516.6	1,440.7	

Table 12. (continued)

TOTAL:	10,381.10	21,271.2	20,684.2	20,009.3	22,507.5

NOTE: 1978 Totals

Cardenal = 642.3

Cucha = 2,125.2

Neon = 24.6

Ramiresi = 227.1

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Morales, J. P., A. Brugman and C. Perdomo. 1979. Peces Ornamentales Colombianos y el Desauollo de su Industria, presented at the 3rd National Seminar of Fish Culture. University of Valle, Cali, Colombia. February 1979.

Thomerson, J. E. 1976. The impact of commerical collecting of ornamental aquauium fishes in South America. Final report: DOI contract 14-16-0008-786. Southern Illinois University at Edwardsville. 41 p. plus tables.

APPENDIX I. List of ornamental fish species encountered in the Upper Meta River investigation. Scientific names are assigned to common name based on a list of scientific and common names for Colombian ornamental fish in Morales et al. (1979).

Characidae

Aphyocharax sp.	Coli rojo
Axelrodia rieseli	Rubi, Rubi Tetra
Chalceus macrolepidotus	Arari
Charax gibbosus	Jiboso
Cheirodon exelrodi	Cardenal
Ephiphicharax sp.	Rosita
Exodon paradoxus	Dos Puntos
Hemigrammus armstrongi	Brillante
H. rhodostomus	Rodostomo, Cabezi Rojo, Pico Rojo
Megalomphodus sweglesi	Rojito
Metynnis sp.	Moneda, Metin
Paracheirodon innesi	Neon syn: Hyphessobrycon innesi

Ctenoluciidae

Ctenolucius hujeta-Agujon

Lebiasinidae

Copeina arnoldi - copeina

Gasteropelecidae

Carnegiella strigata - estrigata

Prochilodontidae

Semaprochilodus laticeps - sapuara

Anostomidae

Anostomus taeniata - Lisa

Leporinus fasciatum - leporino
Leporinus strifasciatus - Estrifaciata
Hemiodontidae

Hemiodopsis semitaeniatus - Tijero

Chilodentidae

Chilodus punctatus

Gymonotidae

Apterenotus sp. Cuchillo Negro, Ituí.

Eigenmannia virescens -Cuchillo Transparente.

Gymnotus carapo - Cuchillo Carapo.

Sternarch orchynchus ps. - Cuchillo Oso

? ? Cuchillo Caballo.

? ? Cuchillo "7"

Doradidae

Acanthodoras spinossisims-Riqui Raque de punto, Dora.

Acanthodoras sp. - Sierra.

Amoblydoras hancocki - Riqui Raque comun, Dora

Platydoras costatus - Rique Raque rayado, Dora.

? ? Rique Raque negro.

Aspredinidae

Bunocephalus sp. - Catalina

Pimelodidae

Microglanis sp. - Pacamu

Pimelodus pictus Tigrito, Tigre
Pimelodus ornatus Guacamaya
Pimelodus sp. Cuatro Lineas

Callichllyidae

Corydoras metae Corridoras Meta

Corydoras aeneus ? Coridora Verde

Loricariidae

Ancistrus sp. Cucha

Farlowella spp. Lapicero.

Loricaria spp. Loricaria

Otocinclus sp. Otocinclo.

Panaque negrolineatus Cucha Real

Hemiancistrus sp. Cucha Pina

Plecostomus sp. Corroncho, Corocoro, Hipostomo.

Pseudoancistrus spp. Cucha, Cucha Albina.

Cichlidae

Aequidens sp. Mojarra

Apistograma remirezi - Ramiresi

Geophagus sp. Juan Viejo.

Cichlasoma festivum - Festivum, Escalar Falso.

Crenicichla spp. Mataguaro, Bocon, Satena

(species for which systematic classification is missing).

Corunta

APPENDIX II.

A. Calculation of catch per unit effort (a ratio) and its standard error.

Catch per unit effort was calculated by summing all catch (c) from the interview data and dividing by all corresponding effort (f):

$R = CPE = \frac{C}{f}$ where C can be equal number of fish or number of pesos and f = fisherman-days

The standard error (S) of the ratio (R) of C/f was calculated by the formula from Cochran (1963) section 2.9.

$$S(R) = \frac{1-F}{N \times f} \sqrt{\frac{Ci^2 - 2R\ cifi + R^2\ fi^2}{n-1}}$$

1 - F was reduced simply to 1, since F is meant to indicate the relation of the number of fishing trips recorded in interviews divided by the total number of fishing trips completed. We assume this fraction is small, therefore, F is small and insignificant.