

A DESCRIPTION OF FISHING ACTIVITY
ON THE ATLANTIC COAST OF COSTA RICA
WITH OBSERVATIONS OF THE RESOURCES AVAILABLE

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Las finalidades que persigue el Proyecto son las de fomentar la explotación racional de los recursos pesqueros disponibles en aguas del mar y salobres de la región; el uso de las técnicas más apropiadas de procesamiento y de mercadeo de los productos pesqueros; el consumo nacional e intra-regional y la exportación de esos productos; así como la consolidación de la administración pesquera en los países participantes.

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TABLE OF CONTENTS

1.	RESUMEN/SUMMARY	2
2.	INTRODUCTION	3
3.	ACKNOWLEDGEMENTS	4
4.	METHODS AND SOURCES OF DATA	4
5.	RESULTS	7
5.1	Description of area	7
5.11	Environmental features	7
5.12	Current fishing activity	11
5.2	Exploratory fishing results	20
5.21	Shrimp trawling	20
5.22	Spiny lobster fishing	22
5.23	Handline fishing	25
5.24	Scallop dredging	25
5.25	Experimental fishing	25
5.3	Results of taggin experiments	26
6.	PRELIMINARY EVALUATION OF AVAILABLE RESOURCES	26
6.1	Fish reference collection	26
6.2	Spiny lobster, <u>Panulirus argus</u> Latreille	27
6.3	Shrimp	29
6.4	Green turtle, <u>Chelonia mydas</u> (Linné)	29
6.5	Tarpon, <u>Megalops atlanticus</u> Valenciennes	30
6.6	Trawl-caught botton fish	31
6.7	Other marine resources	31
6.8	Fresh and brackish water resources	34
7.	CONCLUSIONS AND RECOMMENDATIONS	34
7.1	Shrimp	35
7.2	Spiny lobster	35
7.3	Turtles	35
7.4	Demersal and reef fish	36
7.5	Other marine and brackish water resources	36
7.6	Game fishing	36
7.7	General	37
8.	REFERENCES	38

1. RESUMEN

El siguiente reporte analiza la información disponible que fué compilada durante 1967, 1968 y parte de 1969 sobre la actividad pesquera y los recursos pesqueros en la costa atlántica de Costa Rica. También presenta una cantidad limitada de datos sobre los recursos de la Laguna de Chiriquí y la Bahía del Almirante de Panamá. Además, incluye algunos datos sobre las condiciones ambientales de esta área.

Se concluyó que, aun cuando se espere un aumento moderado en los desembarques de productos marinos de mediano y bajo valor, al través de una pesca intensiva con artes de pesca apropiadas, es muy dudoso que el mercado existente pueda hacer más que un pequeño porcentaje del posible aumento de producción. Además, entre aquellos productos de alto valor unitario, y tal vez apropiados para la exportación, solamente langostas, y probablemente el pargo, pueden mostrar buenas esperanzas para incrementar los desembarques, y esto, en el caso que se puedan localizar recursos significativos en otras áreas diferentes a las tradicionales.

También se creyó que la mayor explotación de sábalo y tal vez de otros pescados hecha por pescadores deportistas, podría traer consigo un aumento de los beneficios económicos y fuentes de empleo en la región.

SUMMARY

The following report reviews available information collected during 1967, 1968 and part of 1969 on fishing activity and on the fisheries resources of the Atlantic coast of Costa Rica. A limited amount of data is also presented on the resources of Chiriqui Lagoon and Almirante Bay of Panama. Some background data are also included on the environmental conditions of the area.

It was concluded that, although a moderate increase might be expected in the landings of medium and lower value marine products through more intensive fishing with appropriate gears, it is doubtful if the existing market could absorb more than a small percentage of the possible increase in production. It was further concluded that, among those products of high unit value, and perhaps suitable for export, only lobsters, and perhaps snappers, show prospects of expanded landings, and these, only if significant resources can be located in areas other than the traditional fishing grounds.

It was also believed that the greater exploitation of the tarpon and perhaps other fishes by sport fishermen might bring increased economic benefits and employment to the region.

2. INTRODUCTION

This report summarizes the present knowledge at the middle of 1969 on fishing activities on the Atlantic coast of Costa Rica together with the results of investigations made in the area chiefly by the Project vessel r/v Orion. For comparative purposes and because of the continuity of the area, the fishing results of the r/v Orion in Chiriqui Lagoon and Almirante Bay, Panamá, have also been included. A review is also presented on the present status of knowledge on the fisheries resources of the area and of the factors which have apparently limited the development of fishing in the area.

Puerto Limón, the principal town of the Atlantic coast of Costa Rica, has a population of approximately 35,000 people and the Province of Limon, which includes the entire Atlantic coast, a population of about 81,000 people.* The population of the port is increasing both naturally and through an influx from the countryside. There has been no equivalent growth in the number of employment opportunities and there is widespread under-employment and unemployment in the area, a situation which appears to be worsening. The main employers within the city itself are the port facilities, an oil refinery and the railway company. There are also two saw-mills and a small soap factory. In the rest of the province, agriculture, chiefly the growing of bananas and cacao, represent the main source of income for the people.

Because of the employment situation, the Government of Costa Rica requested the Regional Project for Central America Fisheries Development to place high priority on exploratory and experimental fishing with the Project vessel r/v Orion to investigate the resources of the area in the hope that the expansion of fishing activities might provide an alternative source of employment to partly at least alleviate the underemployment conditions prevalent in the area.

A serious hindrance to any meaningful development, both in general and in the fishing industry (for the local, Costa Rican market), is the lack of adequate transportation facilities between Puerto Limon and the rest of the country and within the Province itself. The canal from Barra de Colorado to Moin, which is almost completed, should be of help in making the transportation of merchandise and people from the isolated communities on the Caribbean coast much easier and less expensive. Also, while land transportation between Limon and the central valley will soon be a reality, the road will initially be very poor at some places and it seems that it will still be some time before the highway, long awaited by the people of Limon, between the port and San José, the capital, becomes a reality. Without this, and more and better roads within the Province of Limon itself, it seems doubtful that much new industry, and jobs, would be attracted to the area.

Since it was clear even at the beginning of the study that,

* Source: Municipality of Puerto Limon, Census taken in July, 1967.

because of the difficulties mentioned above, fishery products from the Atlantic coast would probably not be competitive with those from the Pacific coast in the major marketing centres of the country, it was decided that the exploratory fishing operations of the r/v Orion should be concentrated on those products with actual or potential markets outside of the country, chiefly shrimp and spiny lobsters.

The r/v Orion operated in Costa Rican and Panamanian waters between December, 1967 and November, 1968. It had originally been intended to continue the operations until the beginning of 1969, to try to determine the limits of distribution of the spiny lobster resources during the normal fishing season of December to February. In view of the almost negative results obtained in the fishing operations, it was decided that the vessel should be transferred to the Pacific coast. This was done at the beginning of November, 1968 and the lobster survey was thus considerably less intensive than had originally been intended.

3. ACKNOWLEDGEMENTS

For assistance and advice in the course of these studies, the authors are greatly indebted to Ing. Milton López, Chief of the Fisheries Service of Costa Rica and also to Counterpart-Captain Tranquilino Torres B. and the crew of the r/v Orion. The authors would also like to acknowledge the help received from Mr. William Bussing of the Biology Department of the University of Costa Rica in the identification of fish specimens, and also to Dr. Rafael Lucas R., Chairman of that department, for the use of the laboratory space there. The authors would also like to give their thanks for help received to Captain Frank Jackson of the Resguardo Fiscal in Limon, to the owners, managers and other employees of Mariscos del Caribe, S. A., Eugenio Garron e Hijos, S. A., Altamar, S. A., Empacadora del Norte, S. A., and to many fishermen of Puerto Limon but especially Mr. Fernando Leon and Mr. Delroy Reid.

4. METHODS AND SOURCES OF DATA

The main sources of data on fishing activities and resources were the following:

- a. Production statistics from the processing plants
- b. Interviews of fishermen and other people concerned with the fishing industry
- c. Exploratory and experimental fishing by the Project vessel r/v Orion
- d. Actual trips with local fishermen

The responsibility for collecting statistical data on fisheries landings lies with the Fish and Wildlife section of the Ministry of Agriculture and Livestock. Periodically, due to personnel difficulties, it was not possible to station a fisheries inspector in Puerto Limon and the statistical data had to be received directly from the processing plants. Nor were facilities available to enable inspectors to visit communities other than those in the Puerto Limon area to collect data. During 1968, Project personnel assisted in the collection of data and, in December, 1968, a Peace Corps generalist was assigned to Puerto Limon; since that time, he has been responsible for reporting on fishing activity. Because of the personnel difficulties and because of the fact that landings are made at different places, it has not yet been possible to carry out market sampling of the landings nor to collect data on catches in relation with fishing effort. A summary of statistical data obtained from different sources is presented by Gonzalez Lopez (1967) and (1968). Sources used for economic and environmental data are cited in the text.

In December, 1967, fishermen and others connected with the fishing industry were interviewed by personnel of the Government of Costa Rica and of the Project. Some of the results of this survey were reported by González Lopez (1967). More recent and more complete information was reported on by Wolf (1969 b).

Exploratory and experimental fishing was carried out by the Project research vessel r/v Orion. The r/v Orion is a 50' single rig trawler, similar in design to shrimp trawlers of comparable length operating elsewhere in Central America and the Gulf of Mexico. The vessel is equipped with a Simrad white-line echo-sounder, a hydraulic main trawl winch and a longline hauler. Up to six drop line fishing machines were also used.



Fig. 1 R/V Orion

About thirty days of operations were lost through bad weather and, on other occasions, station keeping was rendered difficult, or impossible, through poor visibility caused by rain. Heavy seas also frequently made it impossible to go alongside the unprotected wharf at Puerto Limon to take on fuel and water. It was felt that, because of the weather conditions of the area, a larger and more sea-kindly vessel would be more suitable for the operations. The sea-kindliness of the r/v Orion was later improved by the fitting of bilge keels.

Some delays were also experienced through mechanical failures or through equipment working below maximum efficiency. These affected chiefly the main winch whose hydraulic system is unknown in the area and where competent mechanics for such systems are not available.

Most of the trawling was carried out with a 45' semi-balloon shrimp trawl and the catch results given later were those taken with this gear. A 60' Marinovitch trawl with extra floats and occasionally, a high opening Norwegian Sputnik one were also used as fish trawls but, the catches of these were largely negative, the fishing results have not been included.

The lobster traps used were those of the local fishery made with branches and chicken wire in a "Z" form. Handlines (droplines) were also used frequently. Hauls were also made with a scallop dredge with negative results in terms of potentially edible products.

A biologist accompanied most cruises of the vessel and standard procedures were used for the sampling of the catches. Estimates of the weights (or actual weights when catches were small) were first taken separately of shrimp, lobsters, other invertebrates, large fish (presently marketable for local consumption) and small fish (not presently marketable except as bait for lobster traps). Weights and numbers were also recorded of the different species of shrimp, lobsters and those species of fish which accounted for a high percentage of the total catch. Spiny lobsters and some samples of shrimp were sexed and measured.

Several specimens of each species of fish were taken to the Biology Department of the University of Costa Rica for confirmation of identifications and to augment the regional fish reference collection maintained by that Institute.

Most of the lobsters caught by the r/v Orion were tagged and released. After the vessel was transferred to the Pacific coast, arrangements were made to continue the tagging programme with a chartered commercial fishing boat. All releases were made in the area of capture. The tagging procedures were those recommended by Weber (1968) based on his studies in Belice (British Honduras).

A total of 345 lobsters were tagged with spaghetti-like streamer tags (Fig. 2). The part protruding from the animal is $3\frac{1}{2}$ inches long. Three different "heads" to the tag were used.

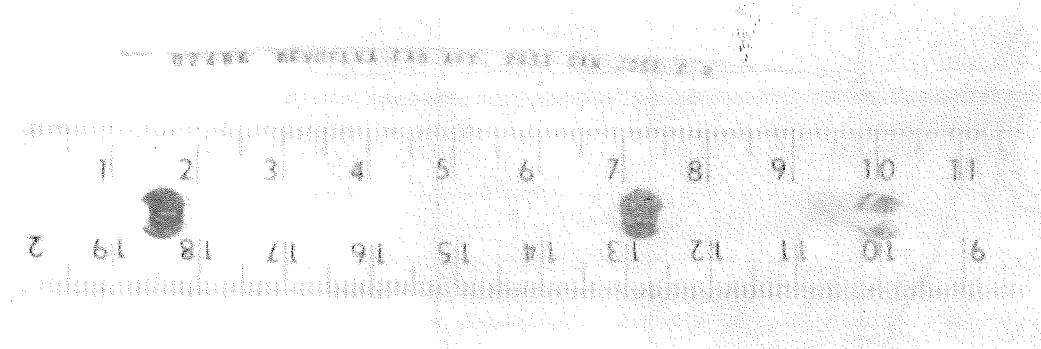


Fig. 2. Spaghetti-type tag used in tagging spiny lobsters with centimetre scale.

No funds were available for the payment of rewards, reliance being placed on the interest and good will of the fishermen and processing plant managers to obtain recoveries. The tagging programme was publicized through radio, newspapers and posters.

5. RESULTS

5.1 Description of area

5.11 Environmental features

The Atlantic coast of Costa Rica has approximately 135 miles of coastline (Fig. 3). It is an open beach system with no protective coves nor inlets other than river mouths and the entire area is exposed to currents and wave action. There are eleven rivers entering the Caribbean along the coastline and, during periods of heavy rains, most of the inshore waters become turbid. The heavy discharge of the rivers is presumably responsible for the deposits of sediments thus giving the characteristic mud/sand bottom.

Except for a few areas with rocky outcrops, the Atlantic coast consists of long expanses of sandy beaches, interrupted in places by large areas of mangrove swamps and palm trees. Beyond this, stretch miles of unbroken tropical rain forest.

Rainfall is heavy throughout the whole area, in some places reaching 180 inches per year. Fig. 4 shows two annual rainfall peaks namely in June/July and the second in November/December which are typical of the Caribbean lowlands (Scott, 1966). Also of importance, is the continuity of rainfall throughout the year.

Temperature shows relatively little variation throughout the year. The 20 years' average of temperature taken at Cairo, in Limon Province, shows a range of 23.4° to 25.8° C (Fig. 4).

Hughes (1968) describes the sea conditions of the area. This

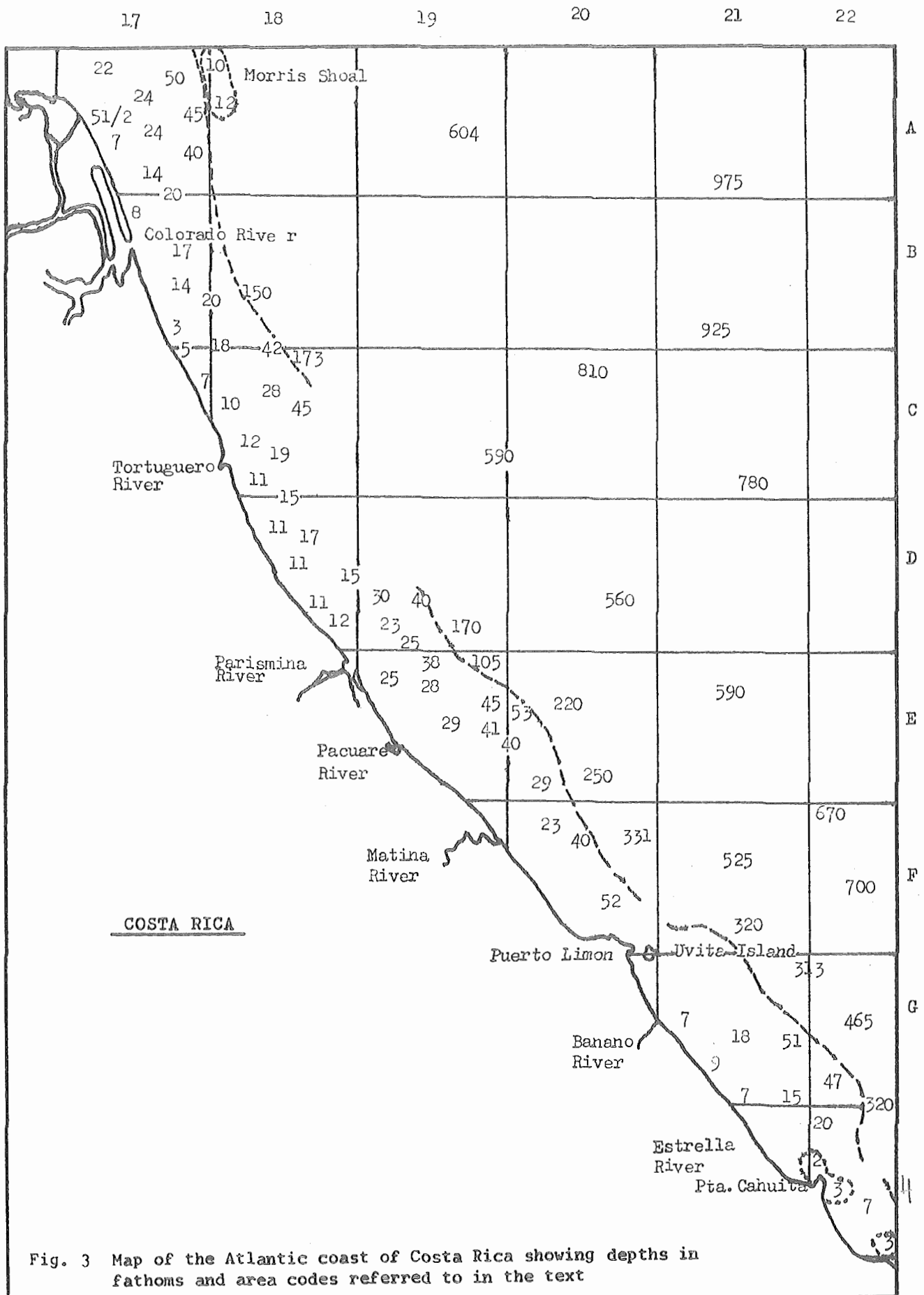


Fig. 3 Map of the Atlantic coast of Costa Rica showing depths in fathoms and area codes referred to in the text

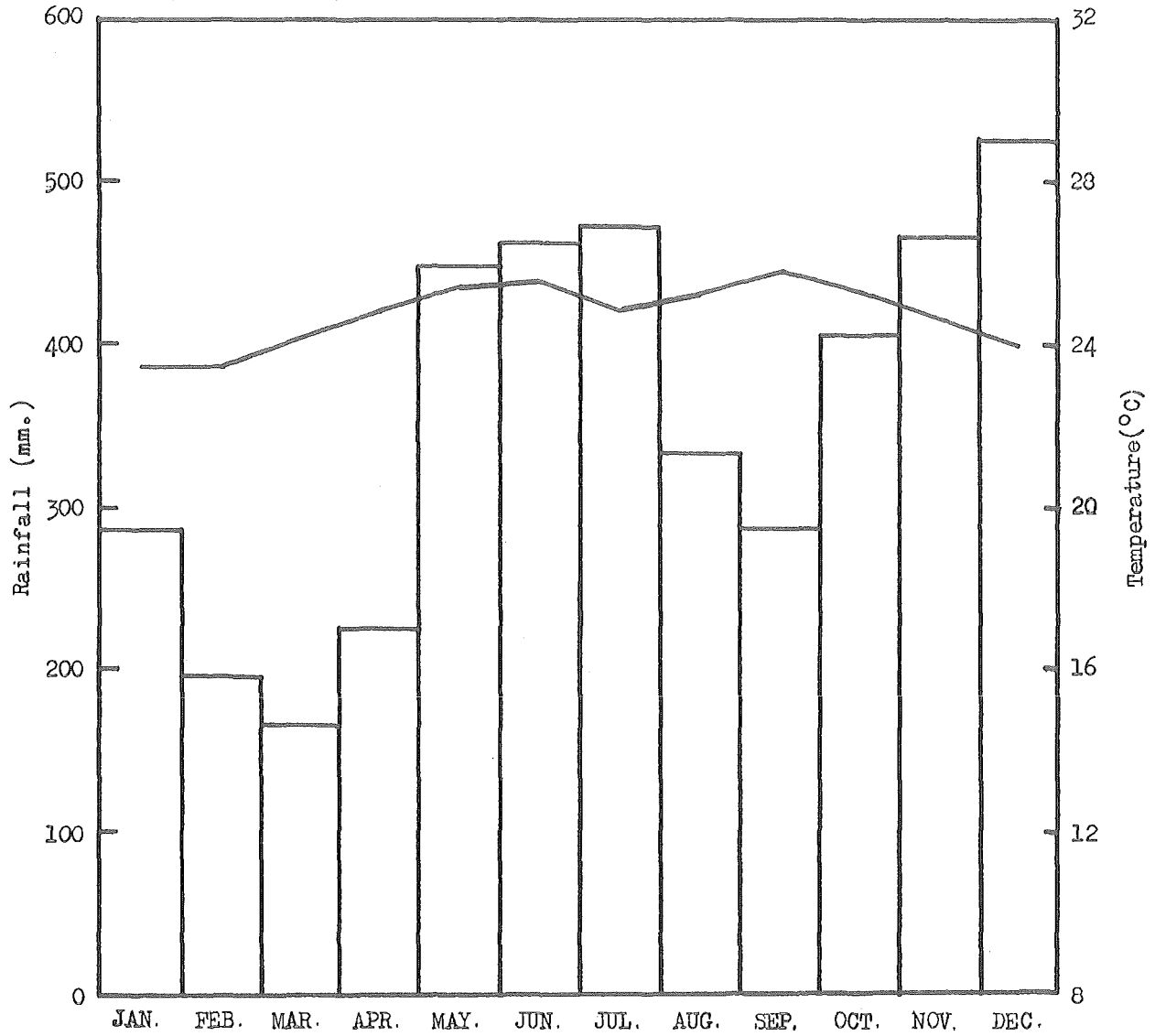


Fig. 4 Monthly average rainfall (Los Diamantes, Province of Limon) and graph of monthly average air temperatures (Cairo, Province of Limon (averages of previous 20 years) 1/

1/ Source: Anuario meteorológico, Servicio Meteorológico, Ministerio de Agricultura y Ganadería, Costa Rica.

information will therefore only be summarized briefly here. The most prominent features of the sea conditions are the strong south-going currents, sometimes reaching speeds of four knots and making station keeping and fishing frequently difficult and sometimes making it impossible for the r/v Orion to come alongside the unprotected harbour of Puerto Limon. The recurrent bad weather resulted in the loss of many fishing days both for the r/v Orion and for the local fishing boats; during one period, neither the r/v Orion nor the local boats could leave port for a continuous period of 20 days. The strong currents, combined with frequent periods of poor visibility caused by rain makes the Atlantic coast an inhospitable place for fishing operations. These strong currents apparently also exert a scouring action on the bottom. It was noteworthy for example, that after one period of such currents which continued for about 20 days, trawl catches were completely negative, not even leaves or other "trash" brought down by the rivers were caught.

Hughes (1968) also describes the bottom conditions of the area. The following description is taken largely from his report. Echo-traces of the typical bottom conditions are also shown in his report.

Although there are some very deep trenches to the north of Puerto Limon, some over 200 fathoms deep and within five miles of the beach, the bottom appears to be all mud or at least covered to a good depth with mud. The Continental Shelf between San Juan del Norte and Rio Sixaola is very narrow, extending only about 12.5 miles offshore at its widest point. This probably accounts for the heavy seas experienced in the area even in the absence of wind. The edge of this shelf is not suitable for trap or trawl fishing, since, in addition to the current in the northern section, the edge descends in most places almost vertically from 30 to 40 fathoms to over 300 fathoms. Nor do there appear to be ledges of sufficient width to allow any worthwhile bottom fishing. The edge appears to be completely covered by heavy mud and dropline fishing results were negative.

From the trawling results, which have been carried out over most of the area, the only noticeable variation in bottom conditions is that some mud areas are heavily covered with sea urchins or with sea stars and little or no vegetation exists. The bottom condition changes mainly according with depth. Beyond 22 fathoms almost anywhere along the coast, the bottom is covered with sea urchins and it was found impossible to trawl, as even the trynet picked up 100 pounds or more of these animals in ten minutes.

From observations of bottom conditions, it appears that there are very few reef areas which could sustain small local populations of lobsters of reef fishes. There are small reef areas near Puerto Limon and Punta Cahuita. During the echo-sounding survey of the r/v Orion, two rocky areas previously unknown to the local fishermen, were found. One is located in 35 to 60 fathoms of water off Tortuguero and the other is outside Rio Parismina in 35 to 50 fathoms of water.

5.12 Current fishing activity

The information obtained so far refers almost exclusively to Puerto Limon and to the small communities lying within an area of about ten miles on either side. This area accounts for the bulk of the population of the Atlantic coast of Costa Rica and for the bulk of the fishing activity of the area. It would seem likely that most of the people living in communities other than those of the Limon area fish at least part time, but presumably almost all of the production resulting from this fishing is consumed within the communities.

(a) Fishermen:

Table I shows the results of a survey conducted by the Project and the Government of Costa Rica in December, 1967. Although the number of fishermen involved, namely 197, is almost certainly fewer than the true number, the table does indicate the characteristic feature of fishing activity in the area. Three distinct groups of fishermen can be identified. These are firstly, year round fishermen; secondly, fishermen who only fish during the lobster season; and thirdly, a group who have alternative professions but who become fishermen only during good lobster seasons. The number of fishermen in the third group fluctuates widely depending upon the relative success of the lobster fishery. When the catches of lobsters at the beginning of the season are high, professional and business men from the area become fishermen almost overnight. In a good season, the second group of fishermen can earn enough money during the season which, if handled wisely, can sustain them and their families throughout the year.

Table I Survey conducted of the fishermen of Puerto Limon; December, 1967

Groups	Permanent	Transitory	Total
Number of fishermen	108	89	197
Number that fish for lobsters only	17	52	69
Number that fish for everything	84	28	112
Number that use own boat	44	25	69
Number that use rental boat	25	11	36
Salaried worker	33	42	75

(b) Boats and operating procedures:

Table II shows the number of new boats registered with the Port Captain during the past eight years. It is estimated that most, but not all, of these were used for fishing. González López (1968) estimates the number of boats at 350. In response to more recent inter-

views of fishermen, estimates of up to 500 boats for the Limon area and 2,000 for the entire coast were received. These estimates, even if approximately accurate, are misleading in terms of fishing activity, since probably a high percentage of those in the region will only be activated as fishing boats during a better than average lobster fishing season. Many seem to have been acquired during the unusually good lobster season of 1960-61. A good estimate would be that about 100 boats are activated during a good lobster season, while a minimum of 20 boats operate all year round. Most of the dugout canoes are 25-35 ft. long and 3-4 ft. wide. A photograph of a typical boat is shown on Fig. 5.



Fig. 5 Photograph of a typical fishing boat ("cayuco") used in this area.

Table I shows that some fishermen own their boats while others rent them, but in view of the difficulty in estimating the number of fishermen, the relative numbers shown in the table of privately owned against rented boats may not be typical of the situation as a whole.

The average number of fishermen per boat varies according to the size and type of boat and the type of fishing to be undertaken. The fishermen in boats with oars or paddles usually go alone or, less commonly, with one other person. The larger canoes with motors operate with two or three fishermen, with two being the most common when fishing for turtles or fish. During the lobster season, the average is three per boat. Direct observations on various days during the 1968-69 lobster season showed that 25% of the boats had two fishermen, 69% had three and 6% had four. The percentage given for four fishermen would perhaps have been somewhat higher if a longer time series of observations had been made.

Table II Number of new boats registered with the Port Captain in Puerto Limon

Year	Number of boats
1961	226
1962	79
1963	15
1964	22
1965	26
1966	30
1967	43
1968	36
Total	477

Source: Office of the Captain of Port, Puerto Limon

There are five main areas near Limon where fishing boats are stored namely, Moin, Portete, Piuta, Rio Cieneguita and the beach of Barrio Cristobal Colon, Cieneguita (Fig. 6). During a large part of



Fig. 6 Photograph of one of the five mayor boat landing area Rio Cieneguita

the year, because of sea and wind conditions, the main docks of Limon are not suitable for the operation or storage of small fishing vessels. During the lobster season, most boats operate from Portete which is the best protected of the possible landing sites and has a small privately owned dock.

Theft of lobsters from traps is reported to be a problem. To minimize this, Government authorities in the port insist that the fishermen do not leave port before 6 a.m. so that, theoretically, all boats can reach the grounds at the same time. This does not in fact happen, since some boats are faster than others. Most boats make daily trips and during the 1968-69 lobster season, some boats were at sea every day except Christmas, New Year and one other day when the weather was bad. During the remaining part of the year, those boats continuing to fish will average about twenty trips per month.

(c) Fishing gear:

Different types of fishing gear are used for the capture of lobsters, turtles and fish. For lobsters, almost all fishermen use the type of trap shown in Fig. 7 which is made of chicken wire supported by branches. The usual size of a trap is about $1\frac{1}{2}$ by $5\frac{1}{6}$ by 7 feet and it is valued from C.R. ₱ 30.00 to ₱ 60.00, depending on whether the fisherman makes them himself or buys them already constructed. Floats are pieces of bamboo, painted with different colours and

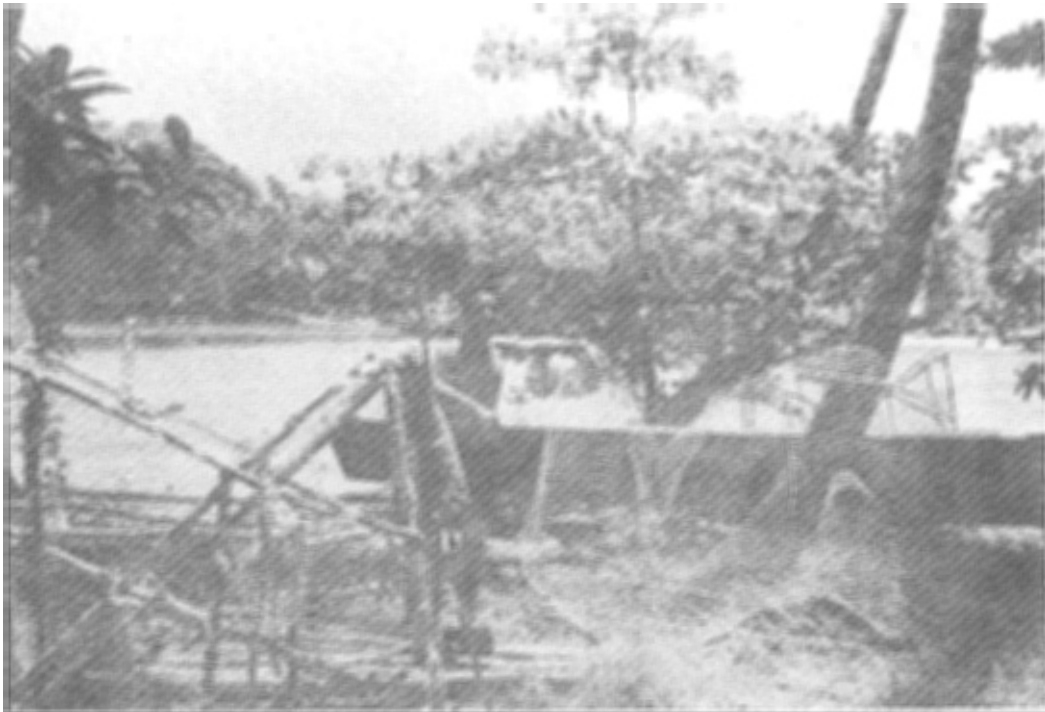


Fig. 7 Photograph of the type of lobster traps typically used in this area. To the left is the finished trap while the one of the right lacks the wooden supports.

the number of their owner's boat for identification purposes. Also, some cane traps are still in use. Most traps are hauled by hand over a metal pulley mounted in the bow of the boat, but there are several gasoline winches that are also used. The traps are heavily baited with fish and it is quite frequently necessary to buy the fish (at C.R. ¢0.75 to ¢0.90/pound) from Puntarenas on the Pacific coast, a relatively high price for a product to be used only as bait.

Turtles are caught by harpoons and by large meshed nets which are usually handmade. The nets are set with objects resembling turtles made of wood on either side which apparently attract the turtles and cause them to become tangled in the net. The catching of turtles on the beach when nesting is prohibited by law but enforcement of the law is difficult due to the lack of personnel and facilities and it is likely that some turtles and eggs are caught illegally.

Fish are caught chiefly by hand lines (used either as a drop-line or for trolling) but cast nets, gill nets and beach seines are also used. About fifteen of the latter nets are reported to be used in the area with about seven men each. Most fishing for fish takes place near the mouths of rivers and, in these conditions, the gill nets are used to "stop" channels, and sometimes catch small quantities of local shrimp.

(d) Catches

Tables III and IV show the quantities of spiny lobsters and turtles reported as processed by the processing plants in Puerto Limon during recent years. The quantities of lobsters probably represent fairly closely the actual catches except for relatively small quantities consumed locally. Since it is believed that some illegal turtle fishing takes place, the actual catches are probably somewhat higher than the quantities shown in the table. A discussion of the trends in the landings will be presented in a later section, but it seems to be worthwhile pointing out at this stage, the highly variable nature of the landings of both turtles and spiny lobsters from year to year.

Fish are sold in the streets of Puerto Limon (Fig. 8) and in the municipal market (Fig. 9). Table V shows the quantities sold in the market. It is reported that the quantity sold in the streets is greater than that sold in the market but no statistics are available on the quantity. Even if the former were twice the latter, the total still represents a relatively insignificant quantity in relation with the numbers of regular fishermen in the area, perhaps less than 2,000 pounds per fisherman per year.

The principal species caught are snappers, jacks and mackerel. Other species taken include kingfish, groupers and snook. Tarpon, usually salted and smoked, is eaten by some people but is not widely in demand.

The best fishing occurs near river mouths and bars, near Parismina, Pacuare and Matina, north of Limon and Rio Banano and Westfalia to the south. Near Limon itself, the best fishing is near Moin, Isla Pajaros, Isla Uvita and the Basura Dump. The boats using oars or paddles are limited to these latter areas.



Fig. 8 Typical scene of a fish vendor on the streets of Puerto Limon.



Fig. 9 Booths in the Municipal Market where freshly caught fishes are sold.

Table III Estimated landings of spiny lobsters in Puerto Limon. 1/
(Total weights in thousands of pounds)

Season	Sept	Oct	Nov	Dec	Jan	Feb	Mar- Aug	Total for season
1958-59	xxx	xxx	xxx	xxx	19	0	0	xxx
1959-60	3	0	0	53	256	0	0	312
1960-61	1 117	1 271	120	310	1 879	89	15	4 801
1961-62	0	0	0	187	17	0	0	204
1962-63	122	0	0	420	49	0	0	591
1963-64	0	0	0	57	127	8	0	192
1964-65	25	0	0	1 384	83	1	0	1 493
1965-66	0	0	0	175	25	0	0	200
1966-67	0	0	0	133	231	0	0	364
1967-68	0	0	0	66	73	1	0	140
1968-69	19	0	0	654	73	0	0	746
Averages	128	127	12	341.3	257	9	1	904

xxx: no data

1/ Source: Sección de Pesca y Vida Silvestre, Ministerio de Agricultura y Ganadería, Costa Rica.

Table IV Number of green turtles processed in Puerto Limon. 1/

<u>Year</u>	<u>Number of green turtles</u>
1956	839
1957	1 507
1958	997
1959	207
1960	123
1961	329
1962	1 096
1963	637
1964	1 419
1965	2 745
1966	1 562
1967	1 866
1968	157
1969*	1 288

* month of June only

1/ Source: Sección de Pesca y Vida Silvestre, Ministerio de Agricultura y Ganadería, Costa Rica.

(e) Utilization of the catches

On board, lobsters are put in burlap bags which weigh approximately 100 pounds each. Turtles are turned over on their shells (Fig. 10) and will not be bought by the processing plants unless they



Fig. 10 Live turtles ready for market. Turtles are placed on their backs to prevent them from escaping as well as to keep them alive.

are still alive. Fish are gutted, the gills are removed and the fish are stowed in a shaded part of the boat. Ice is not normally used. Two processing plants operate the year round and process chiefly lobsters and turtles. During the lobster season, these are supplemented by representatives of two further exporting companies and also buyers who ship the lobsters live by air to San José, where they are either sold directly to restaurants or in the streets. During the 1968-69 season the fishermen received C.R. ₡2.50/lb., live weight, for their lobsters.

Fish are unloaded wherever the fishermen keep their boats and are carried in strings or boxes to the town to be sold. The fish are usually sold by middlemen who work either out of a stall in front of the municipal market or on street corners. The fish caught early in the day are sold fresh, while the rest is iced or frozen in one of the two processing plants that make their facilities available when they are not being used to store frozen meat or yuca. They charge the fishermen C.R. ₡0.10/lb.

Table V Kilograms of fishes sold in the Municipal Market in Puerto Limon. 1/

Month	1969	1968	1967
Jan.	2 218	436	365
Feb.	1 323	1 175	977
Mar.	1 255	1 362	1 228
Apr.	1 210	1 560	1 324
May	1 850	2 166	575
June	1 337	2 251	1 044
July	-----	1 080	401
Aug.	-----	707	303
Sept.	-----	449	703
Oct.	-----	1 471	1 032
Nov.	-----	938	989
Dec.	-----	660	610
Total	-----	14 225	9 551

Source: Mercado Municipal, Puerto Limón

During 1968 three classes of fish are recognized, consisting of the following: first class, including mackerel, kingfish and snapper selling to the consumer for about C.R. ₡2.50/lb.; second class is jack selling for C.R. ₡2.00/lb.; and third class, snook and tarpon at about C.R. ₡1.50/lb. During times of scarcity or abundance, these prices may vary somewhat.

Fish prices are relatively competitive with those of meat. All fish (excluding lobsters) are cheaper than the better grades of meat and the cheapest grades of fish and meat sell for about the same, fish sometimes being lower.

It is difficult to estimate the number of people involved in the processing and selling of fish and other sea foods in the area since two of the processing plants only operate for a few months per year namely, during the lobster season, and the two plants open the year round process and store other products as well as fish and sea-foods. During the turtle and lobster seasons, the processing plants probably employ a peak of about 200 people however, some of these workers are also concerned with activities unrelated to fishing. Almost all turtle products, like lobster, are exported. The meat, the neck and rear skin (used to make leather), the fat (used to make an oil used for cosmetics), and the calipee (the gelatin used in turtle soup recipes) are all processed and exported. The processing plants pay the fishermen C.R. ₡40.00 per live turtle, without regard to size or weight.

(f) Supply and demand for fish and sea-food

To the best of the knowledge of the authors, no shipments of fish or seafood, other than lobsters have been sent from Limon to the Central Valley, where the capital city is located and which is the

most populated part of the country. Shipping charges by rail from Puerto Limon to San Jose are C.R. ¢0.18 per kilogram and rail shipping would require the use of ice for fresh products. Nor does it appear at present that sea products from the Atlantic coast are sold in any quantity to communities inland from the coast (for example, in the plantations of the banana companies). Thus, aside from those products exported, and the small quantity of lobsters sent to San Jose, the entire production from the Atlantic coast is consumed and/or sold within the coastal and nearby communities.

The only other resource processed or sold to any degree outside of the Limon area is shark in the Barra de Colorado area, (approximately seventy miles north of Puerto Limon). In 1969 there were two shark operations in the Barra that utilize shark meat (to make bacalao), the fins, and the jaws. The hides of the particular variety of shark most often caught (Carcharhinus leucas, Valenciennes, or Bull shark), have no value, for they tend to spot upon tanning. Other varieties of shark whose skins would be of value also occur in the area, generally at a greater distance from the coast but these are not actively fished at present.

A bacalao-type product is made by salting and drying the meat in the sun. The fins are also utilized by drying and are either sold in Puerto Limon or are shipped to Hong Kong. Most of the dried meat is sold in San José at Easter time. At the beginning of 1969, one processor had accumulated over C.R. ¢10,000.00 worth of meat awaiting the Easter market. The price paid to fishermen ranges from C.R. ¢10.00 to ¢20.00 per shark, or ¢0.30 per pound. The meat is sold wholesale in San José for ¢2.00 to ¢2.50 per pound and retail for about ¢4.00 per pound. The fins have a value of about ¢2.50 fresh or ¢5.00 dried to the fishermen while the jaws are worth about ¢2.75. Further information on this topic is given by Wolf (1969a).

5.2 Exploratory fishing results

5.21 Shrimp trawling

The sea bottom of the entire area from the Nicaragua/Costa Rica frontier to Belen, Panama and including Chiriqui Lagoon and Almirante Bay was surveyed by the echosounder following a grid pattern with lines running out from the coast, ten miles apart, to about 75 fathoms. When the bottom appeared to be suitable, the try net was set in different depth zones. When the try net and/or the echosounder indicated signs of animals, the large shrimp trawl was set. The first six months of operations were described by Hughes (1968). Each area was sampled about four times during the eleven month period and areas where catches, especially of shrimp occurred, were fished more frequently. Tables VI and VII show summaries of the shrimp trawling results. A total of 179 hours trawling in Costa Rican waters produced a little over 1,000 lb of shrimp, about 140 lb. of marketable fish and about 13,000 lb. of small fish which the local fish buyers considered too small for human consumption but some of which was used on the r/v Orion as bait or sold in Puerto Limon for this purpose. The hourly catch rates of marketable products, namely shrimp and large fish, strongly suggest that at no part of the coast is shrimp

trawling an economically feasible operation. The actual availability of resources, especially shrimp, was even less than that indicated by Tables VI and VII since, after some experience, it was found that the concentrations of fish and shrimp could be located by the echosounder. After this had been established, sets of the trawl were rarely made unless traces were shown on the echosounder. It was further established that a single school of shrimp (perhaps indicated on the echosounder by the fish feeding on them) could be followed and, after repeated trawl sets on this school, the catches dropped almost to zero. The shrimp and fish caught almost always occurred in areas sheltered from the fast running currents. Since such areas are of very limited extension in Costa Rica, only a very small population of shrimp would be expected to occur.

The results from Panamá were more surprising, especially those from sets made in Chiriqui Lagoon. This lagoon possesses a relatively large area of smooth bottom and sheltered waters and "looks" as though it would be suitable for shrimp. This was also the opinion of members of the shrimp industry of Panama who offered to send vessels to fish with the r/v Orion. The Project discouraged them from doing this until some preliminary exploratory work had been done. The later results showed that this action saved these commercial vessels from incurring losses. Chiriqui Lagoon did, however, yield large quantities of small fish. It might be marginally profitable for one small trawler to fish for these to sell to in Puerto Limon, Costa Rica as bait during the lobster fishing season to replace the relatively expensive bait transported from the Pacific coast of that country.

Table VI Summary of shrimp trawling results by r/v Orion in Costa Rican water, December, 1967 to November, 1968. ^{1/}

Area ^{2/}	Total hours trawled	Pounds per hour		Total fish	Depth in fathoms
		Shrimp	Marketable fish		
A 17	6	0.2	0	4	5-35
B 17	2	4.0	0	12	5-22
C 17	1	7.0	0	25	9-10
C 18	20 1/2	4.7	0.6	43	8-75
D 18	13	1.5	0	18	5-45
E 19	9 1/2	6.3	0.5	58	5-30
F 19	6	12.7	0	62	2-15
F 20	30 1/2	6.9	2.0	77	4-60
G 20	8	4.8	0.2	62	3-17
G 21	44	3.8	0.6	139	2-15
H 21	7 1/2	6.8	0.7	112	4-14
H 22	31	12.3	0.9	52	4-40
Totals	179	6.2	0.8	75	2-75

^{1/} 45' semi-ballon trawl was used

^{2/} Area codes are shown in Fig. 3

Table VII Summary of shrimp trawling results by r/v Orion in Panamanian waters, December, 1967 to November, 1968. ^{1/}

Area ^{2/}	Total hours trawled	Shrimp	Pounds per hour Marketable fish	Total fish	Depth in fathoms
I 24	5 1/2	0.5	0	69	2-30
J 24	8 1/2	3.2	0	23	2-30
J 25	19	3.4	0.3	8	7-15
K 24	2	3.5	0	12	8-13
K 25	10 1/2	2.9	2.9	17	4-16
L 25	11 1/2	2.0	1.2	47	4-21
L 26	5	7.8	2.0	114	3-28
L 27	1/2	0	0	0	18
M 26	140	4.4	0	186	2-16
M 27	2	0	0	40	10
M 29	1	0	0	0	15-25
M 31	1 1/2	0	0	0	10-30
Totals	207	3.9	0.3	136.4	2-30

^{1/} 45' semi-balloon trawl was used

^{2/} Area codes are shown in Figs. 11 and 12.

5.22 Spiny lobster fishing

As was mentioned above, it had previously been intended to concentrate on the lobster investigations after September, 1968 and to continue them during the normal lobster fishing season, namely December to February. These plans were disrupted when it was decided to transfer the vessel to the Pacific coast in November, 1968. The intensity of lobster trapping was therefore much lower than had been intended. Table VIII shows a summary of the fishing results in Costa Rican and Panamanian waters. Most of the fishing was done in areas not exploited by the local commercial fishermen and, as can be seen in the table, the catches were very low. The highest catch rates, in areas F 19 and F 20, occurred when the traps were set alongside those of the local fishermen, to obtain spiny lobsters for the tagging experiments (see Fig. 3).

In Costa Rican waters, reef areas, usually believed to be the natural areas for lobsters, are infrequent and of relatively limited extension, and fishing trials in these areas produced practically no lobsters. Most of the lobsters caught were taken on relatively flat, sandy, muddy bottoms and appear to have been in migration. Fishing in areas not presently exploited by the fishermen or at times of the year other than the traditional fishing season produced few or no lobsters. The catches taken alongside the local fishermen, to obtain lobsters for tagging purposes, showed comparable catch rates to those of the local fishermen.

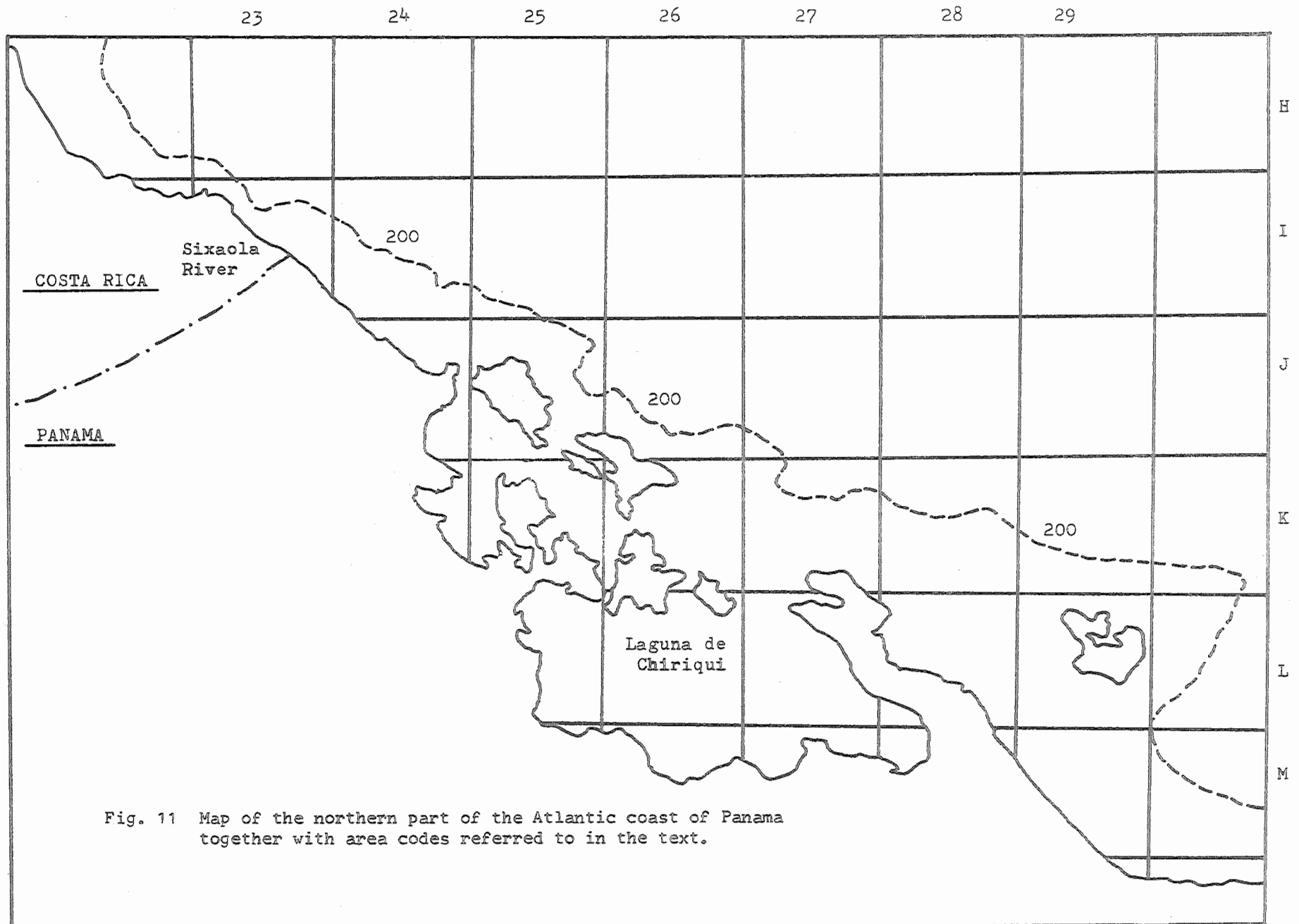


Fig. 11 Map of the northern part of the Atlantic coast of Panama together with area codes referred to in the text.

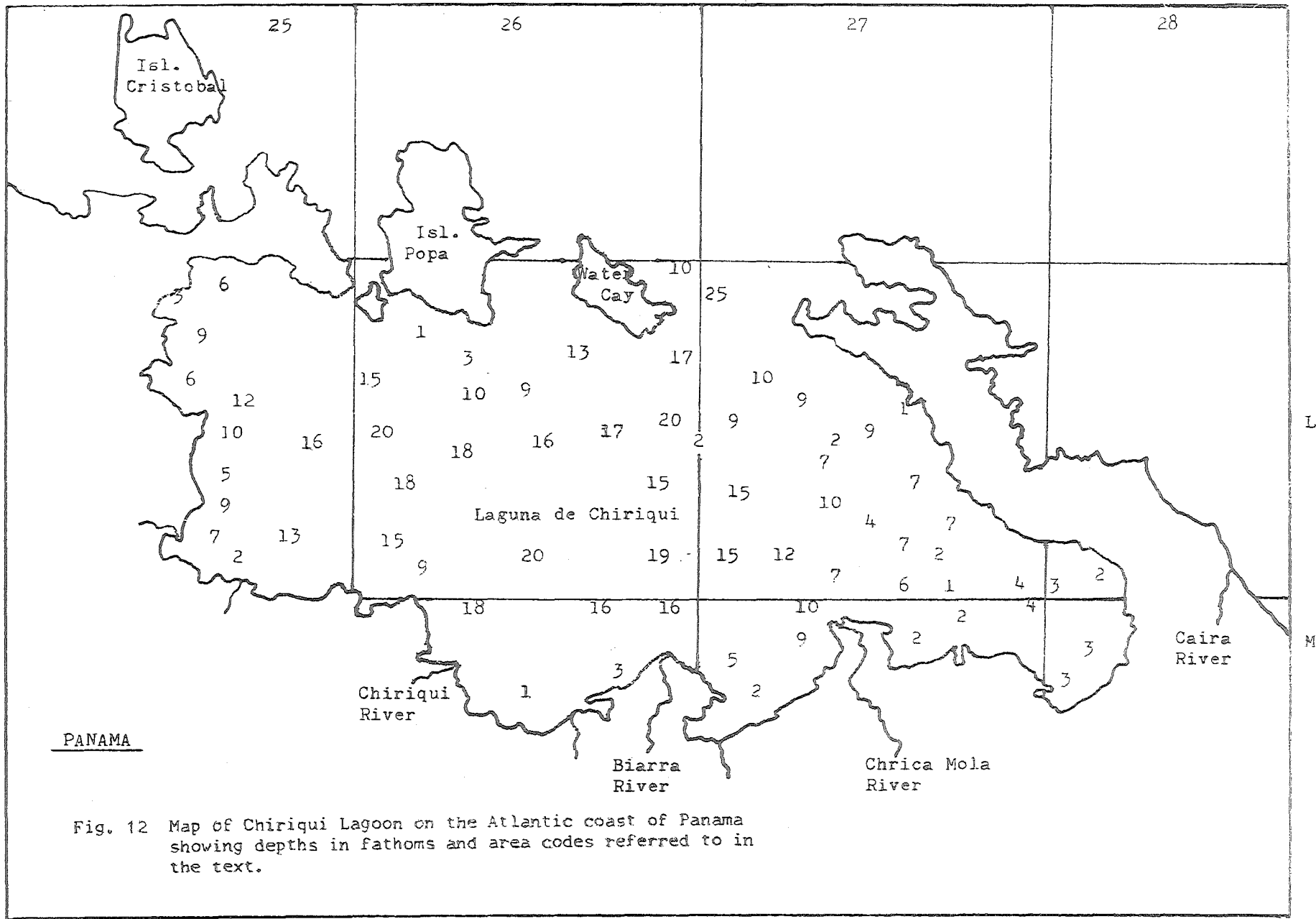


Fig. 12 Map of Chiriqui Lagoon on the Atlantic coast of Panama showing depths in fathoms and area codes referred to in the text.

Limited lobster fishing was carried out in Panamanian waters but the impression gained was that the lobsters were scarce at times of the year other than the traditional season which, in Panamá, is more or less at the same time as in Costa Rica. It was not possible to determine if a resident population existed or whether the animals were migratory.

Following exploratory fishing, Peace (1965) reported good lobster fishing potential in the Bocas del Toro area of Panamá.

Table VIII Summary of results of lobster and fish trapping operations in Costa Rican and Panamanian waters, December, 1967 to November, 1968.

Area	Number of trap days	Catch per trap/day		Depth in fathoms
		Number of lobsters	Pounds of fish	
C 18	5	0	8.0	9-75
D 18	10	0	1.0	5-45
F 19	12	1.4	0	15
F 20	139	1.3	0.7	10-60
G 21	10	0	0	35-40
H 22	4	0	0	15
J 24	26	0	0.3	12-21
J 25	32	0.1	0	7-20
K 26	32	0	0	10-40
L 26	20	0	0.5	3-28
M 26	18	0	0.7	5-15

5.23 Handline fishing

In both countries, this was conducted incidentally to trawling and trap fishing and in general catches were very low. On one occasion however, better than average results were obtained and, when three small boats from Puerto Limon were directed to the area, they caught 2,000 lbs. of snapper in one night.

5.24 Scallop dredging

The scallop dredge was set in various parts of the coastline of both countries but practically no live mollusks of any type were taken. In Chiriqui Lagoon the bag quickly filled up with dead grass and dead shells and the gear proved to be difficult to operate.

5.25 Experimental fishing

The various gears used are listed above and include different types of trawls and traps. Because of the poor catches obtained, it was not possible to draw significant comparisons between the relative efficiency of the different gears.

5.3 Results of tagging experiments

Table IX shows a summary of the results of the lobster tagging experiments. From 345 lobsters tagged, 37 (10.7%) were recovered. Since it had not been possible to issue rewards and it was only possible to inspect directly a small proportion of the lobsters as they were landed, it is almost certain that the captures of tagged animals were higher, perhaps considerably, than the number of recoveries shown. To cite evidence of this, one company which processed less than 20% of the total production, returned 57% of the recovered tags, perhaps because of their having taken greater care in looking for the tags, or perhaps their processing procedures made the tags more readily discovered. Further evidence lies in the fact that two tags were returned from restaurants in San José, both the fisherman and the buyer having failed to find them.

Since tags were not always recovered directly from the fishermen, it was only possible to obtain data on the exact date and fairly accurate position for 13 of the recovered animals. Less complete information was available for a further 10. It is appreciated that this is a small sample and clearly, any conclusions drawn from the data must be considered tentative.

Table IX Summary of results of tagging experiments in Costa Rican and Panamanian waters, September to December, 1968

Number of lobsters tagged	345
Number of lobster tags recovered	37
Percentage of lobster tags recovered	10.7 %
Tags with usable recovery data	13
Tags with limited recovery data	10
Tags for which no recovery data available	14
Range of distance travelled between tagging and recovery	0-34 miles
Range of duration between tagging and recovery	1-62 days
Maximum rate of movement	4.9 miles/day

Only two of the tags for which recovery data are available were in the water for longer than eight days. One of the two exceptions was recaptured 29 days later at a distance of forty miles from the area of release and the other, between 62 and 65 days later at a distance of three miles. All tag recoveries came from south of the area of tagging, mainly between Doce Millas and Isla Uvita, but two returns came from two to three fathoms in the coral reef area of Punta Cahuita.

6. PRELIMINARY EVALUATION OF AVAILABLE RESOURCES

6.1 Fish reference collection

A fish reference collection was established in the Biology

Department of the University of Costa Rica, available for the use of governments, universities, the Project and any other interested agencies. The collection from the Atlantic coast contains 167 species representing 64 families, most taken from the operations of the r/v Orion. The species occurring most frequently are shown on tables X and XI.

6.2 Spiny lobster, Panulirus argus Latreille

a. Annual fluctuations

Table II shows the estimated annual landings in Puerto Limon by months and by fishing season. Most of the data was not collected directly by government inspectors; the information was mailed to the government Fisheries Service by the processing plants and no information was obtained on fishing effort. The accuracy of the data is therefore not known, but the figures are believed to be close enough to reality to enable conclusions to be drawn on the major trends.

It has been reported that prior to about 1960, the processing plants were not organized to handle exports of lobsters on a large scale and the fishermen frequently could not find a buyer. The fishing effort at that time was probably low and the landings may bear little or no relation to the resources available. During 1960, and subsequently to that year, the fishing effort apparently increased markedly in response to an unlimited demand for the product by the processing plants.

It was observed during the 1967-68 fishing season, the poorest on record, that since the unit value of the lobsters and the demand for them is much higher than for alternative products, most fishermen will continue to set their traps during the traditional fishing season, even when catches are low. Since, in 1960-61 the fishermen of the Puerto Limon area were capable of producing 4.8 million pounds, it seems likely that perhaps during that year, but certainly during the other years since 1960, they would be capable of catching a relatively high percentage of the available lobsters and further, that the annual landings reflect the quantity available each year. It also seems to be true that, since the traditional fishing grounds are of limited extension, during years of moderate to poor catches, the fishermen and their fishing equipment are underutilized and that, during these years, the available lobsters could be caught with a lower level of fishing effort.

Table III shows that the highest landings, namely 4.8 million pounds, occurred during the 1960-61 season and the lowest of 140 thousand pounds during the 1967-68 season. Some fishermen claim that good seasons occur in cycles of three years. This does not however seem to be the case, judging from the data shown. Poor and moderate or good seasons seem to alternate and three seasons of much better than average landings, namely 1960-61, 1964-65 and 1968-69, are each separated by four moderate or poor seasons, suggesting a five year cycle. It is not known whether these trends occurred through coincidence or whether they have biological or other significance.

b. Monthly fluctuations

Table III shows that the highest landings occur in December and January and, with the exception of the 1960-61 season, only very small quantities were landed during other months of the year. These data appear to confirm information obtained from other sources on the seasonal availability of the spiny lobster in the traditional fishing grounds with one exception. During most moderate or good seasons, the main December-January "run" of lobsters was preceded by a small run in September. This is not always shown in the statistics received by the government since they are bought for local consumption by buyers other than the processing plants.

With the exception of the unusually good season of 1960-61, spiny lobsters are practically never landed except in very small quantities, between March and August and in October and November. Since, as stated above, the fishermen prefer to fish for lobsters than for anything else, it would seem that the lobsters are only available on fishing grounds accessible to the fishermen in September and between December and February, or at least the abundance during the other months is very low. Similar results occurred during the exploratory fishing operations of the r/v Orion; no lobsters were caught either in traps or in the trawl except during the months of the traditional fishing season. Possible explanations of these trends will be given below.

c. Effect of the fishery on the resources

Only very tentative comments can be made on this topic since information on fishing effort is almost totally lacking.

The "facilities" (fishermen, boats, gear, etc.) required for the exploitation of up to 4.8 million pounds of lobsters existed in Puerto Limon area during the 1960-61 season. This would infer that, since that time and especially during poor seasons, these facilities have been underutilized. It probably also indicates that, during most seasons, the fishing intensity was high in relation with the resources available.

d. Migrations

Migrations of the spiny lobster, Panulirus argus L., have been described by several authors including Smith (1968) and Weber (1968). They report that, while lobsters migrate quite long distances, up to 100 miles in one recorded case, the most common pattern is that of a movement into shallow water for feeding about October, and into deeper water for spawning about March. It is difficult to reconcile this information with the observed habits of the Costa Rican spiny lobsters, namely the apparent southerly movement shown by the tag recoveries during the fishing season of December to February. The interpretation of the trends is further complicated by the fact that, during the "run" which sometimes occurs in September, a high percentage of the females are carrying eggs and by the fact that the nearest area of hard bottom normally considered be the favoured environment of the lobster occurs in the area of Punta Mica, in Nicaragua, more than 100 miles north of Puerto Limon. The apparently "eccentric"

behaviour of the Costa Rican lobsters can perhaps be partly, or largely, explained by the bottom configuration of the area together with the current patterns. The Costa Rican lobsters seem to be arriving from southern Nicaragua, perhaps from the Punta Mica area, looking for food. (It is perhaps of relevance to point out that the peak of the chief lobster fishery in Nicaraguan waters, in the Corn Island area, also occurs between November and January (Anon, 1970).) The strong south-going currents may encourage this movement. The sandy muddy bottom which extends from Punta Mica all along the coast of Costa Rica fails to provide feeding areas. The gradual narrowing of the continental shelf causes the schools to become more concentrated. A deep water "cut" which reaches about two miles from shore about three miles north of Puerto Limon concentrates the schools even more and it is at this point where most of the fishery takes place. Further evidence for this theory is the fact that, when caught, the lobsters are clearly very hungry, practising cannibalism in the traps and even eating the wood of the traps. Since a very large number of traps are set in the very small area where the lobsters would seem to have to pass, probably a very high percentage of the migrating animals will be caught. It is not known if the small fishery which occurs in Panama near its frontier with Costa Rica is supported by stragglers from Costa Rica or whether local stocks exist there.

6.3 Shrimp

Except for very limited periods and in restricted areas, shrimp do not appear to occur in commercial quantities in the area investigated by r/v Orion. The schools which were observed in Punta Cahuita, Costa Rica and in Chiriqui Lagoon, Panama, were clearly of limited extension and the numbers were quickly reduced by fishing.

The three most common species of shrimp which occurred in the catches of the r/v Orion were Penaeus schmitti, Burkenroad, P. duorum Burkenroad and Xiphopenaeus kroyeri (Heller). One of the junior authors observed a "run" of the latter species in February, 1968 at the mouth of the Río Cieneguita. Such runs reportedly occur annually but rarely in February. During the run, the shrimp occur in very large concentrations along the beaches in very shallow water, appearing in the morning, and apparently retiring to deeper water in the evening.

6.4 Green turtle, Chelonia mydas (Linné)

Table III shows the numbers of turtles reported as having been butchered by the processing plants in Puerto Limon. The actual numbers harvested each year is almost certainly higher than this quantity since some of the turtles which are killed for local consumption are not handled by the processing plants while others are slaughtered for the calipee, the gelatinous material between the bones of the under-shell which is the essential ingredient in all recipes for clear green turtle soup.

After the spiny lobster, the green turtle is the most sought after animal by the fishermen of the Atlantic coast and by a beneficial

coincidence, the turtle run occurs at a different time of the year (June-August) than that of the spiny lobster, permitting the fishermen to diversify their operations to some extent. Present evidence suggest that this state of affairs may not continue for much longer. Carr (1968) and his associates have been studying the turtle (especially green turtle) resources for several years and report that the green turtle is in serious danger of extinction through overexploitation and the stocks are likely to reach dangerously low levels within a few years unless drastic conservation measures are applied. Current information on the stocks of green turtles in the Caribbean was reviewed by Ellis (1969), the main source materials being Carr (1968) and Schroeder (1969).

6.5 Tarpon, *Megalops atlanticus* Valenciennes

A brief discussion is presented here on the resources of tarpon because of the actual, and potentially greater, benefits which tarpon fishing by anglers yields to parts of the Atlantic coast of Costa Rica. The tarpon is one of the most sought-after gamefish of the entire Gulf of Mexico and Caribbean area. Anglers are prepared to travel long distances and spend large sums of money to participate in tarpon fishing, especially tarpon fishing tournaments.

Tarpon reportedly occur fairly extensively in the inland waterway system of the coast of Costa Rica north of Puerto Limón, although its total abundance is unknown. They occur also in Lake Nicaragua, perhaps through migrations up the San Juan River whose mouth connects with the waterway at Barra Colorado, Costa Rica. It lives in fresh, brackish and salt water although is rarely found more than a few miles from the shore with a maximum of about 12 miles. At times of the year, concentrations of tarpon occur usually at river mouths, probably for spawning. It is probably such a concentration that occurs at Barra Colorado during the tarpon tournament each year at Easter time. Clearly, the fish are unaware of the significance of Easter or of the tournament, so one might expect that concentrations would occur over a much more extended period than the three days of the tournament and at least, more than once during the year.

During the tarpon tournament of Easter, 1968, biological data were collected from 31 fish landed out of the 155 caught by 52 anglers of the tournament. These ranged in length from 114 cm. to 148 cm. and in weight from 42 to 92 lbs., the females showing a higher average length and weight than the males. Approximately 66% of the female tarpon sampled had ripe ovaries and about half of the males extruded sperm when pressure was applied to the abdominal region. Food was almost totally absent in the stomachs and the stomachs appeared to be somewhat shrunken suggesting that the animals had not fed for some time. The above observations tend to confirm that the tarpon caught were part of a spawning concentration.

Since the smaller fish were released after capture, the group of fish sampled was clearly a biased sample of the total number caught. It was reported however that all fish caught were relatively large and were probably part of the spawning concentration and hence mature.

Economic data collected at the same time were reported by Hawkins (1968). Tarpon will be eaten if the price is low enough or free, as in the case of the 1968 tournament when the people of the local communities received 5,246 lb. In view of the actual and potential importance of the tarpon as a tourist attraction, it would probably be unwise to encourage a commercial fishery for it. The resources may not be sufficiently abundant to support both commercial and sport fishing; sport fishing, as presently practiced, only exploits large, mature animals and even some of these are released.

Accommodations for sport fishermen are currently available in Barra Colorado and Parismina and a new facility will be opening shortly in Tortuguero.

6.6 Trawl-caught bottom fish

Since only about 1% of the fish caught by r/v Orion during trawling operations are presently considered to be marketable for human consumption and no trawl fishery exists in the area, any detailed discussion of the species composition of the catches is only of academic interest and not appropriate to a report of this type. A wide range of species were found with no one or more species predominating over the others. A summary of the species composition and average lengths of each of the catches of the trawls made on the exposed Caribbean shore line is shown on Table X and similar data from Chiriquí Lagoon and Almirante Bay on Table XI. No further comments will be made on these data for the reasons given above.

6.7 Other marine resources

The primary objective of the exploratory fishing made by r/v Orion was the location of those resources, chiefly shrimp and spiny lobsters, which might be suitable for export. Most of the fishing effort was therefore done with gears designed to catch these. With a somewhat lower level of priority, exploratory fishing for reef fish, particularly snappers, was also included in the plan of work, to be done with drop lines. Few reef areas were located by the vessel's echosounder and only a limited amount of reef fishing was done, usually with poor results except on one occasion when local fishermen were directed to one apparently good area where they caught 2 000 lb. of snappers in one night. Because of the low intensity of fishing, these results cannot be considered to be conclusive. The only other information available on possible marine resources are the catches and observations of the fishermen themselves. The fishermen report the occurrence of at least moderate quantities of mackerel, jacks, kingfish, sharks and other, chiefly surface and midwater fish. The fishermen already catch quantities of these and other species and claim that their catches could be increased if a market existed for the products and perhaps also with more suitable gears. In view chiefly of the marketing problem, it does not seem likely however, that the resources of these other species by themselves could sustain the operations of larger mechanized vessels. If a market could be found, initially at least, the exploitation of these species would probably be done more intensively by existing fishermen and gear, at

Table X List of the most commonly occurring species of fish in the shrimp trawls of the r/v Orion between San Juan del Norte, Nicaragua, to Cahuita, Costa Rica

Scientific name	Common names		Aver. stan. length mm.
	English	Spanish	
Occurring in 75-100% of the hauls			
<u>Larimus breviceps</u>	Cabezon	Cabezon, china	100.6
<u>Cynoscion</u> spp. 1/	Weakfish, corvina	Corvina,	146.4
<u>Bagre marinus</u>	Sea catfish	Bagre	115.2
Occurring in 50-74% of the hauls			
<u>Arius spixii</u>	Catfish	Cuminante	120.5
<u>Polydactylus virginicus</u>	Threadfins	Bobo	129.5
<u>Vomer setapinnis</u>	Jadis, Cavallas	Palometa	88.2
<u>Opisthonema oglinum</u>	Thread herring	Arenque, sardina	91.8
<u>Micropogon furnieri</u>	Drummer	Verrugato	118.3
Occurring in 25-49% of the hauls			
<u>Umbrina broussonetti</u>	Croaker	Corvina	157.0
<u>Chloroscombrus chrysurus</u>	Cavallas	Jureles	101.1
<u>Anchoa</u> spp. 2/	Anchovy	Anchoveta	89.5
<u>Paralanchurus brasiliensis</u>	Croaker	Rayado	105.9
<u>Menticirrhus martinicensis</u>	Croaker	Corvina, Verrugato	146.4
<u>Trichiurus lepturus</u>	Cutlassfish	Pez machete	281.7
<u>Syacium</u> spp. 3/	Flunder	Pez hoja	87.4

1/ Cynoscion jamaicensis and C. virescens

2/ Anchoa argenteus and A. spinifer

3/ Syacium micrurum and S. pappillosum

Table XI List of the most commonly occurring species of fish in the shrimp trawls of the r/v Orion in Chiriqui Lagoon, Panamá

Scientific name	Common names		Aver. stan. length mm
	English	Spanish	
Occurring in 75-100% of the hauls			
<u>Gerridae</u> 1/	Mojarra, shad	Mojarra	92.6
<u>Menticirrhus martinicensis</u>	Croaker	Salmoneta	131.0
<u>Bagre marinus</u>	Sea catfish	Bagre	193.4
<u>Lutjanus</u> spp. 2/	Snapper	Pargo	122.4
<u>Chloroscombrus chrysurus</u>	Cavallas	Jureles	122.1
Occurring in 50-74% of the hauls			
<u>Upeneus parvus</u>	Goatfish	Salmonete	116.8
<u>Polydactylus virginicus</u>	Threadfins	Bobo	136.8
<u>Trichiurus lepturus</u>	Cutlassfish	Pez machete	258.7
Occurring in 25-49% of the hauls			
<u>Larimus breviceps</u>	Cabezon	Cabezon	120.8
<u>Sphyraena</u> spp. 3/	Barracuda	Barracuda, Picuda	200.0
<u>Pomadasyidae</u> 4/	Croaker	Roncador	109.2
<u>Anchoa</u> spp 5/	Anchovy	Anchoa	86.9
<u>Cynoscion</u> spp. 6/	Weakfish, corvina	Corvina	153.5

- 1/ Eucinostomus gula and Diapterus rhombeus
- 2/ Lutjanus mahogoni and L. Synagris
- 3/ Sphyraena guachancho and S. picudilla
- 4/ Conodon nobilis and Pomadasys corvinaeformis
- 5/ Anchoa argenteus and A. spnifer
- 6/ Cynoscion jamaicensis and C. virescens

times of year other than the present turtle and lobster seasons to make fishing more of a year around activity for a larger number of fishermen.

Resources of crustaceans and molluscs appear to be relatively scarce along the coast. Several sets of the scallop dredge in various areas produced negative results and only a few shellfish were taken in the trawling operations of the r/v Orion. The only animal which appears to occur in at least moderate quantities is an oyster, Isognomon alatus Gmelin. This may have some commercial potential but only grows to about 2-3 inches in length and is thin with a low meat yield. Tests made of samples of these oysters in the Chemistry Department of the University of Costa Rica indicated that they were safe within the sanitary standards of Costa Rica.

6.8 Fresh and brackish water resources

Fresh water shrimp reportedly occur fairly commonly in the rivers and estuaries along the Atlantic coast of Costa Rica. Two were caught in a trap set by r/v Orion, at Barra Colorado and identified as Macrobrachium carcinus (Linneus). This animal is highly esteemed as food and its production could perhaps be increased through more intensive fishing with appropriate gears in appropriate areas.

Resources of other fresh and brackish waters animals exist in the fairly extensive inland waterway system to the north of Puerto Limon. Mention has already been made of the occurrence of fresh water shrimp and tarpon and, it has been reported that the snook is also common, particularly at the mouths of rivers. Other species occurring in the area are reported by Hawkins (1968). Samples have also been obtained of a brackish water oyster, tentatively identified as Crassostrea rhizophorae Guilding. This oyster grows to 2-6 inches in length and has a higher meat yield than the marine one mentioned above. This species might be suitable for culture.

It has not been possible to make even a rough estimate of the resources of the area although it seems that the production of at least some of the species could be increased, perhaps considerably, through more intensive fishing.

Dredging operations are presently being undertaken to open an inland water canal in the area which should make it more accessible.

7. CONCLUSIONS AND RECOMMENDATIONS

The most obvious conclusion was that the Atlantic coast of Costa Rica does not offer promising prospects for a significant increase in fishing activity certainly not in the near future, and perhaps never. Sea conditions severely restrict the operations of small fishing vessels yet the available resources do not seem to justify the use of larger ones. Because of poor communications to the more densely populated parts of the country, products of low unit value can

only be sold among the relatively restricted population of the Atlantic coast. This tends to limit prospects for fisheries expansion in the near future.

It would seem to be worthwhile here to summarize briefly the available knowledge of the major resources which have been recognized and to comment on their actual or potential future importance.

7.1 Shrimp

It does not appear that the shrimp resources of the Atlantic coast of Costa Rica or of Chiriqui Lagoon or Almirante Bay of Panama are sufficiently abundant to support the year around operations of even one small shrimp trawler. Small schools were found infrequently and it seems that might provide additional earnings to boats normally fishing for other resources. The exploratory fishing of r/v Orion would seem to have been sufficiently complete both geographically and seasonally to enable it to be concluded that further exploratory shrimp trawling would not provide different conclusions about the shrimp resources.

7.2 Spiny lobsters

It appears that only a few spiny lobsters are present on the continental shelf of Costa Rica throughout the year but that these do not constitute an important resource. The major lobster resource appears to consist of groups of animals arriving probably from Nicaragua, sometimes in September, but with the main run in December and January. During this run, the animals seem to be looking for food but with little success since few suitable feeding areas appear to exist within a distance of at least 100 miles north of Puerto Limon. Thus the Costa Rican catches are based upon lobsters which are actually migrating. If this is true, the most obvious recommendation concerning the fishery would be that the fishermen should be encouraged to catch as many as possible when they are available.

It is possible that, at least during years of less than peak abundance, a greater economic return from the fishery could be obtained from the lobster resource in Costa Rica if the total fishing effort were reduced through the restriction of permits. During such years, there may in fact be justice in restricting the fishery to persons who derive all or most of their annual earnings from fishing.

It is impossible at this stage, to predict the possible effect on the Costa Rican lobster resource of an expansion of fishing activity in Nicaragua. An expansion in the Punta Mica area, the predicted point of take-off for the Costa Rican lobsters, could conceivably reduce the number migrating towards Costa Rica.

7.3 Turtles

From a conservation point of view, there seems to be no doubt that all exploitation of turtle eggs, juvenils and nesting females on the Atlantic coast of Costa Rica, and elsewhere in the

Caribbean, should be prohibited. There is evidence that the stocks of these animals are at a dangerously low level and they will have practically disappeared within a few years if the exploitation is allowed to continue. The Government of Costa Rica are fully aware of this situation and are taking steps both nationally and internationally to try to establish a Caribbean conservation programme for the green turtle. The authors feel that national and international agencies should support the efforts of the Government of Costa Rica in this endeavour.

7.4 Demersal and reef fish

Prospects for the expansion of the fisheries for demersal and reef fish seemed to be relatively poor. Information on the demersal fish was obtained from the extensive trawling carried out through the areas by the r/v Orion. Catches were almost totally negative on the Costa Rican coast and in Almirante Bay. The catches in Chiriqui Lagoon consisted almost exclusively of small fish, not presently considered to be marketable. Although it is possible that these fish could be sold as bait in Costa Rica during the lobster season, even if the legal problems could be solved, this activity would only occupy the fishermen for about two months per year and would have to be combined with something else.

A few concentrations of reef fish were discovered in the exploratory fishing operations of the r/v Orion but suitable bottom type for these fish is very scarce in Costa Rican waters. Prospects in Panamanian waters may be better but the survey was less complete in that area. A small expansion of production of reef fishes might be expected if accompanied by exploratory fishing but it is doubtful if the economic benefit of such expansion would justify the costs of the exploratory fishing.

7.5 Other marine and brackish water resources

A relatively wide variety of other species of fish, and two species of oysters, reportedly exist in both the ocean and in the fresh and brackish waters of the inland waterway system. The most important of these appear to be the snook, tarpon, mackerel, kingfish and grouper. Aside from the by-products of the shark, these fishes do not appear to be suitable for the export market because of their relatively low unit value. No information is available on their abundance but it seems to be certain that at least a moderate increase in production would be achieved through more intensive fishing and perhaps also through the use of more suitable fishing gears. There seems to be no doubt that the major limiting factor to the expansion of the fishery for these species is the lack of a market for them. Presently, almost the entire production is consumed within the Puerto Limon area with a population of about 40,000 people.

7.6 Game fishing

An activity which may have been partially neglected, in the light of the resources available is game fishing. Tarpon, and per-

haps snook, appear to be at least moderately abundant, especially near the river mouths and perhaps also in the inland waterway system. Although some game fishing takes place throughout the year, most of the fishing for tarpon is concentrated during the tournament at Easter time. Almost the only information available on the abundance of actual or potentially attractive game fish is that of the catches made during the tournament. The promotion of game fishing might bring economic, if not nutritional, benefits to the area in anglers expenditures on guide services, room and board, boat rentals etc. It is understood that improvements have been made in accommodations for anglers. A further worthwhile step would seem to be the conduct of a survey by means of interviews of game fishermen and local inhabitants to obtain information on the seasonal and geographic availability of the species of fish traditionally attractive to anglers and, in particular, of tarpon and snook. The results of the survey, together with the updating of the report by Hawkins (1968), might be used in a more active promotional campaign to try to attract more anglers, particularly on a year around basis.

7.7 General

The authors do not predict a significant increase in fishing activity on the Atlantic coast of Costa Rica in the near future; in fact, little expansion can probably be expected until an all weather road to the populated centres of the Central Plain. The authors feel however, that the Government should give consideration to the possibility of the provision of sheltered loading and unloading facilities for fishermen in connection with any project for port improvements for Puerto Limon, provided that this can be done at relatively low cost. While such facilities might only marginally reduce the costs of fishing, they would provide more substantial benefits in the convenience and safety of operations.

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