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AN APPRAISAL OF THE SHRIMP RESOURCE OF THE GUATEMALAN PACIFIC COAST

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CONTENTS

		Page
1.	ABSTRACT	1
2.	ACKNOWLEDGEMENTS	1
3.	INTRODUCTION	1
4.	SHRIMP SPECIES EXPLOITED	2
5.	HISTORY OF THE PACIFIC FISHERY	2
6.	THE PRESENT FISHERY	3
	6.1 PESCA, S.A.	3
	6.2 MARISCOS DE GUATEMALA	5
	6.3 GUATEMALAN FISHING LAWS	5
7.	COMMERCIAL SHRIMP STATISTICS	6
	7.1 FISHING EFFORT	6
	7.2 PRODUCTION DATA	7
8.	TRENDS IN PRODUCTION	7
	8.1 WHITE SHRIMP	7
	8.2 BROWN SHRIMP	7
	8.3 RED SHRIMP	8
	8.4 CAMARONCILLO	8
9.	APPRAISAL OF THE RESOURCE	9
10.	RECOMMENDATIONS FOR SHRIMP RESOURCE MANAGEMENT	10
11.	RESUMEN EN ESPAÑOL	12
	11.1 ESTIMACION DE LOS RECURSOS	12
	11.2 RECOMENDACIONES PARA REGLAMENTACION DE LOS RECURSOS DE CAMARON	13
12.	REFERENCES CITED	15
13.	FIGURAS Y CUADROS	17

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1. ABSTRACT

White shrimp, Penaeus vannamei and P. stylirostris, and brown shrimp, P. californiensis, form the basis of the Guatemalan Pacific fishery. The author estimates that less than 30 fishing vessels are needed to effectively exploit the limited commercial resource. Schaefer's model predicts that this effort would yield average yearly landings of 2.3 million pounds of headed shrimp; yearly landings will vary between 1.4 and 3.1 million pounds.

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3. INTRODUCTION

The shrimp industry is Guatemala's only developed fishery. For several years, a small trawl fishery existed on the Caribbean Coast, but this ceased operations in 1963. The Pacific trawl fishery began in 1957 with two vessels. In 1966, the fleet reached its present size of 28 doublerigged trawling vessels. In the sixties/, This fishery contributed approximately 1.5 million dollars yearly in exports to the economy. However, in 1968, production fell; total landings were only one-third those of 1966. The Guatemalan government's concern for this decline prompted the preparation of this paper.

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Lindner (1957) and Croker (1967) made surveys of the Guatemalan fishery. The production data have been published (Bol. Estad. Pesca #1), but never analyzed. With the exception of Panama and El Salvador (Boerema, 1961; Ellis, 1965, 1968), this situation exists throughout the Central American Region.

This paper will describe the history and characteristics of the Pacific shrimp fishery, evaluate the trends in production from 1960 to 1969, offer an appraisal of the resource, and recommend management procedures to assure its rational exploitation.

4. SHRIMP SPECIES EXPLOITED

Ten species of shrimp comprise the Pacific landings: white- Penaeus stylirostris STIMPSON, P. vannamei BOONE, and P. occidentalis STREET, brown- P. californiensis HOLMES, red-P. brevirostris KINGSLEY, and camaroncillos. The term camaroncillos refers to five species: Trachypenaeus byrdi ALCOCK, T. faoea LOESCH and AVILA, T. similis pacificus BURKENROAD, Protachypene precipua BOUVIER, and Xiphopenaeus riveti BURKENROAD.

These species have a distinct vertical distribution. White shrimp inhabit waters of 7 to 25 faths (13 to 45 m) but P. vannamei is found in deeper waters than P. stylirostris. Brown shrimp are encountered in waters of 15 to 35 faths (27 to 64 m). Red shrimp are fished in depths of 35 to 65 faths (64 to 119m). Camaroncillos are found in the same depth range as white shrimp.

Kutkuhn (1966) summarized the life cycle of penaeid shrimp. The adults spawn in the open sea, and the microscopic, semi-buoyant eggs hatch soon thereafter into small planktonic nauplii. The shrimp pass rapidly through the protozoeal and mysis stages to the postlarval stage while the shrimp move or are transported by ocean currents towards river mouths or through passages into wide, shallow estuaries. Once in the brackish waters of the estuaries, the postlarvae grow rapidly into juveniles, reaching commercial size in two to four months. At this time, they return to the open sea. The average life span of penaeid shrimp is 1.5 to 2 years.

The author believes the relatively low productivity of Guatemalan waters is related to the paucity of nursery grounds for larval shrimp. There are few estuary systems that have permanent openings to the sea. Thus, it is possible that the Guatemalan fishery is dependent on northward migrations of shrimp populations from the Gulf of Fonseca in El Salvador or southward migrations from the Gulf of Tehuantepec in Mexico. However, no studies have been conducted to determine the importance of Guatemalan estuaries to the offshore fishery.

5. HISTORY OF THE PACIFIC FISHERY

In 1957, the commercial shrimp fishery initiated operations. Within three years, there were 17 boats in the fishery (Table 1). In 1961, Copesgua, S.A. and Pesca, S.A. built a new packing plant in Champerico. Mariscos de Guatemala brought nine boats into the fishery in 1962 and opened a packing plant in San Jose. In the same year, 14 Nicaraguan shrimp boats and four Mexican boats entered the fishery bringing the fleet to 53 boats. Early in 1963, the catches dropped, and 27 boats left the fishery; Mariscos de Guatemala closed its plant and transferred its boats to Panama; the operating license of the Nicaraguan firm, Inpesmar, expired and under Guatemalan law could not be renewed. Except for Mariscos de Guatemala's temporary transfer of its boats to Panama and Nicaragua, the size of the fleet has remained at approximately 30 boats since 1963.

6. THE PRESENT FISHERY

The 230 km Pacific coastline has no natural harbours (Fig. 1). The Pacific ports are Puerto San José, located approximately 75 km from the El Salvadorean border, and Champerico, 120 km further north. Un-protected roadsteads with piers, but no docking facilities characterize the port facilities of both towns. Loading and un-loading of the vessels at the pier are always difficult, and in rough weather may be hazardous. Mariscos de Guatemala constructed a road from the Chiquimulilla Canal to its plant near Puerto San José, and its vessels unload behind the plant. However, navigation of the canal entrance is difficult. Pesca, S.A. uses the present facilities at Champerico. Plans have been approved for the construction of a good harbour and port facility near Champerico, but it will be some time before the port is in operation.

The narrowness of the continental shelf limits the available fishing grounds. The fleet presently trawls down to 65 faths (120 m). Substantial stocks of shrimp have not been found beyond these limits.

Many companies with different size vessels characterized the early years of the fishery (Tables 1 and 2). Operational efficiency apparently was low during this period; in 1962, only 38 to 66 percent of the fleet was fishing during any particular month. Since there were no boat yards in Guatemala, the fleet went for repairs to Salina Cruz, Mexico, 525 km north of Puerto San José.

Presently, Pesca, S.A. and Mariscos de Guatemala are fishing the Pacific resource. Each company uses standardized vessels (Table 3) and repairs its boats at dry dock facilities built near Iztapa.

Appendix I summarizes the production data of the commercial fishery from 1960 to 1969. There is also a castnet fishery for juvenile and sub-adult shrimp in the estuaries, but there are no data available on this sector of the fishery.

6.1 PESCA, S.A.

Pesca, S.A. is the largest shrimp company in Guatemala, and the only company that has operated continuously since 1959. It is now a Guatemalan-Japanese enterprise with the Japanese firms of Mitsubishi and Nichiro holding a 49 percent interest.

The fleet supervisor and most of the boat captains are Japanese, but the four man crew-- machinist, winch operator, and two crewmen are Guatemalans. The captains receive a monthly salary plus a commission from the catch. The crew receives only a percentage of the value of the shrimp landed.

The company has divided the coastline into numbered areas (Fig. 1). The captain keeps records for each haul recording date, hour, area number, and the estimated number of pounds of white, brown, red shrimp or camaroncillos caught. When analysis of the data shows production of large white and brown shrimp dropping in certain areas, the company will close these areas, an encourage its boats to fish for the lower priced red shrimp and camaroncillos by raising the price it pays the crew for these types.

The fleet of Pesca, S.A. is composed of 62 to 73 ft (19 to 22m) wooden vessels. The boats trawl two nets in the manner described by Knake, Murdock, and Cating (1958).

The average fishing trip is 12 to 14 days, however, in times of poor fishing, trips are as short as 4 days, and in times of good fishing, as long as 20. The boats are overhauled every six months at the company's dry dock.

Nets are trawled for 2 to 2.5 hours at a time, 24 hours a day. Day fishing is directed at white shrimp populations in 7 to 25 faths (13 to 46 m). At night, the boats move further offshore and fish for brown and red shrimp.

Several fishing vessels search the coastline for concentrations of shrimp. When a shrimp bank is located, the fleet is notified. Part of the fleet converges on the area, while the scout boats resume their exploratory fishing. The monthly pay of the scouting boats'crews is based on the average number of pounds landed per fishing boat.

Most shrimp are de-headed on board, washed, and placed by type (white, brown, red shrimp, and camaroncillos) in refrigerated brine tanks. There are six 2,000 lb (907 kg) tanks on board, and one is usually reserved for fish. At Champerico, the shrimp are placed into fifty gal (190 l) drums by type, lowered to a small company boat that transports them to the pier, and then hoisted to the dock. From here, the drums are transported by tractor-drawn trailer to the plant, 0.75 km away. Shrimp are graded by type. The most common sizes are: U-10, 11-15, 16-20, 21-25, 26-30, 31-35, 36-40, 41-45, and more than 45 tails to the pound. Large white and brown shrimp are packed in one and five pound boxes, glazed, and hard frozen within 3.5 hours. The smaller white, brown, and red shrimp and camaroncillos and broken pieces are placed in one pound plastic bags. The plant has an 80,000 lb (36 t) cold room that keeps the shrimp at $-35^{\circ}C$ until shipment. The plant at Champerico is strictly a packing plant. Practically all of the shrimp is boxed, headed shrimp. Exports of peeled shrimp only accounted for 0.6% of exports to the United States in 1968 (Table 4).

Smaller shrimp are sold on the local market, but the majority of the shrimp are exported. Some shrimp is exported to Japan by boat from Champerico, but most exported shrimp is sent to the United States using the trailer-ferry from Puerto Matías de Galves on the Caribbean. The distributor in the Miami area is International Fisheries Trading Company. Mitsubishi International, Inc. handles distribution to Los Angeles, New York, and Japan. Cerra Commercial is the distributor in Puerto Rico.

6.2 MARISCOS DE GUATEMALA

A Panamanian based company, Sui Chan and Co., Ltd. founded Mariscos de Guatemala in 1962. In 1969, "El Ganadero", a Guatemalan cattle firm, bought the company.

The low production per boat from 1962 to 1968 resulted from poor management. The new owner over-hauled the fleet, and by better management increased production.

All crewmen are Guatemalans. The pay of the winch operator, mechanic, and crewman is based on a percentage of the catch's value. The captain's salary depends on the quantity of shrimp landed.

The boat captains work independently, however, they will often signal one-another upon locating a rich shrimp bank. Competition is keen between Mariscos and Pesca. Pesca reports the activities of its scout boats in Japanese to prevent Mariscos from utilizing the information. Nevertheless, on several occasions, the author has observed three to four boats of Mariscos' fleet fishing in the vicinity of Pesca's fleet.

Mariscos' fleet is composed of 61 ft (18.5m) steel boats. Each trawls two 65 ft (20 m) nets. The average fishing trip is 10 to 16 days. The boats trawl day and night.

Shrimp are de-headed on board, washed, and placed in refrigerated brine tanks. The shrimp are un-loaded directly behind the plant in Iztapa, placed in wooden boxes of 200 lb (90 kg) capacity, and trucked 1 km to the plant. Of the shrimp landed, 70 to 80 percent are destined for export. These are graded, packed in five lb (2.2 kg) boxes, quick frozen, and shipped by trailer ferry to Miami. The distributor in the U.S. is Gulf Export. Shrimp for local sale are frozen in five pound plastic bags.

6.3 GUATEMALAN FISHING LAWS

The majority of Guatemalan fishing laws are contained in Decreto 1235 (18 January, 1932), Decreto 1470 (23 June, 1961), and a government resolution concerning the rational exploitation of fishery resources (16 August, 1962).*

The Ministry of Agriculture through the Division de Fauna is authorized to issue licenses to firms and individuals for ocean fishing on a large scale. Companies wishing to obtain a commercial fishing license must have boats of not less than 30 tons nor more than 100 equipped with fishing gear adequate for the type of fishing proposed and refrigeration.

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*"Acuerdo gubernativo que contiene el reglamento para la aplicación de la ley sobre explotación en forma racional de los recursos pesqueros del país"

The shrimp fleet is restricted to 50 vessels. Boats not registered in Guatemala are limited to six months of operation. At the end of this term, they must register or leave Guatemalan waters; their license cannot be renewed. Likewise, Guatemalan boats are prohibited from fishing in foreign waters for more than six months; after that time, their operating license is subject to revocation.

The laws encourage fishing operations with more than 50 percent Guatemalan capital by granting free operating licenses and waiving dockage fees. For firms with less than 50 percent Guatemalan capital, the annual license fee is calculated at Q30* to Q160 per ton for each foreign flagship in their fleet, and dockage fees are charged at Q25 to Q50 per ton for shrimp boats, and Q5 to Q10 per ton for boats engaged in other fishing. These companies must have a permanent representative in Guatemala and must have from Q2,000 to Q5,000 collateral before initiating fishing.

Companies that export shrimp through Guatemala must provide processing and packing facilities at their port of operation. Only foreign flagships that send their catch directly to foreign markets are exempt from this provision. Guatemalan law states that companies processing shrimp must land other fishery products (fish, squid, lobster) caught incidentally with the shrimp at a percentage determined by the Ministry of Agriculture; however, this statute is not enforced. The companies must reserve for local sale 60 percent of the fish, lobster, and squid landed, and 10 percent of the shrimp.

At the present time, there is no export tax on fishery products. There is a monthly fee of Q450 charged to each shrimp company to cover the salaries and office expenses of the government fishery personnel.

7. COMMERCIAL SHRIMP STATISTICS

7.1 FISHING EFFORT

Fishing effort is recorded by the Marine Fisheries Department as the number of days a fishing vessel spends at sea. Unless the boat leaves port before noon, the day of departure is not included in the number of fishing days. Boats fish for white, brown, and red shrimp, and camaroncillos during the same trip; however, the effort expended in the capture of each type of shrimp is not recorded.

The fishing fleet spends little time in "searching activity" since the scout ships of Pesca, S.A. locate the shrimp banks, and the boats of Mariscos de Guatemala frequently fish in the vicinity of Pesca's vessels.

On the average, seven 2 to 2.5 hour hauls are made daily. The rest of the time is spent repairing nets and traveling to new fishing areas.

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* Q 1.00 (one quetzal) = $1.00 (one U.S. dollar)

7.2 PRODUCTION DATA

Daily production differed among different size vessels of the fleet (Table 5). The 72 ft (22 m) boats powered with 300 HP engines caught the most shrimp (Table 6); these longer boats trawl larger nets, and their more powerful engines permit trawling at higher speeds. Generally, the boats of Pesca, S.A. land more shrimp per boat than those of Mariscos de Guatemala.

The difference in production among the different boat classes and between the two shrimp companies suggests that production data would be more meaningful if they standardized to those of a standard size category of vessel. Although this has not been done for the analysis presented in this report, standardization of the data would permit more accurate comparisons of fishing effort among years.

The conversion factors from headed to heads-on weight are not well documented for the species landed in Guatemala. For this reason, all shrimp landings are reported as pounds of headed shrimp.

8. TRENDS IN PRODUCTION

The yearly production data and fishing effort for the fishery are diagrammed in Figure 2. The relationship between fishing effort and total landings can be better understood by examining yearly production by shrimp type.

8.1 WHITE SHRIMP

P. vannamei and P. stylirostris predominate the catches of white shrimp; P. occidentalis comprise less than 1% of total white shrimp landings. Yearly landings remained relatively constant from 1964 to 1969, fluctuating from 555,100 to 710,000 pounds.

Since 1963, white shrimp have comprised 21 to 39 percent of shrimp landings. They are the largest and most valuable shrimp caught (Table 7). The tails per pound data (Table 8) indicate a stable population structure since from 1965 to 1969, the number of shrimp graded U-15 only varied by 11 percentage points. For these years, 70.4 percent of white shrimp landed was graded under 15 tails to the pound.

Catches of white shrimp were highest from September to January (Figures 3 and 4). Although spawning and recruitment occur throughout the year, landing data suggest that heaviest recruitment may occur seasonally (Keiser, 1971).

Apparently, landings are not directly dependent on fishing effort. Between 1967 and 1968, white shrimp catches increased by 23,000 pounds, but fishing effort decreased by 3,150 days.

8.2 BROWN SHRIMP

Since 1963, brown shrimp have constituted 40 percent of all shrimp landed. They command a price per pound second only to white shrimp (Table 7).

Recruitment to the fishery occurs year-round (Keiser, 1971). The periodicity in the landings (Fig. 5) probably reflects changing fishing effort for white shrimp.

Yearly production of brown shrimp fluctuated between 661,000 and 1,192,000 pounds of headed shrimp until 1968 when only 332,000 pounds were landed. Although over-all fishing effort for 1968 was low, a comparison of monthly effort (Appendix II) illustrates that during the period of greatest landings (February to May), effort was higher than in 1966. The 1968 effort during this period was higher than in 1964, the best year for the brown shrimp fishery.

The low brown shrimp landings in 1968 cannot be attributed to overfishing in the previous year. The 1967 level of production has been exceeded three times (Appendix I). In two instances, 1964 and 1966, this was followed by moderate decreases in landings; however, from 1963 to 1964, landings actually increased by 235,000 pounds. Furthermore, the shrimp landed in 1968 were actually larger than in 1967 (Table 8); this would not be expected if overfishing had indeed occurred.

For these reasons, the author assumes that natural factors decreased the standing populations of brown shrimp in 1968. Landing for 1969 were 56 percent higher than those of 1968 indicating that the standing population is again increasing.

8.3 RED SHRIMP

Red shrimp are smaller and less valuable (Table 7). Landings have fluctuated between 144,000 and 435,000 pounds during the last four years (Figures 4 and 6).

The fishery for red shrimp increased rapidly from 1964 to 1966. This seems to reflect the price of red shrimp on the U.S. market (Table 7), which was increasing at a faster rate than the price for either white or brown shrimp. Before 1964, red shrimp were an untouched resource. Since 1966, the market price for red shrimp has remained relatively constant although the value of white and brown shrimp has continued to rise. Thus, economically, it has become more important to devote effort to the capture of white and brown shrimp since they command a price per pound almost double that of red shrimp. Because of the strong influence of economic factors, the landing data probably do not reflect the density of the standing shrimp population.

Since spawning and recruitment occur throughout the year (Keiser, 1971), the periodicity in the landings (Figures 4 and 6) is caused by a shift in fishing effort.

8.4 CAMARONCILLO

Camaroncillo landings have fluctuated greatly in recent years from 1 million pounds in 1964 to 138,000 pounds in 1968. They are the smallest and least valuable shrimp (Table 7). Camaroncillos are caught incidentally with white shrimp; however, during certain months, they are fished extensively near the El Salvadorean and Mexican borders.

Presumably, the economics of the red shrimp fishery are applicable to the camaroncillo fishery. Since 1966, the U.S. price of white shrimp has increased by more than 50 percent while the amount paid for the smaller camaroncillos has actually decreased slightly. In addition, the smaller size of these shrimp results in more boat time in de-heading and sorting and more plant time in processing.

There have been large yearly fluctuations in camaroncillo landings. Production more than doubled between 1963 and 1964 and between 1965 and 1966. The reasons for the cyclic nature of the fishery are not known. No relationship was found between the number of pounds of camaroncillos landed and the number of boats in the fishery in any one year.

Production data reveal that landings have been consistantly poor during the first three or four months of each year, but later have risen rapidly reaching a peak in June and, in some years, a second peak in November (Figures 4 and 7). It is not possible to tell from the data whether there are fewer camaroncillos during the first three months of the year, or if the fleet is directing most of its effort in these months for white and brown shrimp.

9. APPRAISAL OF THE RESOURCE

The proportion of the shrimp population landed depends on: 1) the selectivity of the gear--2 inch (51mm) stretch mesh allows a percentage of ocean shrimp to escape capture; 2) selectivity of the fishermen--some small shrimp are discarded at sea; and 3) the value of one shrimp species in relation to another--more effort is directed at the more valuable species. These factors limit the usefulness of landing data in estimating standing shrimp populations.

The amount of shrimp landed per unit effort is related to the standing shrimp population at that period of time; when there is a large population, shrimp are landed in large quantities; when there is a small population, shrimp are harder to find and quantities landed are smaller. Thus, the ratio of fishing effort to pounds of shrimp landed is proportional to the population. Kutkuhn (1962) called this ratio the fishable biomass index.

Assuming that biomass is reflected in the ratio of total catch to total fishing effort, it is possible to obtain an estimate of the biomass. This can be done by calculating the regression between these two parameters and later constructing a curve using this relationship. (Schaefer, 1955, 1957).

There are limitations to applying the Schaefer Model to the Guatemalan data: 1) effort data are not separated by species, and pro-rating the data artificially by weight or value of the catch is considered invalid (Keiser, 1970) and 2) the model considers fishing effort to be the only factor acting on the shrimp populations; however, evironmental conditions do influence shrimp abundance. Furthermore, landings of red shrimp and camaroncillos are strongly related to abundance of white and brown shrimp stocks.

The regression of total catch vs. total effort (Table 9) shows that the two variables are strongly related (Table 10, Fig. 8). The predicted yield at each level of fishing intensity was computed by substituting values in the regression equation.

The data appear to predict that a fishing effort of 8,000 days would result in an annual yield of 2.45 million pounds of headed shrimp. However, examination of Figure 9 reveals that a 33 percent increase in fishing effort from 6,000 to 8,000 days results in only a 6% increase in actual landings. Furthermore, natural fluctuations in shrimp stocks must also be considered. Lindner (personal communication) reported that catches of P. setiferus (white shrimp) and P. aztecus (brown shrimp) in the Gulf of Mexico fluctuated annually by factors of 3 and 7, respectively. These species occupy the ecological niches filed by the white and brown shrimp of the Guatemalan Pacific fishery.

The author believes that an average yield of 2.3 million pounds of headed shrimp could be maintained with 6,000 24-hour fishing days. Because of natural fluctuations in shrimp abundance, this effort would yield yearly landings between 1.4 and 3.1 million pounds.

10. RECOMMENDATIONS FOR SHRIMP RESOURCE MANAGEMENT

There are two important considerations in resource management: the conservation of the resource and the protection of economic investment. There are several common practices used in the management of sea fisheries. They are based on the principles of 1) limitation of the age and size that fish can be taken by the commercial fishery and 2) regulation of the mortality caused by the fishing fleet.

Regan, et al (1956) examined mesh size restrictions as a method of reducing young shrimp mortality. They found that 2 1/4 inch (57 mm) mesh allowed the greatest number of small shrimp to escape without significantly decreasing the catches of large shrimp; the percent of small shrimp that successfully passed through the mesh was not known. Lindner (1965) stated that for proper escapement chaffing gear would need to be removed. Also, since only 1.5 inch (38 mm) in total length is the difference between 80 and 30 count, mesh restriction is of dubious benefit to shrimp resource conservation. The imposition of limits on shrimp size is a wasteful practice since discarded shrimp are lost both to the natural resource and to the fishing industry.

Closed seasons in the open sea are effective only if small shrimp are extremely abundant during a period when large shrimp are scarce. Guatemalean data reveal that young shrimp are entering the fishery throughout the year (Keiser 1971). It would be unwise to impose closed seasons in the open sea or limit the catches that the fleet may take since these measures would only serve to underexploit the resource; shrimp not taken by the fishery will be removed by predation and natural mortality.

The life history of penaeid shrimp suggest that protection of the estuarine nursery grounds might provide an effective management tool. The extent to which the present cast-net fishery affects the resources of offshore adult shrimp is unknown. Also, shrimp may migrate into the area from neighbouring countries.

There is, therefore, no evidence available justifying the banning of the present cast-net fishery. Also, the economic hardship that would be imposed on the artisanal fishermen must be weighed before considering such action. Notwithstanding, pending further studies, any expansion of the cast-net fishery should be discouraged.

The most feasible way of managing shrimp resources is by limiting fishing effort. This can be accomplished by limiting the Number of fishing units, the area distribution of effort, the total amount of fishing time, or the catching power of the individual units. Of these, limited entry is the easiest to enforce, and fleet limitation acts to prevent overfishing of shrimp populations while guaranteeing maximal economic returns to the fishing industry.

The Schaefer Model discussed above predicted that the best annual catch would be obtained with a fishing effort of about 8.000 24-hour days. The increase in total catch obtained from increasing effort, from 6.000 to 8.000 days fishing, is probably not enough to justify the expense of the extra effort needed. Since from 1964 to 1969, the fleet averaged 289 days of fishing per boat annually, 21 boats would provide sufficient effort to assure maximum returns and maintain shrimp stocks. In the past, the Guatemalean fishing industry suffered economic hardships. In 1968, when production per boat was only one-half that of 1966, Mariscos de Guatemala transferred its vessels to Nicaragua and Pesca SA., retired several vessels from operation. The poor landings of 1968 prompted Pesca SA. to request that the fishing fleet be restricted to 25 boats instead of the 50 presently permited by law.

Unless economic returns are higher than is apparent, it would seem that a fleet of less than 30 boats is sufficient for harvesting the available shrimp resources. This fleet might in poor shrimp years, have poor economic returns (1968), which, however, should be balanced by high profits in a good year (1966). Considering the known limits of the sea resource, the author believes that 21 to 28 vessels would effectively utilize the Pacific shrimp resource. This figure should be re-evaluated if larger, more powerful boats enter the fishery, if exploratory fishing locates new shrimp populations, or if the present price difference between white, brown, red shrimp and camaroncillos changes.

11. RESUMEN EN ESPAÑOL

La industria camaronera es la única pesquería desarrollada en Guatemala. Durante varios años, existió una pequeña pesquería de arrastre en la costa del Caribe, terminando sus operaciones en 1963. La pesquería del Pacífico comenzó en 1957 con sólo dos embarcaciones, en 1966 la flota alcanzó su volumen actual de 28 barcos arrastreros equipados con doble equipo de arrastre. En la década del 60 esta pesquería contribuyó a la economía nacional con aproximadamente 1.5 millones de US dólares anuales, correspondientes al valor de las exportaciones. Sin embargo, en 1968 la producción descendió bruscamente con un desembarque total de solamente 1/3 de la cifra de 1966; el Gobierno de Guatemala preocupado por esta declinación solicitó la preparación de este trabajo.

Lindner (1957, y Crocker 1967), realizaron investigaciones de la pesquería guatemalteca. Los datos de producción han sido publicados (Vol. Estad. Pesca # 1) pero nunca analizados. Con la excepción de Panamá y de El Salvador (Boerema, 1961; Ellis, 1965, 1968), esta situación existe en toda la región centroamericana.

Este trabajo describe la historia y características de la industria camaronera del Pacífico, evaluando las tendencias de producción entre 1960 y 1969, considerando una estimación de los recursos y recomendaciones para la reglamentación a fin de asegurar su explotación racional.

11.1 ESTIMACION DE LOS RECURSOS

La fracción de la población camaronera desembarcada depende de: 1) la selectividad del arte de pesca, la malla de 2 pulgadas (51 mm.) permite a un cierto porcentaje de camarones escapar a la captura; 2) selectividad de los pescadores, algunos camarones pequeños son devueltos al mar y 3) el valor de una especie de camarón en relación a las otras, mayor esfuerzo de pesca es dirigido hacia especies de mayor valor económico. Estos factores limitan la utilidad de los datos de desembarques para la estimación de existencias de poblaciones camaroneras.

La cantidad de camarón desembarcado por unidad de esfuerzo esta relacionada con la existencia o densidad de la población camaronera en ese período de tiempo; cuando existe una gran población se desembarcan camarones en grandes cantidades; cuando existe una pequeña población los camarones son más difíciles de encontrar y se desembarcan en cantidades menores. Por lo tanto, la relación entre el esfuerzo de pesca y las libras de camarón desembarcadas es proporcional a la población. Kutkuhn (1962) denomina a esta proporción, índice de biomasa capturable.

Asumiendo que la biomasa se refleja en la razón entre la captura total y el esfuerzo de pesca total, es posible obtener una estimación de la biomasa. Esto puede hacerse calculando la regresión entre estos dos parámetros y posteriormente construir una curva usando esta relación (Schaefer, 1955, 1957).

Existen ciertas limitaciones para aplicar el modelo de Schaefer a los datos de Guatemala: 1) la información sobre esfuerzo de pesca no está separada por especie y proratear los datos artificialmente por peso o valor de la captura se considera inválido (Keiser, 1970), y 2) el modelo considera al esfuerzo de pesca como el único factor actuando sobre la población de camarones; sin embargo, factores ambientales en realidad influencian la abundancia de camarones. Por otra parte, los desembarques de camarón rojo y camaroncillo están fuertemente relacionados con la abundancia de los stocks de camarones blanco y café.

La regresión de captura total versus esfuerzo total (Cuadro 9) indica que las dos variables están fuertemente relacionadas (Cuadro 10, Fig. 8). La captura estimada para cada nivel de intensidad de pesca se calculó substituyendo los valores obtenidos en la ecuación de regresión.

Los datos parecen predecir que a un esfuerzo de 8.000 días de pesca correspondería un desembarque anual de 2.45 millones de lb de colas de camarón. Sin embargo, el examen de la Fig. 9 revela que un incremento del 33 por ciento en el esfuerzo de pesca, entre 6.000 y 8.000 días, se traduce solo en un 6 por ciento de aumento en los desembarques actuales. Por otra parte, se deben considerar también fluctuaciones naturales en los stocks de camarones. Lindner (Comunicación personal) informa que las capturas de camarones blanco (P. setiferus) y camarón café (P. aztecus), fluctúan anualmente en el Golfo de México por factores de 3 y 7 respectivamente. Estas especies ocupan el nicho ecológico llenado por los camarones blanco y café en la pesquería del Pacífico de Guatemala.

El autor considera que un desembarque promedio de 2.3 millones de lb de colas de camarones podría mantenerse con 6.000 días de pesca de 24 horas. Debido a las fluctuaciones naturales en la abundancia de camarones, este esfuerzo produciría desembarques anuales entre 1.4 y 3.1 millones de lb.

11.2 RECOMENDACIONES PARA REGLAMENTACION DE LOS RECURSOS DE CAMARON

Existen dos consideraciones importantes en la reglamentación de recursos pesqueros: la conservación de recurso y la protección de inversiones económicas. Existen varios procedimientos utilizados en la reglamentación de pesquerías marinas, basados en los siguientes principios: 1o., limitación de la edad y tamaño en que el pez puede ser capturado por la pesquería comercial y 2o., la regulación de la mortalidad causada por la flota pesquera.

Regan et al (1956), examinaron las restricciones de tamaño de malla como un método para disminuir la mortalidad de ejemplares pequeños de camarón. Ellos encontraron que una malla de 2 1/4 pulgadas (52 mm) permitía escapar el mayor número de camarones pequeños sin disminuir significativamente la captura de camarones más grandes; no se determinó el porcentaje de camarones pequeños que escapaban exitosamente a través de la malla. Lindner (1965) indica que para permitir un escape adecuado debería removerse la protección del copo ya que la diferencia entre las clasificaciones 80 y 30 es de solamente 1.5 pulgadas (38 mm) en longitud total; las restricciones en cuanto a tamaño de mallas son de beneficio dudoso para la conservación del camarón. La imposición de limitaciones en tamaños de camarones es un procedimiento inútil, ya que los camarones rechazados se pierden para el recurso y la industria pesquera.

Las temporadas de pesca o vedas en mar abierto son efectivas solamente si los camarones pequeños son extremadamente abundantes durante un período en el que los camarones grandes escasean. Los datos de Guatemala indican que los camarones juveniles se incorporan a la pesquería a través de todo el año (Keiser, 1971). No sería aconsejable imponer temporadas de pesca en mar abierto o limitar las capturas que la flota podría pescar ya que estas restricciones sólo servirían para sub-explotar el recurso; los camarones no capturados por la pesquería serán removidos por predación y mortalidad natural.

El ciclo biológico de los camarones Peneidos sugiere que la protección de las zonas estuarinas de crecimiento podría ser un procedimiento de reglamentación efectivo. En el presente, se desconoce la magnitud en que la actual pesquería con atarraya afecta los recursos exteriores de camarón adulto. Por otra parte, los camarones podrían inmigrar hacia la zona desde los países vecinos, es decir, no existe una evidencia poderosa para justificar la prohibición de la pesquería de atarraya. Igualmente, el daño económico que se impondría a los pescadores artesanales debería ser considerado antes de realizar este tipo de prohibición. Por lo tanto, cualquier expansión de la pesquería con atarraya debería ser controlada en espera de mayores estudios.

La manera más factible de reglamentación para recursos camaroneros es la limitación del esfuerzo de pesca. Esto se puede obtener limitando el número de unidades de pesca, la zona de distribución del esfuerzo, el tiempo total de pesca, o el poder de pesca de unidades individuales. De ellas, la limitación en la entrada de unidades es la más fácil de controlar y se realiza para prevenir sobre pesca de poblaciones camaroneras, garantizando el máximo retorno económico a la industria pesquera.

El modelo de Schaefer discutido anteriormente, indica que la mejor captura anual podría obtenerse con un esfuerzo pesquero aproximadamente de 8,000 días de pesca de 24 horas. El aumento en la captura total a obtener de un mayor esfuerzo pesquero, de 6,000 a 8,000 días de pesca, probablemente no es suficiente para justificar los costos de este esfuerzo suplementario. Desde 1964 a 1969, la flota camaronera alcanzó un promedio anual de 289 días de pesca por barco, por lo tanto, 21 barcos generarían un esfuerzo suficiente para asegurar máximos retornos y mantener las existencias de camarón. En el pasado la industria pesquera Guatemalteca sufrió dificultades económicas. En 1968, cuando la producción por barco era solamente la mitad de la de 1966, la Compañía Mariscos de Guatemala trasladó sus barcos a Nicaragua y Pesca, S.A. retiró de operación varias embarcaciones. Los bajos desembarques de 1968 llevaron a Pesca, S.A. a solicitar que la flota camaronera fuese restringida a 25 barcos en vez de las 50 unidades actualmente permitidas por la ley.

A menos que los retornos económicos fuesen mayor que lo que evidencian, parecería que una flota inferior a 30 barcos, es suficiente para explotar los recursos camaroneros disponibles. Esta flota podría tener bajos retornos económicos en años pobres en camarones (1968), que sin embargo, se equipararían con elevadas utilidades en años buenos (1966). Considerando los límites conocidos del recurso, el autor estima que 21 a 28 embarcaciones podrían utilizar eficientemente los recursos camaroneros del Pacífico. Esta cifra debería ser reevaluada si embarcaciones más grandes y más poderosas se incorporan a la pesquería, si se detectan nuevas poblaciones camaroneras a través de pesca exploratoria o si cambia la actual diferencia de precios entre camarón blanco, café, rojo y camaroncillos.

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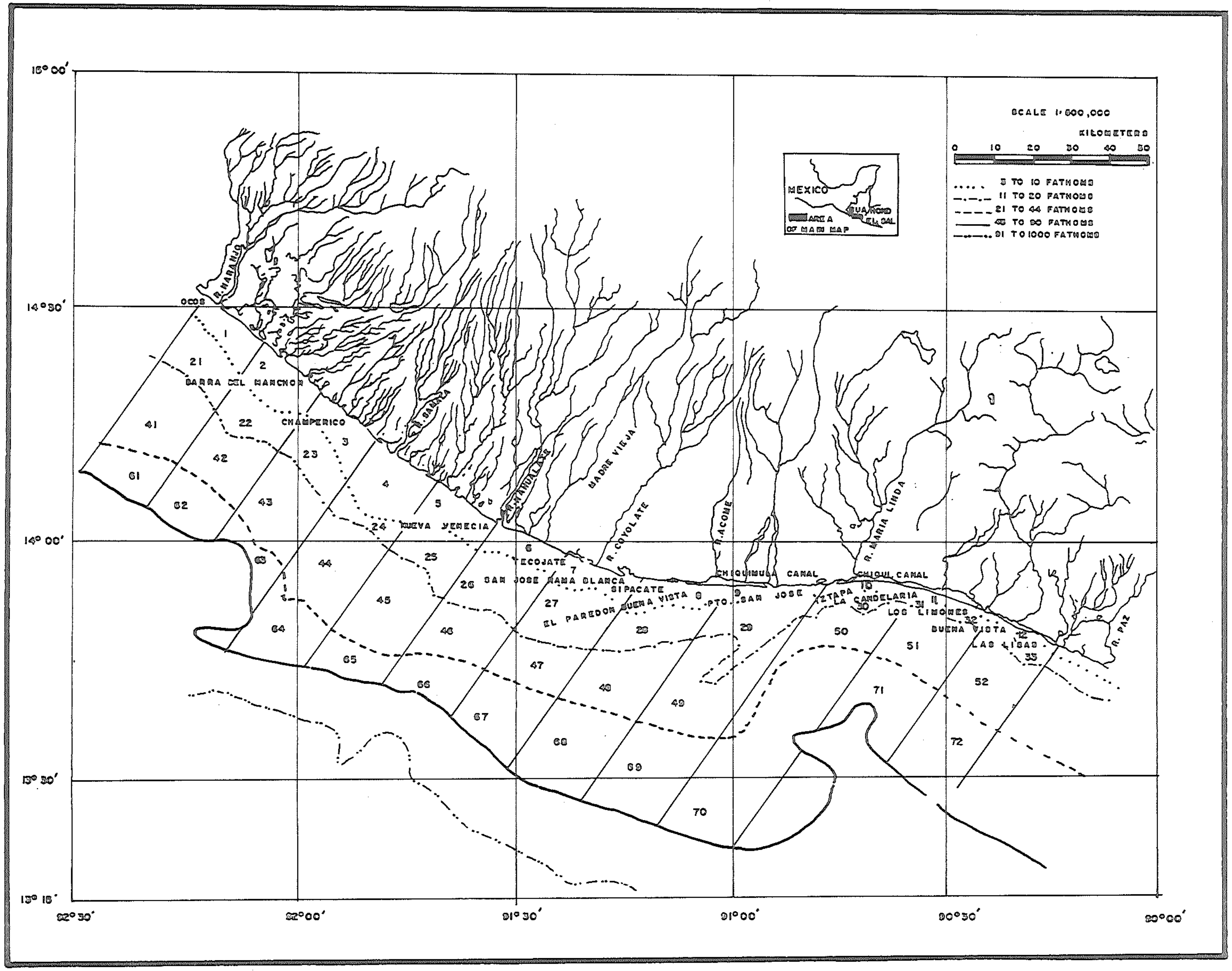

Fig. 1. Map of the Pacific Coast of Guatemala. Numbers refer to fishing areas of Pesca, S.A.

Fig. 1. Mapa de la Costa Pacífico de Guatemala. Los números se refieren a zonas de pesca empleados por la Compañía Pesca, S.A.

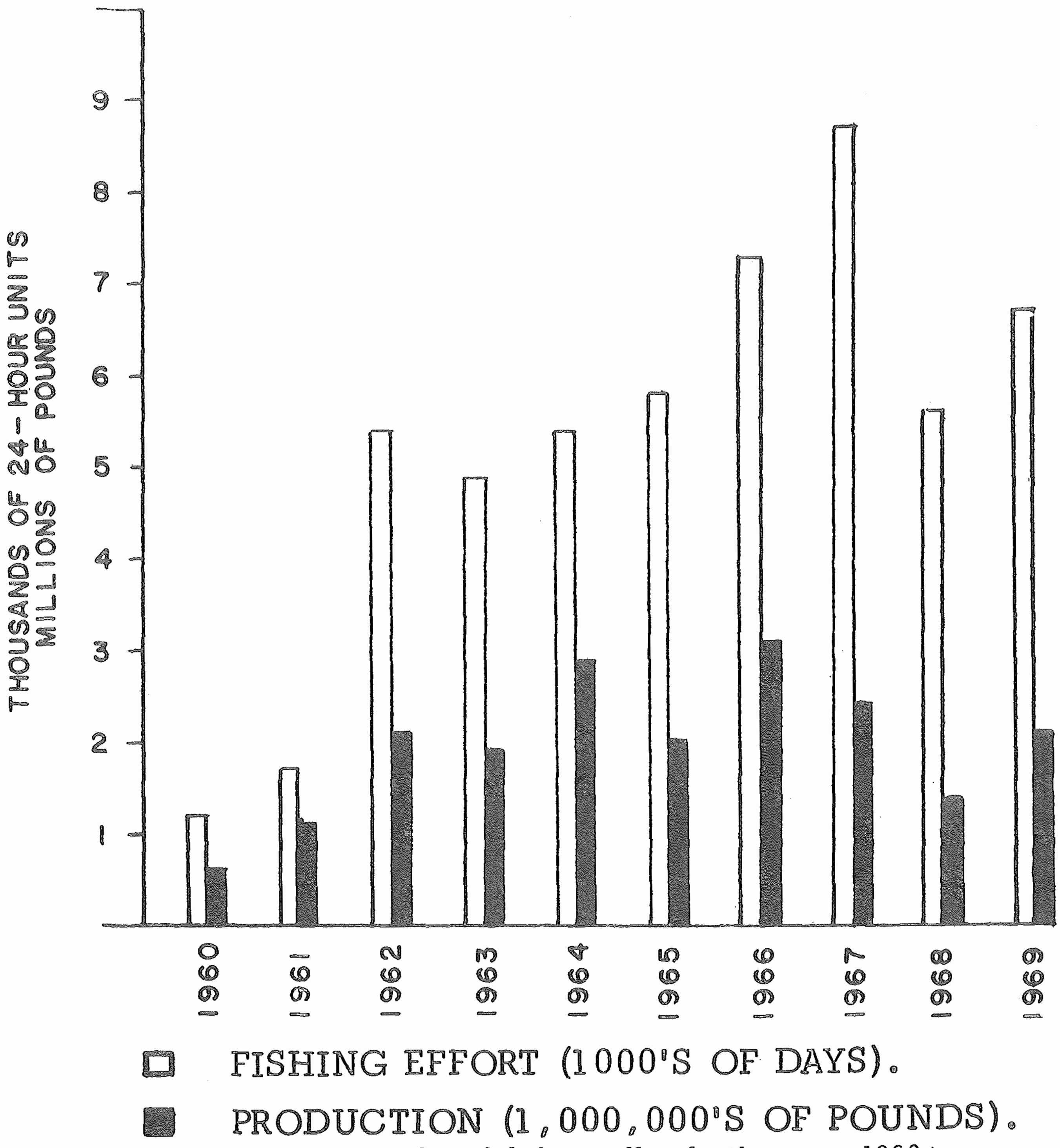

Fig. 2. Total landings and total fishing effort for the years 1960 to 1969.

Fig. 2. Desembarque total y esfuerzo pesquero total de los años 1960 a 1969.

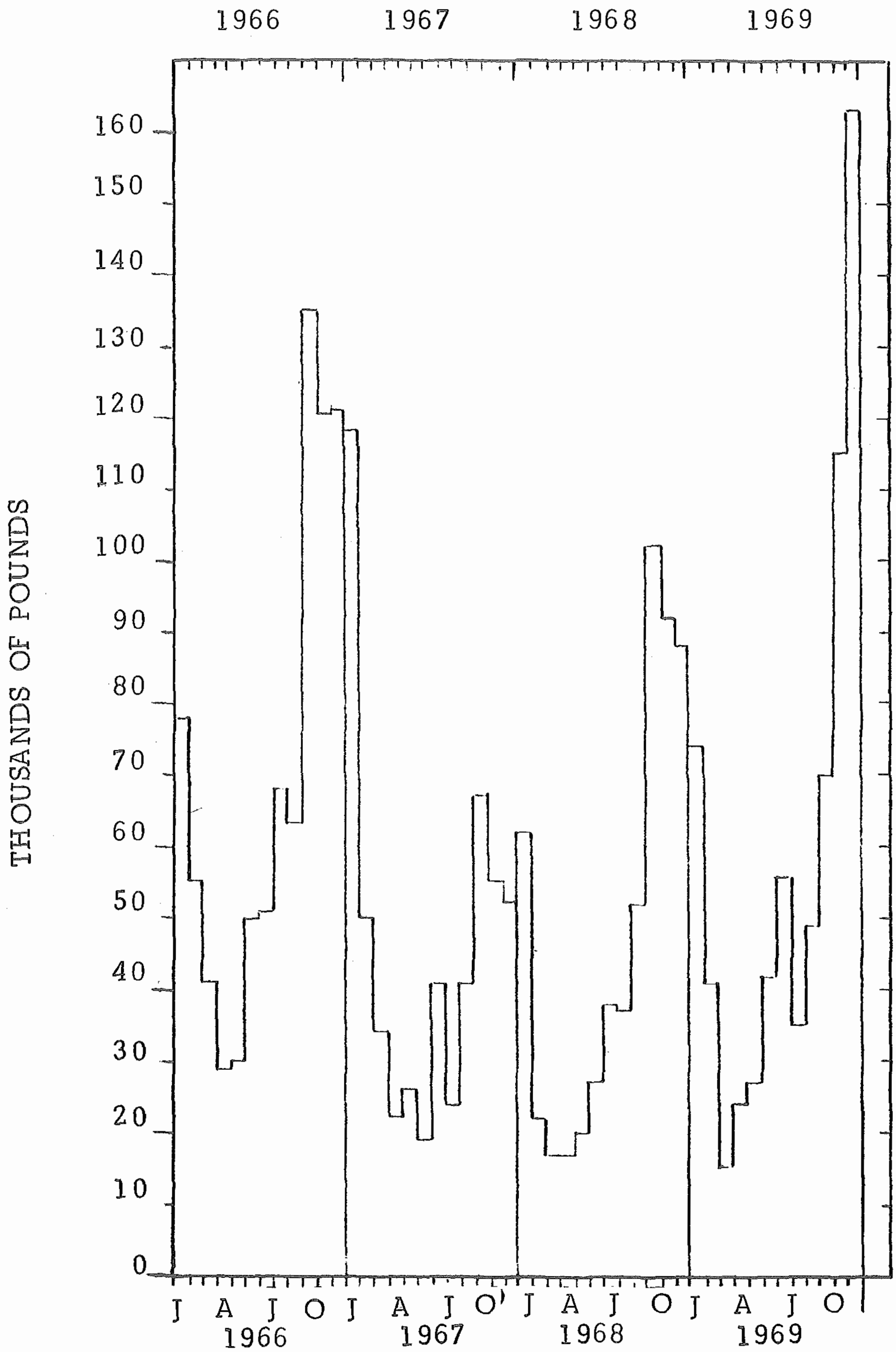

Fig. 3. Monthly landings of white shrimp, P. stylirostris and P. vannamei, from 1966 to 1969. Landings are in thousands of pounds of shrimp tails.

Fig. 3. Desembarque mensual de camarón blanco P. stylirostris and P. vannamei, para los años 1966 a 1969. Los desembarques se expresan en miles de libras de colas de camarón.

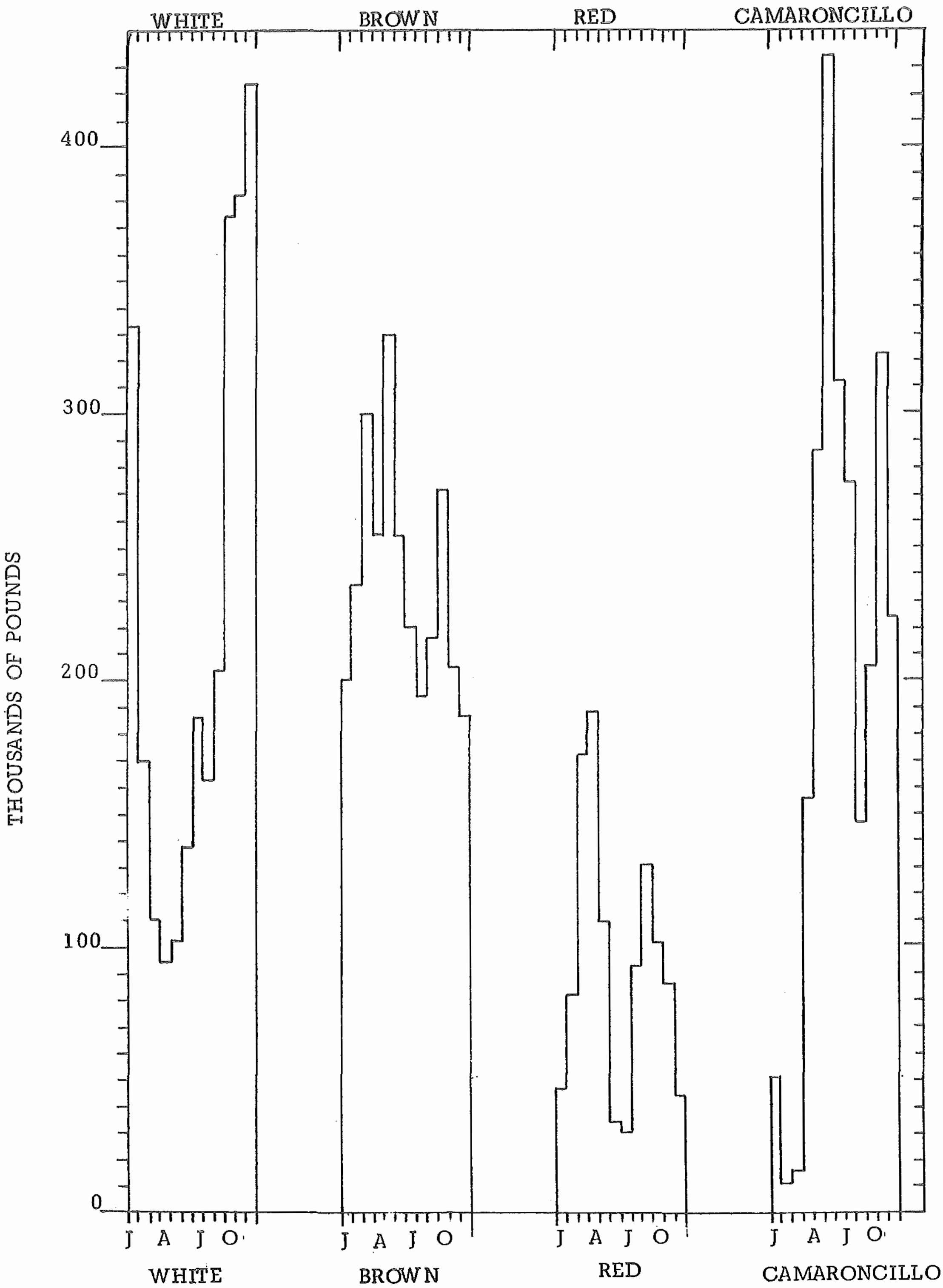

Fig. 4. Landings of white, brown, and red shrimp and camaroncillos summed by month for the years 1966 to 1969. Landings are in thousands of pounds of shrimp tails.

Fig. 4. Desembarques de camarón blanco, café y camaroncillo agrupados mensualmente para los años 1966 a 1969. Los desembarques se expresan en miles de libras de colas de camarón.

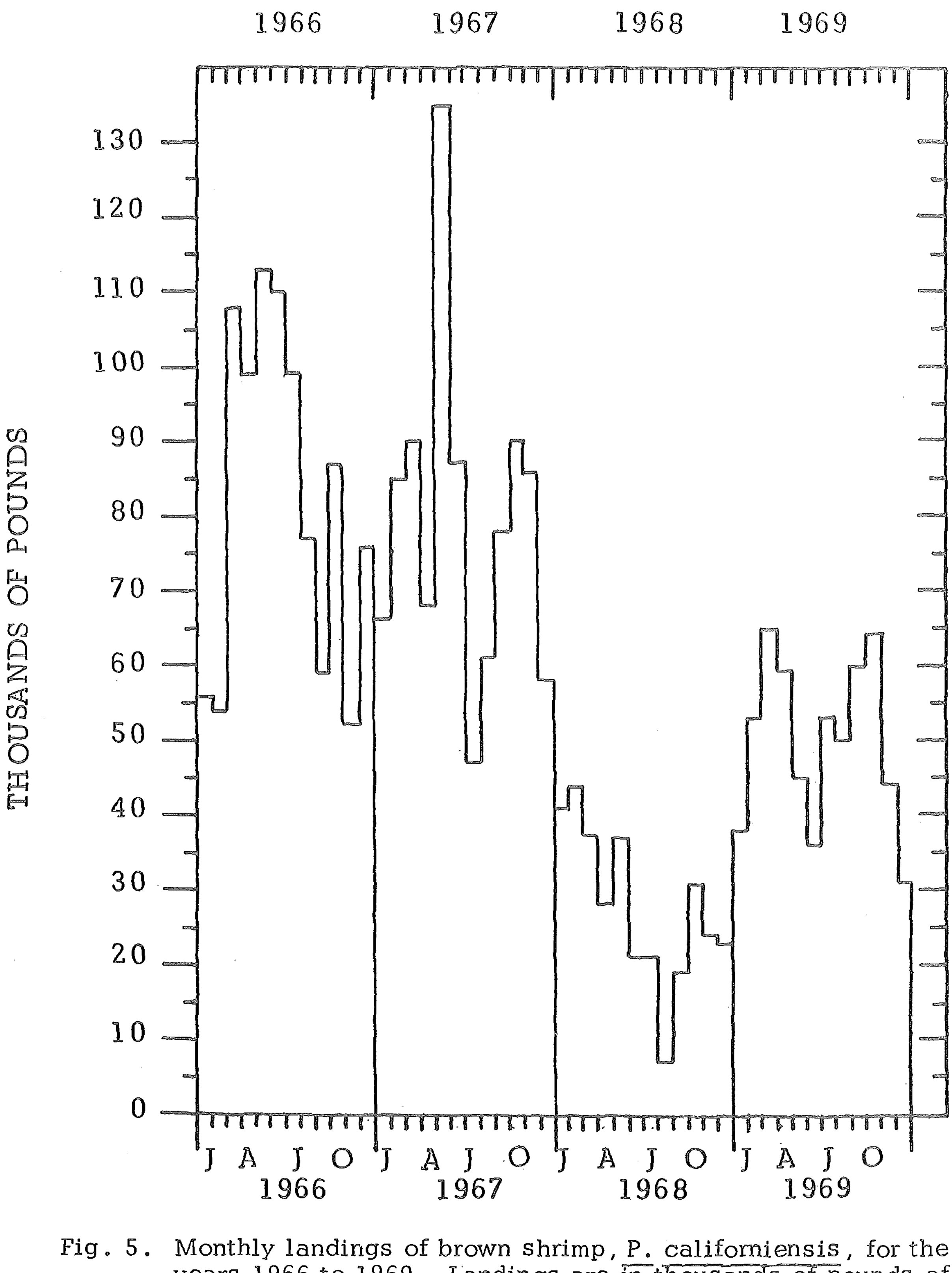

Fig. 5. Monthly landings of brown shrimp, P. californiensis, for the years 1966 to 1969. Landings are in thousands of pounds of shrimp tails.

Fig. 5. Desembarque mensual de camarón café, P. californiensis, para los años 1966 a 1969. Los desembarques se expresan en miles de libras de colas de camarón.

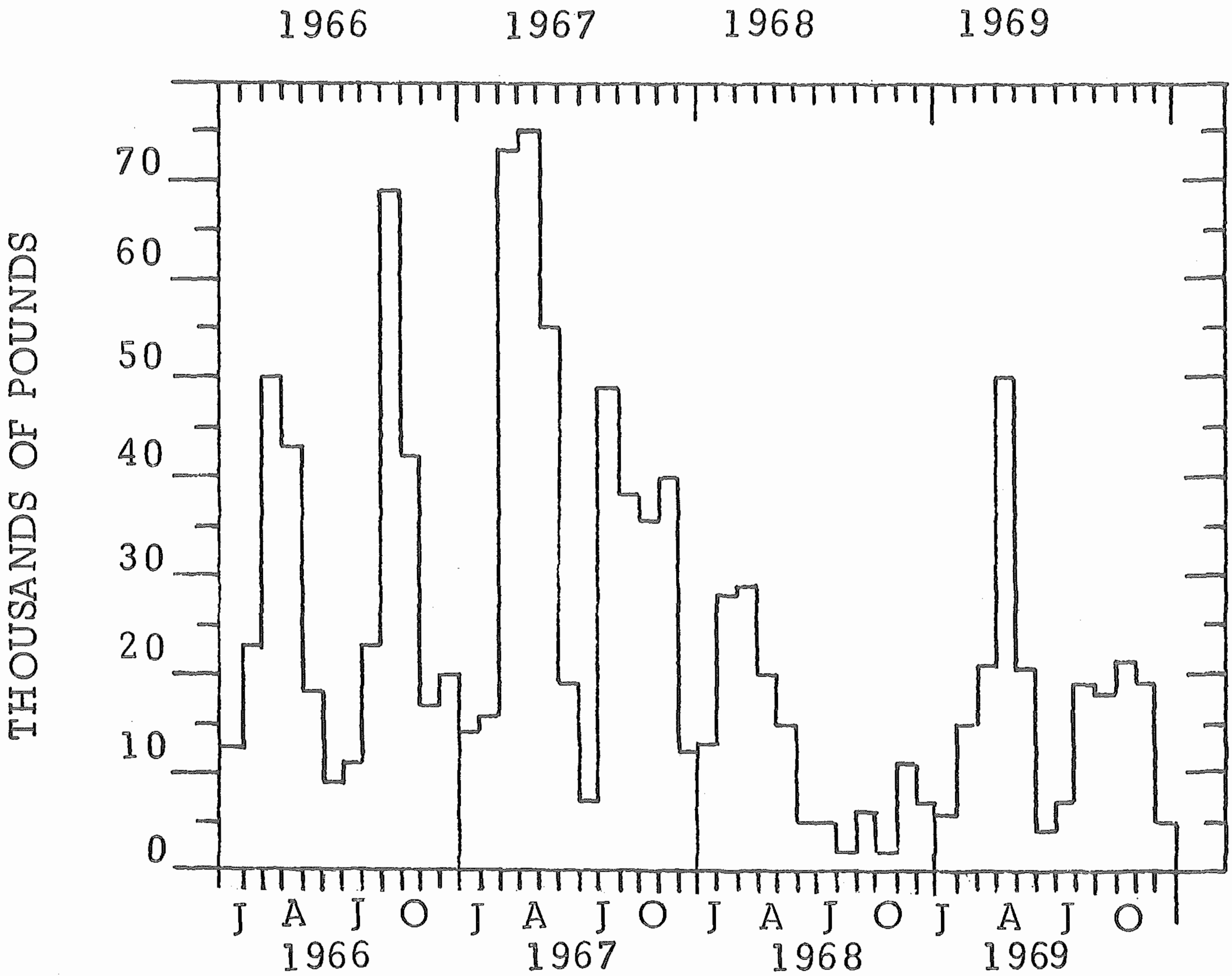

Fig. 6. Monthly landings of red shrimp, P. brevirostris, for the years 1966 to 1969. Landings are in thousands of pounds of shrimp tails.

Fig. 6. Desembarque mensual de camarón rojo, P. brevirostris, para los años 1966 a 1969. Los desembarques se expresan en miles de libras de colas de camarón.

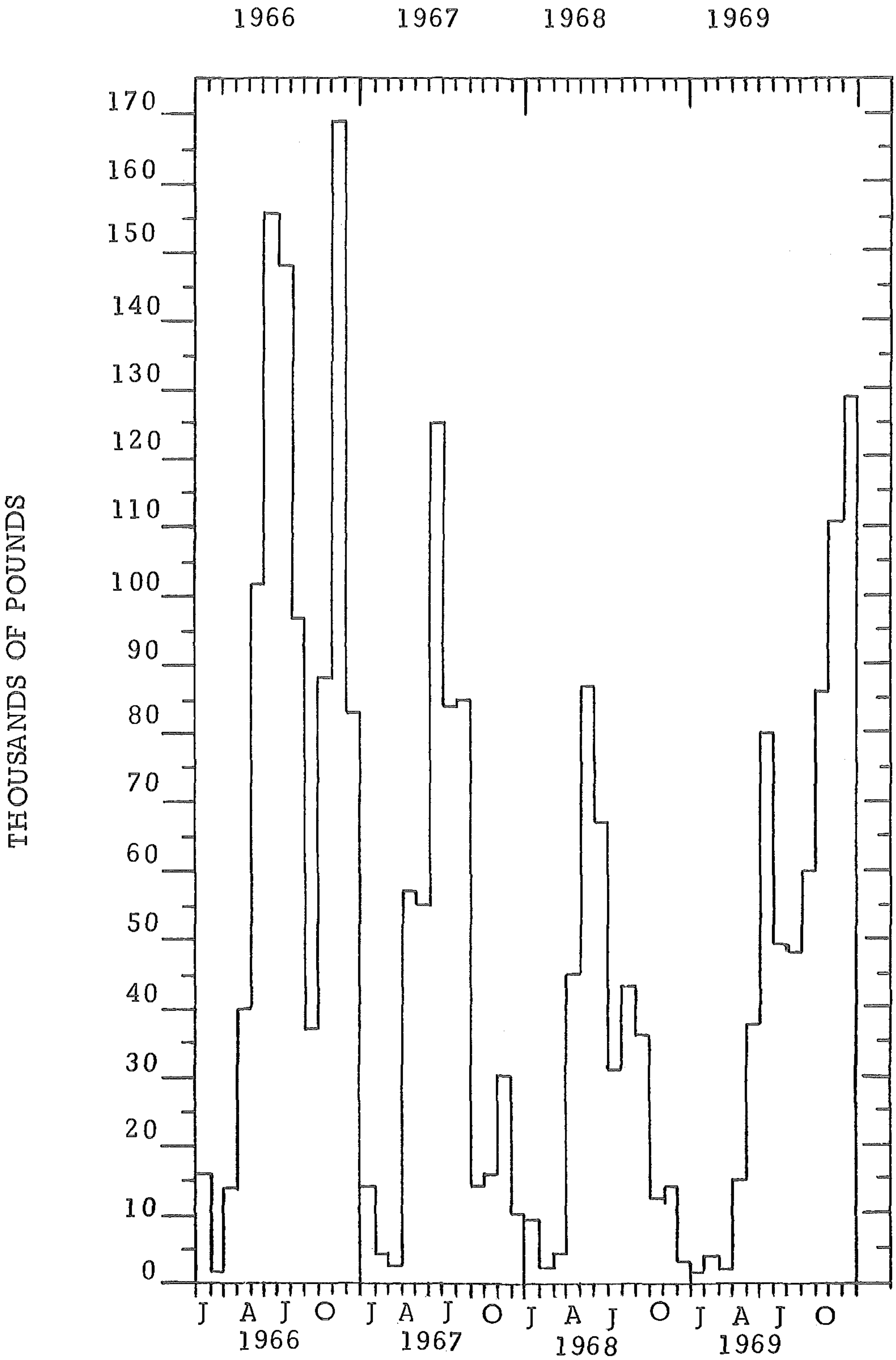

Fig. 7. Monthly landings, of camaroncillos, Trachypenaeus byrdi, T. Faoea, T. similis pacificus, Protachypene precipua, and Xiphopenaeus riveti. Landings are in thousands of pounds of shrimp tails.

Fig. 7. Desembarques mensuales de camaroncillos, Trachypenaeus byrdi, T. Faoea, T. similis pacificus, Protachypene precipua, y Xiphopenaeus riveti. Los desembarques se expresan en miles de libras de colas de camarón.

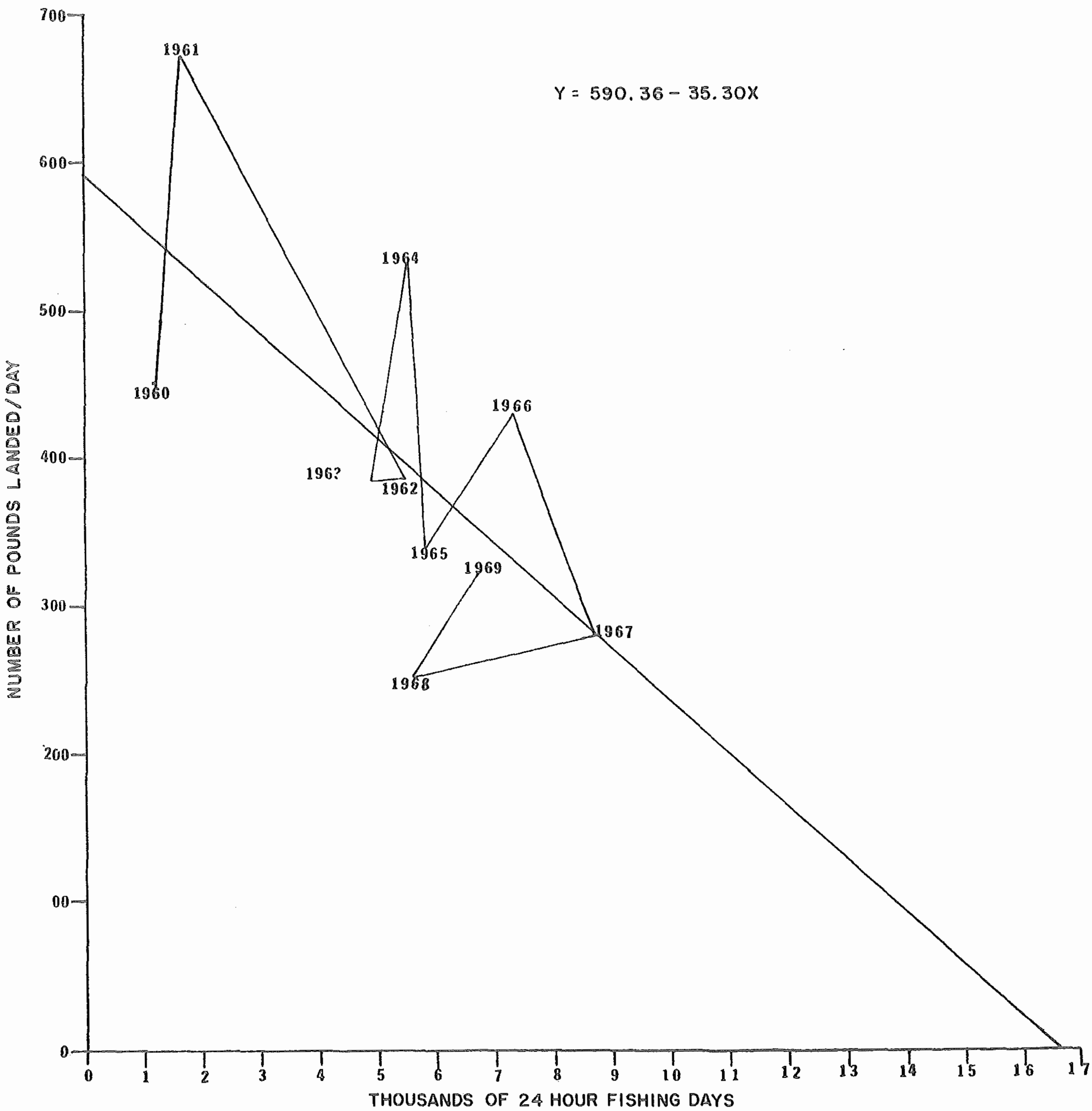

Fig. 8. Scatter diagram and calculated regression line of catches/day of all shrimp and total days of fishing for the years 1960 to 1969.

Fig. 8. Distribución y recta de regresión calculada para captura por día de todos los camarones y total de días de pesca para los años 1960 a 1969.

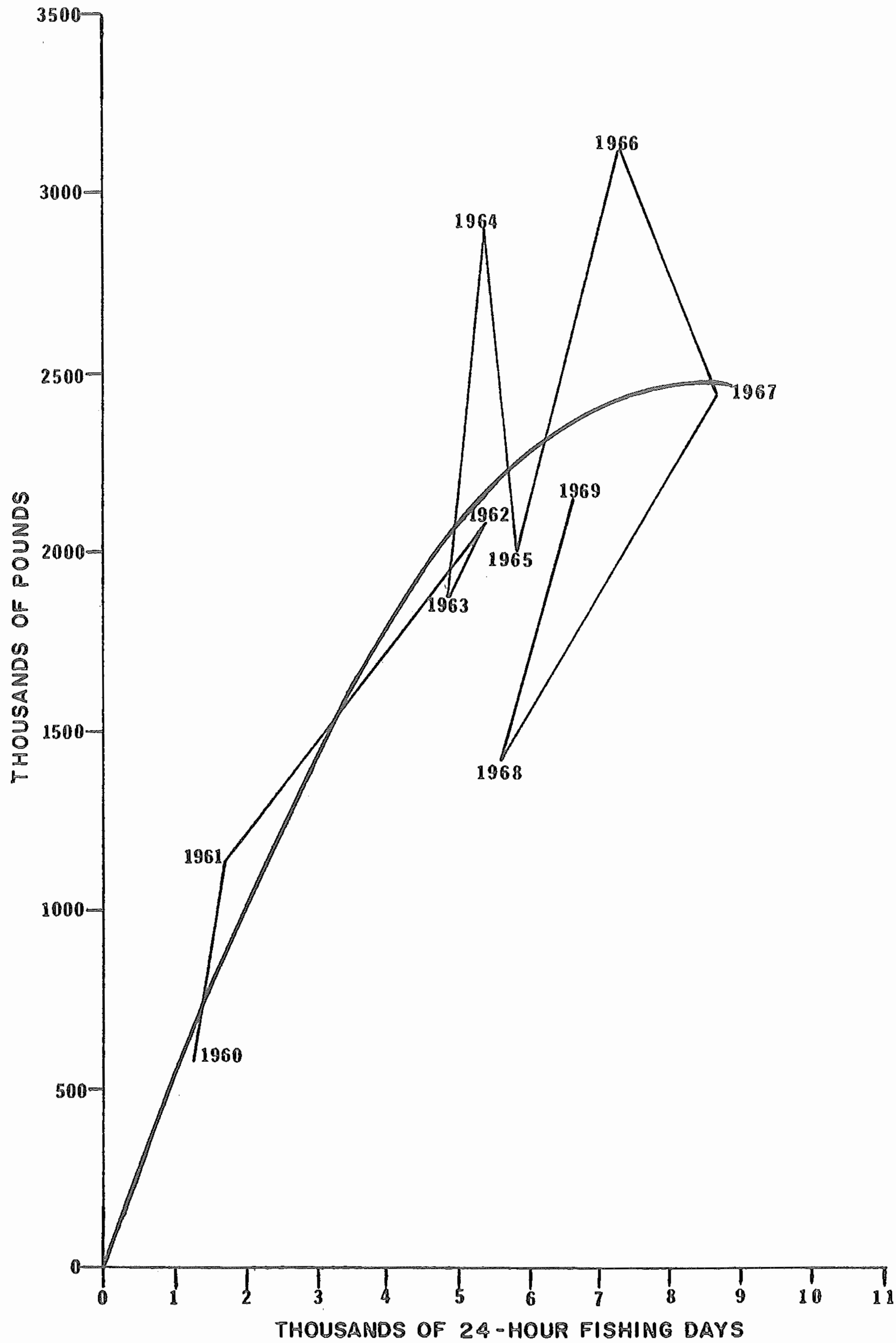

Fig. 9. Graph showing the estimated exploitable shrimp resource at varying fishing effort. Points show the actual catches for the years 1960 to 1969.

Fig. 9. Magnitud estimada del recurso camaronero explotable a diferentes esfuerzos de pesca. Los puntos indican la captura real para los años 1960 a 1969.

TABLE 1. The number of boats of each shrimp company for the years 1959 to 1969

CUADRO 1. Número de barcos de cada compañía camaronera para los años 1959 a 1969.

Company / Compañía	Operating base / Base de operaciones	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Copesgua (Guatemalan)	A	2	2[2]	-	-	-	-	-	-	-	-	-
Copesgua, S. A. (Guatemalan)	A	-	7	9	13	10	10	10	10	10	[3]	-
Pesca, S. A.	A	-	-	3	6	10	11	11	10	10	21	20
Jhon Leeper (Guatemalan)	B	-	1[4]	-	-	-	-	-	-	-	-	-
Pesquero del Atlántico (Mexican)	B	-	7	8	7	4	-	-	-	-	-	-
Inpesmar (Nicaraguan)	B	-	-	-	14[4]	-	-	-	-	-	-	-
Lincona Morel (Mexican)	B	-	-	-	4	2	-	-	-	-	-	-
Mariscos de Guatemala (Guatemalan)	B	-	-	-	9[5]	-	-	-	10	10	10[6]	9
San José Ltda. (Guatemalan)	B	-	-	-	-	-	-	1[7]	-	-	-	-
Total No. of boats / Número total de barcos		5[1]	17	20	53	26	21	21	30	30	31	29
Minimum-maximum No. of boats in operation in any month / Número mínimo y máximo de barcos operando en cualquier mes		1-5	2-13	4-16	20-35	17-23	17-20	19-20	19-30	29-30	12-30	16-27
Average No. of boats/year / Promedio de barcos por año		4	7	8	27	23	19	20	24	29	23	23

A: Champerico
B: Puerto San José
1/ Data incomplete for 1959
2/ Formed Copesgua, S. A.
3/ Merged with Pesca, S. A.
4/ Only operated half-year
5/ Only operated half year; ceased operations until 1966
6/ In May, the boats left for Nicaragua
7/ Only operated 3 months.

1/ Información incompleta para 1959
2/ Constituyó Copesgua, S. A.
3/ Se integró con Pesca, S. A.
4/ Operó solamente medio año
5/ Operó solamente medio año; cesando sus actividades hasta 1966
6/ En Mayo, los barcos fueron a pescar en Nicaragua
7/ Operó solamente 3 meses

TABLE 2. Size distribution of the boats in the shrimp fleet from 1960 to 1969.

CUADRO 2. Distribución de barcos por eslora en la flota camaronera desde 1960 a 1969.

Length (ft) / Eslora (ft)	Years / Años									
	1960*	1961*	1962	1963	1964	1965	1966	1967	1968	1969
48-48			1	-	-	-	-	-	-	-
50-54			4	2	-	1	-	-	-	-
55-59			11	-	-	-	-	-	-	-
60-64			34	17	12	10	19	19	18	17
65-69			2	-	-	-	-	-	-	-
72-72			-	7	9	10	10	10	10	10
73-73			-	-	-	-	1	1	3	2
75-75			1	-	-	-	-	-	-	-
Total	17	20	53	26	21	21	30	30	31	29

TABLE 3. Characteristics of the fleet of Mariscos de Guatemala and Pesca, S. A.

CUADRO 3. Características de la flota de Mariscos de Guatemala y Pesca, S. A.

Company Compañía	Length (ft) Eslora (ft)	Width (ft) Manga (ft)	Draw (ft) Calado (ft)	Type of construction Tipo de construcción	HP	Net size trawled Tamaño de la red	Freezer capacity Capacidad del congelador	Tonnage Tonelaje	
								Brute Bruto	Net Neto
Mariscos de Guatemala	61	18.9	10	steel acero	200	61-65	12,000	85.6	47.6
Pesca, S. A.	62	18.0	6	wood madera	170 220	45-48	12,000	52.0	24.0
Pesca, S. A.	72	18.5	8	wood madera	220 300	66-66	12,000	73.0	34.0
Pesca, S. A.	73	20.0	10	wood madera	300	66-66	12,000	98.0	56.0

TABLE 4. Weight and value of headed and peeled shrimp exported to the United States from 1959 to 1969

CUADRO 4. Peso y valor total de camarón descolado y pelado exportado a los Estados Unidos, para los años 1959 a 1969.

Year / Año	Total amount of shrimp exported / Total camarón exportado		Peeled shrimp exported / Camarón pelado exportado		
	Weight * / Peso	Value ** / Valor	Weight * / Peso	Value ** / Valor	% of total / % del total
1959	182.2	133.4	-	-	-
1960	257.4	111.1	-	-	-
1961	742.9	405.0	-	-	-
1962	2 297.8	1 491.3	32.2	16.9	1.4
1963	1 942.5	1 062.1	244.3	138.9	12.6
1964	2 206.3	1 134.9	256.5	155.4	11.6
1965	1 515.0	891.8	500.1	470.7	33.0
1966	2 480.8	1 968.3	403.8	321.0	16.3
1967	1 923.5	1 589.2	198.7	159.4	10.3
1968	1 315.0	1 135.0	7.3	4.3	0.6
1969	1 700.0	1 533.3			

* Weight in 1000's of lb.
** Value in 1000's of dollars.
Note: Until 1963, the data included shrimp from the Caribbean Coast.

* Peso en miles de libras
** Valor en miles de dólares
Nota: Hasta 1963, los datos incluyen camarones de la Costa Caribe

Source: U.S. Imports of merchandise of consumption.
Fuente: Annual Reports 1959 to 1968. Files of the Division de Fauna, 1969.

TABLE 5. Daily production of different size vessels of the Pacific fleet from 1966 to 1969

CUADRO 5. Producción diaria según eslora para barcos de la flota del Pacífico, 1966 a 1969

Boat length (ft) Eslora	Production (lb/day) Producción (lb/día)				
	1966	1967	1968	1969	Average Promedio 1966 to 1969
61	277	193	125	309	218
62	448	310	281	295	339
72	482	348	290	342	368
73	442	295	342	363	368
Yearly average Promedio anual	427	280	257	322	323

TABLE 6. Difference in daily production between 72 foot boats powered by 220 HP and 300 HP engines for the years 1966 to 1969

CUADRO 6. Diferencias en la producción diaria de barcos equipados con motores de 200 y 300 HP, para los años 1966 a 1969

HP	Production (lbs/day) Producción (lbs/día)				
	1966	1967	1968	1969	Average Promedio 1966 to 1969
220 300	463 515	335 365	282 313	339 349	359 395

TABLE 7. Wholesale price in Miami of selected sizes of shrimp exported to the United States from 1963 to 1968. (Data courtesy of Pesca, S.A.)

CUADRO 7. Miami, precios al por mayor de camarones exportados a Estados Unidos desde 1963 a 1968 (cortesía de Pesca, S. A.)

Year Año	White Blanco	Brown Café		Red Rojo	Camaroncillo Camaroncillo
	U-15	U-15	21-25	31-40	51-60
1963	1.15	1.08	0.96	-	0.35
1964	0.99	0.96	0.69	0.50	0.39
1965	1.05	1.01	0.84	0.59	0.44
1966	1.03	1.10	1.02	0.70	0.53
1967	1.26	1.23	1.04	0.63	0.49
1968	1.58	1.54	1.24	0.65	0.48

TABLE 8. Percentage of white and brown shrimp landings graded U-15 and brown shrimp landings graded U-25

CUADRO 8. Porcentaje de camarón blanco y café clasificados U-15, y camarón café clasificado U-25, en los desembarques de 1964 a 1969

Year Año	Percentage of white shrimp graded Porcentaje de camarón blanco	Percentage of brown shrimp graded Porcentaje de camarón café	
	U-15	U-15	U-25
1963	72.4	24.1	72.1
1964	55.6	23.5	66.7
1965	63.8	20.1	56.2
1966	74.9	22.8	64.7
1967	68.9	27.2	76.7
1968	74.4	30.9	80.7
1969	69.2	39.6	72.7

TABLE 9. Fishing effort in 1000's of 24-hour days and yield in pounds of shrimp tails landed per day for the years 1960 to 1969

CUADRO 9. Esfuerzo de pesca en miles de 24 horas día y captura en libras de colas desembarcadas diariamente para los años 1960 a 1969

Year Año	1000's of fishing days Miles de días de pesca	Pounds of shrimp tails landed per day Libras de colas desembarcadas por día
1960	1.26	444.6
1961	1.65	672.9
1962	5.37	387.4
1963	4.89	383.6
1964	5.44	533.1
1965	5.81	340.1
1966	7.30	427.0
1967	8.71	279.6
1968	5.56	253.0
1969	6.68	322.0

TABLE 10. Analysis of variance of the regression of catches per day of all shrimp and total days of fishing, 1960 to 1969

CUADRO 10. Análisis de varianza para la regresión de captura por día de todas las especies de camarones y total de días de pesca, durante los años 1960 a 1969

Source of variation Fuente de variación	df	Sums of squares Suma de cuadrados	Means square Cuadrados medios	F
Total Total	9	140,925.58		
Regression Regresión	1	59,421.90	59,421.90	5.83*
Residual Residuo	8	81,503.68	10,187.96	

* Significant at 0.05 level
Significativo al nivel 0.05

APPENDIX I. Summary of shrimp production and effort for the years 1960 to 1969

ANEXO I. Resumen de producción camaronera y esfuerzo para los años 1960 a 1969

Shrimp tail landings (1000's of lb) Desembarque de colas (1000' de lb)	Years Años									
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
white shrimp camarón blanco	64	169	389	430	701	606	841	551	574	710
brown shrimp camarón café	50	6	661	960	1 192	839	990	951	332	598
red shrimp camarón rojo	-	58	286	1	4	57	338	434	144	207
sub-total sub-total	114	233	1 336	1 390	1 897	1 502	2 169	1 937	1 050	1 515
camaroncillo Camaroncillo	-	-	-	487	1 003	467	948	499	357	634
un-graded no clasificado	448	879	742	-	-	6	-	-	-	-
total total	562	1 112	2 078	1 877	2 900	1 975	3 117	2 436	1 407	2 149
<u>Fishing effort</u> Esfuerzo de pesca										
average no. of fishing boats Promedio de barcos	7	8	27	23	19	20	24	29	23	23
total no. of fishing days No. total de días de pesca	1 263	1 653	5 366	4 893	5 440	5 806	7 301	8 712	5 562	6 678
fishing days/boat/year días de pesca/barco/año	180	207	199	213	286	290	304	300	242	290
Production/boat (1000's of lbs) Producción/barco (1000's de lb)										
<u>Penaeus</u> spp. <u>Penaeus</u> <u>sp</u>.	-	-	-	60	100	75	90	67	49	66
Camaroncillo Camaroncillo	-	-	-	21	53	23	40	17	16	28
all shrimp Todos los camarones	80	139	77	81	153	98	130	84	65	94

APPENDIX II. Monthly effort in days of fishing, the average number of boats operating/year, and the average number of fishing days/boat year for the years 1960 to 1969

ANEXO II. Esfuerzo mensual en días de pesca, promedio anual de barcos operando y promedio de días de pesca/barco/año, de 1960 a 1969

Month / Meses	Years / Años									
	1960*	1961*	1962	1963	1964	1965	1966	1967	1968	1969
January			409	464	551	519	526	707	762	393
February			564	466	479	438	451	700	670	374
March			583	393	510	529	541	768	660	454
April			386	315	379	526	533	714	588	476
May			392	400	472	486	496	755	518	501
June			466	472	482	433	518	707	328	613
July			460	486	506	459	577	755	297	675
August			431	498	439	503	694	699	257	675
September			380	296	447	453	698	707	300	581
October			478	464	354	492	750	721	346	646
November			447	404	412	476	756	729	400	648
December			370	235	409	492	761	749	436	642
Total	1 263	1 653	5 366	4 893	5 440	5 806	7 301	8 712	5 562	6 678
Average No. of boats operating/year Promedio de barcos operando/año	7	8	27	23	19	20	24	29	23	23
Average No. of fishing days/boat/year Promedio de días de pesca/barco/año	180	207	199	213	286	290	304	300	242	290

* Monthly data not available

Información mensual no disponible

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