

Participation of U. S. Trawlers in the Offshore Shrimp Fisheries of French Guiana, Surinam, and Guyana, 1978-79

ALEXANDER DRAGOVICH and ESSIE M. COLEMAN

Introduction

The waters overlaying the continental shelf area of northeastern Brazil, French Guiana, Surinam, and Guyana, known as the Guianas-Brazil shrimp grounds (Fig. 1), harbor four commercial species of shrimp: Brown shrimp, *Penaeus subtilis*; pink-spotted shrimp, *P. brasiliensis*; pink shrimp, *P. notialis*; and white shrimp, *P. schmitti*. The Guianas-Brazil shrimp fishery, a multimillion dollar international fishery known as one of the most productive fisheries in the

western hemisphere, emerged in the late 1950's. The fishery's history is reviewed by Naidu and Boerema (1972) and Dragovich (1981). Under the auspices of WECAFC (Western Central Atlantic Fishery Commission), an international working group met in Panama in 1979 and reviewed the existing knowledge of the Guianas-Brazil shrimp fishery and assess-

ed its state of exploitation. The same group reviewed and discussed suitable management measures and research needs and priorities. The proceedings

The authors are with the Miami Laboratory, Southeast Fisheries Center, National Marine Fisheries Service, NOAA, 75 Virginia Beach Drive, Miami, FL 33149-1099. This paper is Contribution No. 83-27M.

ABSTRACT—The offshore shrimp fishery of French Guiana, Surinam, and Guyana is known as one of the richest fisheries in the western hemisphere. The four principal species harvested are brown shrimp, *Penaeus subtilis*; pink-spotted shrimp, *P. brasiliensis*; pink shrimp, *P. notialis*; and white shrimp, *P. schmitti*. Brown and pink-spotted shrimp made up the bulk of landings. In 1978 and 1979, the U.S. catch off the three Guianas was 7.0 and 8.9 million pounds of shrimp or 38 and 39 percent, respectively, of the total landings by all fleets operating in this fishery during these years. The average annual catches per U.S. trawler in thousands of pounds were 52.1 (1978) and 67.5 (1979), and the annual catch rates were 13.1 (1978) and 15.4 (1979) pounds per hour. Most fishing was done at night at depths between 21 and 35 fm off French Guiana and Surinam and between 11 and 25 fm off Guyana. Large shrimp (<10 to 26-30 per pound) were prevalent in the landings during the first half of the year, while the smaller sizes (41-50 and >50 per pound) were prevalent during the second half of the year.

In the absence of data for realistic estimates of maximum sustainable yield, our assessment of this fishery was based on trends (1961-79) in total catch of all nations fishing the area and the number of trawlers. The shrimp catches during 1966-79 remained fairly constant with a range of 15,000 to 20,000 t whole weight, as the number of trawlers varied from 281 to 658.

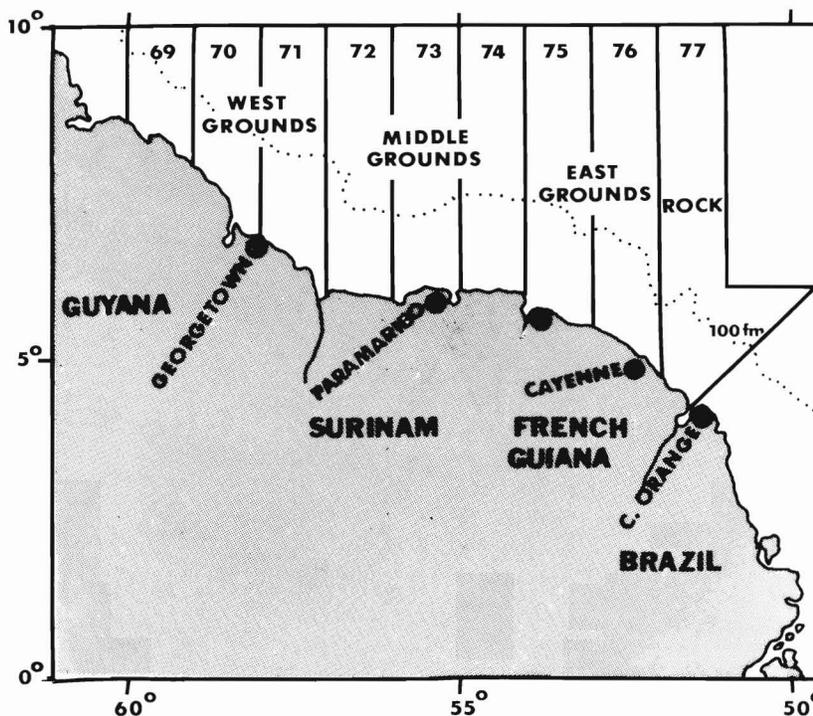


Figure 1.—The Guianas-Brazil shrimp grounds, showing the fishing zones and their common names.

of the Panama meeting were published in February 1980 (Jones and Villegas, 1980a, b). The literature related to the Guianas-Brazil shrimp fishery includes a large number of publications listed by Tashiro and Dragovich (1980).

In this paper we discuss catch and effort statistics for 1978-79 from the U.S. flag trawlers operating off the shores of French Guiana, Surinam, and Guyana, and landing information obtained from processing plant records. In previous reports on this fishery (Jones and Dragovich, 1973; Dragovich and Coleman, 1980), we discussed the catch and effort statistics from the Guianas-Brazil shrimp fishery for 1972-77. During those years, U.S. trawlers fished off Brazil, and relevant statistics on their activity were collected under the terms of the U.S.-Brazil bilateral fishery agreement. The last of these agreements expired in December 1977, and no fishing by U.S. vessels has occurred off Brazil since then.

Sources of Data and Methods Used

Data were obtained on a voluntary

basis from 1) logbooks completed by the captains of U.S. trawlers operating out of the ports of Cayenne, French Guiana; Paramaribo, Surinam; and Georgetown, Guyana, and 2) from landing statistics of processing plants from the same ports.

Captains' logbook records included daily entries on area fished, number of hours fished, number of hauls made, night or day fishing, estimated shrimp catch (pounds, heads-off weight), and most abundant species. Only the retained catch was reported and no estimates were made of the discarded by-catch. We also received monthly and annual landings from U.S. and other-than-U.S. boats that fished the fishing grounds off the Guianas. Each landing record denoted a fishing trip and included the total weight of shrimp in each commercial weight category. Based on the market price of shrimp, landings were listed either as mixed shrimp (pink-spotted, brown, and pink) and/or as white shrimp. In our treatment of the landing's data, the mixed and white shrimp were combined in one category. Landing records did not contain information according to the statisti-

cal zones, as shown in Figure 1. During 1978-79, the fleets based in Cayenne, French Guiana; Paramaribo, Surinam; and Georgetown, Guyana, fished only off these three countries. Thus, the information on the areal origin of landings during 1978-79 is more precise than prior to 1978 when the fleets were fishing anywhere between the Amazon and Orinoco Rivers.

U.S. Catch and Effort Statistics

Annual and Monthly Landings

Prior to the implementation of off-shore jurisdiction, licensing requirements, and landing quotas (Table 1), trawlers operating out of Guyana, Surinam, and French Guiana were not subject to regulations. Starting in 1977 and thereafter shrimp trawlers have been licensed and their numbers have been regulated by each country. The present Guianas shrimp fleet is modern, fairly uniform in size, and uses Florida-type shrimp trawlers. Except for a slight increase in size and engine power and predominance of steel over wooden or fiberglass vessels, characteristics of the present fleet

Table 1.—Coastal countries' regulations affecting shrimp fisheries in the Guianas-Brazil area¹.

Country	Extended fishery jurisdiction and licensing requirements	Closed season	Area restriction	Catch or effort limitations	Shrimp size limitations	By-catch landings
Guyana	Jurisdiction extended to 200 miles on 14/10/77. License fees for foreign-owned Guyana-based vessels (US\$5,000); foreign-based vessels (US\$39,200) and Guyana-owned Guyana-based vessels (US\$2,000); 12-mile territorial sea.	None	None, except foreign vessels must fish outside 12 miles.	None	None	Shrimp vessels required to land 2,000 lb. of by-catch per trip; not strictly enforced.
Surinam	Jurisdiction extended to 200 miles on 10/12/78. No license scheme; 3-mile territorial sea.	None	None	None	None	No regulations, food fish landed according to market demand.
French Guiana	Jurisdiction extended to 200 miles in January 1977 by European Economic Council (EEC). Licensing from France, no fee required at present; 12-mile territorial sea.	None	None, except no shrimping permitted in lagoons or lagoon outlets; no trawling inside 3 miles. From 30 April to 1 January, no shrimping at depths less than 16½ fm.	Total annual quota of 3,000 t set for 1978. Permanent licenses issued to French Guiana-based vessels. Temporary licenses, based on fishing days, issued to foreign-based vessels until total quota is reached.	None	No regulations, food fish landed according to market demand.
Brazil	Jurisdiction extended to 200 miles in 1970. Foreign fishing under licensing scheme permitted until 31/12/77. Since 1/1/78, only joint ventures and leasing arrangements permitted.	None (closed season for foreign boats enforced in 1972-77).	None	Limited entry, only 250 vessels allowed in the region Tutoia-Amapa.	None	No regulations, food fish landed according to market demand.

¹All countries appear to have plans for implementing stricter regulations.

are similar to those presented by Jones and Dragovich (1973).

The total landings by U.S. vessels for 1978 and 1979 were 7.03 and 8.9 million pounds, respectively. These represent 38.2 and 38.8 percent of the total landings by vessels from all countries participating in those years. We assembled data on annual landings, number of trawlers, and average annual landings per trawler for the period 1972-79 (Table 2) to demonstrate trends in shrimping activity by the U.S. fleet operating off the Guianas. The average catch per U.S. trawler in 1979 was 23 percent higher than that of 1978.

The year 1972 is used as a starting point because in July of that year the first U.S.-Brazil bilateral agreement was signed. Our data for 1972 represents only the second half of the year and should not be used in comparisons with data from other years.

Monthly landings of shrimp for French Guiana and Guyana for 1978 and 1979 are shown in Figure 2. Insufficient data were available from trawlers fishing off Surinam to include their landing information in Figure 2.

Pronounced differences occurred in monthly shrimp landings from Guyana and French Guiana (Fig. 2). Whereas the Guyana landings had similar monthly trends in both years, monthly landings in French Guiana were irregular. Following an annual low during the early months of the

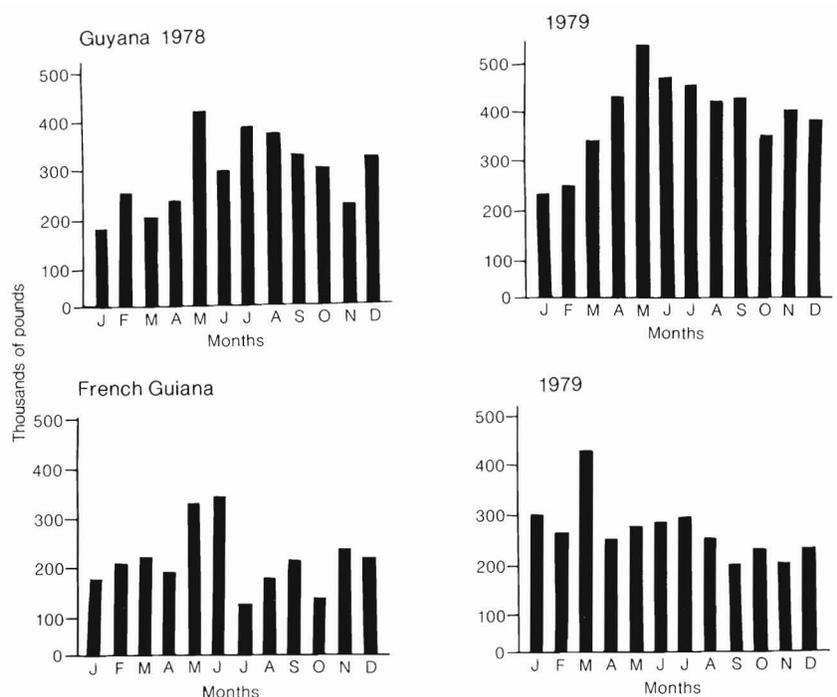


Figure 2.—U.S. monthly shrimp landings fishing off Guyana and French Guiana, 1978-79.

year, landings in Guyana peaked in May and thereafter declined. In 1978, French Guiana landings peaked in May and June and in 1979 in January, March, and July. The number of boats varied only slightly during the 2-year period; French Guiana had 60 boats in 1978 and 56 in 1979, while Guyana had 74 boats in 1978 and 79 in 1979.

Catch Per Unit of Effort (CPUE)

To express CPUE we used 1) catch per hour of fishing and 2) annual average catch per trawler, the latter being a popular method in the Guianas as a measure of fleet efficiency. The average catch per hour of trawling was calculated from the captain's logbooks while the annual average catch rates per trawler are based on landing records.

Average hourly catch rates for 1978 (13.1 pounds) and 1979 (15.4 pounds) were higher than the values for the two previous years (1976 = 11.8

pounds/hour; 1977 = 9.6 pounds/hour). This increase was particularly noticeable in the 15-20 pounds/hour category for which the values more than doubled off Guyana and off Surinam during 1979 (Fig. 3). Catch rates in the categories exceeding 25 pounds/hour were reported only in 1979 off Surinam.

The average annual catches by U.S. trawlers in thousands of pounds were 52.1 and 67.5 for 1978 and 1979, respectively. Except for 1973, the year of the bumper crop, the annual catch per trawler for 1979 was higher than the corresponding values for the previously reported years (Table 1). The relatively high catches by U.S. trawlers in 1978 and 1979 were coincidental with the facts that 1) the fleets were restricted to fishing only off countries of their registry, and 2) the adjoining Brazilian fishing grounds off the mouth of the Amazon were shrimped by 160 instead of 250 trawlers, the maximum allowable number of trawlers for this area.

Table 2.—Annual shrimp landings (million pounds, heads-off), number of trawlers, and weight landed by U.S. flag vessels in the Guianas-Brazil fishery (1972-79). The mean catch values per trawler were computed by using the actual landing figures instead of rounded-off values as shown.

Year	U.S. catch	Number of trawlers	Weight landed per trawler
1972 ¹	5.0	153	32.7
1973	13.6	188	72.3
1974	9.0	207	43.5
1975	6.8	157	43.4
1976	5.9	134	44.2
1977	8.2	141	58.6
1978 ²	7.0	135	52.1
1979 ²	8.9	132	67.5

¹One-half year

²No fishing in Brazilian waters by U.S. vessels.

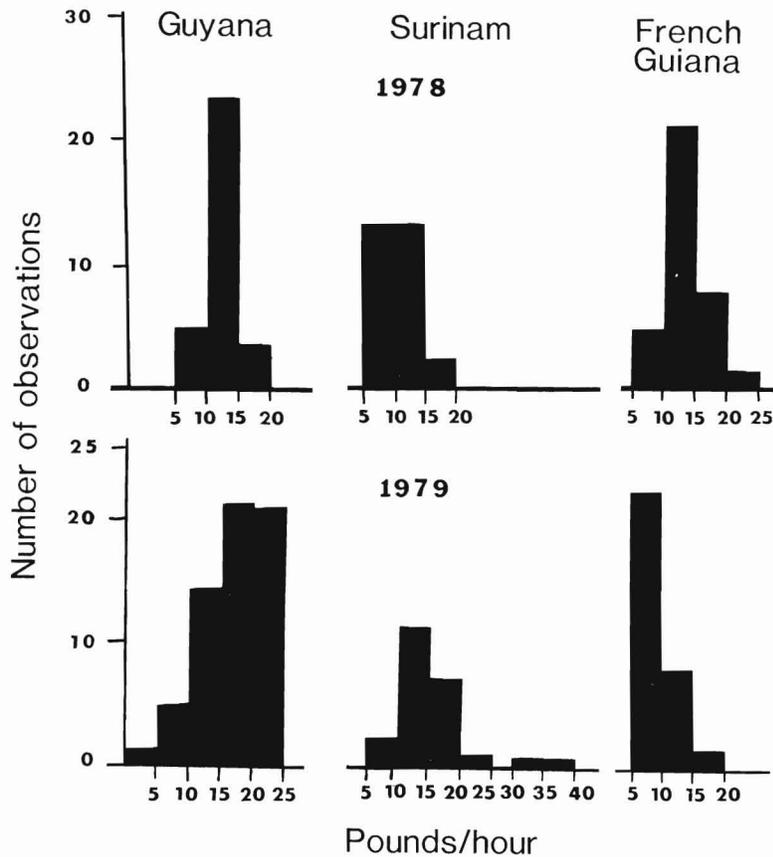


Figure 3.—Frequency distribution of mean catch per hour of trawling by U.S. shrimpers off the coast of Guyana, Surinam, and French Guiana, 1978-79.

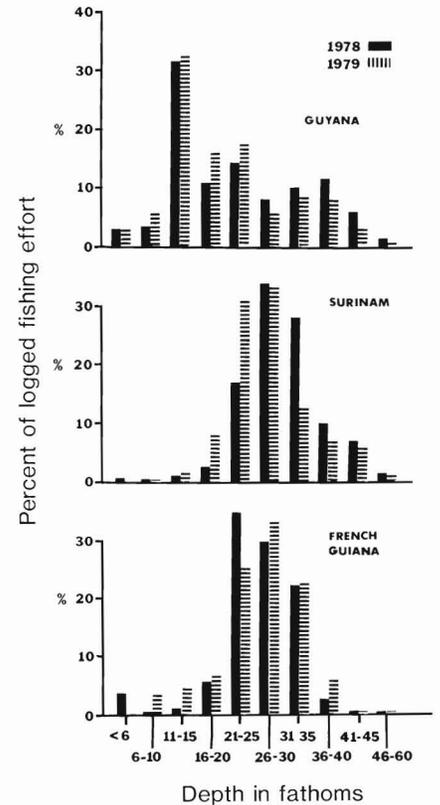


Figure 4.—Distribution of fishing effort by depth interval for Guyana, Surinam, and French Guiana, 1978-79.

Distribution of Fishing Effort and Catch Rates in Relation to Depth and Fishing Zone

Knowledge of areal and depth distribution of fishing effort and related catch rates is very important in the ecological studies of commercially important species of shrimp and is also of practical value to commercial fishermen (Jones and Dragovich, 1977). Based on captains' logbooks, our trawlers fished depths from about 5 to 60 fm. We plotted the distribution of fishing effort in relation to depth (Fig. 4); 98 percent of U.S. shrimpers fished off French Guiana and Guyana. Off French Guiana, more than 80 percent of fishing effort was at the

intermediate depths between 21 and 35 fm during both 1978 and 1979; off Guyana the pattern of effort differed from that off French Guiana as trawlers spread their effort over a much wider range of depths than off French Guiana (Fig. 4).

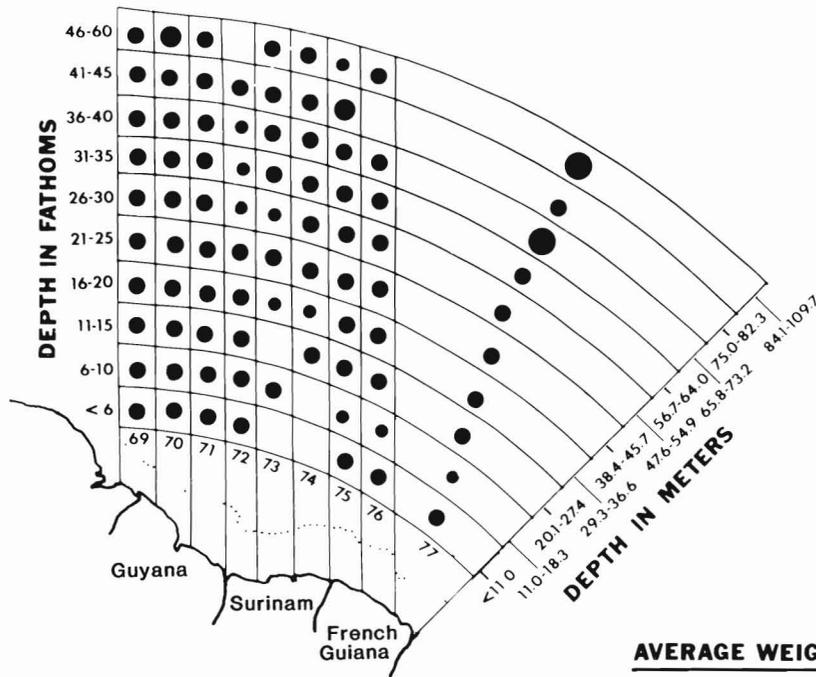
To observe the spatial and temporal distribution of catch rates, we plotted the mean monthly hourly rates for each fishing zone (Fig. 5). The rates varied slightly during 1978 and 1979 in all fishing zones and at all depths (Fig. 6); their coefficient of variations for French Guiana and Guyana combined for 1978 and 1979 were 20.6 and 17.9 percent, respectively. The relatively high frequency of occurrence of low catch rates off French Guiana (Fig. 3) might be related to the

fact that shallow depths (21-35 fm) off French Guiana are fished more frequently than the same depths off Guyana (Fig. 4).

Distribution of Catch and Effort in Relation to Day and Night Fishing

The chief determining factor in the daily distribution of effort on the part of shrimp fishermen is the quantity of marketable shrimp that they can catch. Catch and effort statistics in relation to day and night were collected from captains' logbooks. Catches made between sunrise and sunset were recorded by shrimp captains as day catches, those made between sunset and sunrise as night

1978



AVERAGE WEIGHT/HOUR

	LB	KG
● (largest)	40-49	18.1-22.2
● (medium-large)	30-39	13.6-17.7
● (medium-small)	20-29	9.1-13.1
● (small)	10-19	4.5-8.6
● (smallest)	<10	<4.5

1979

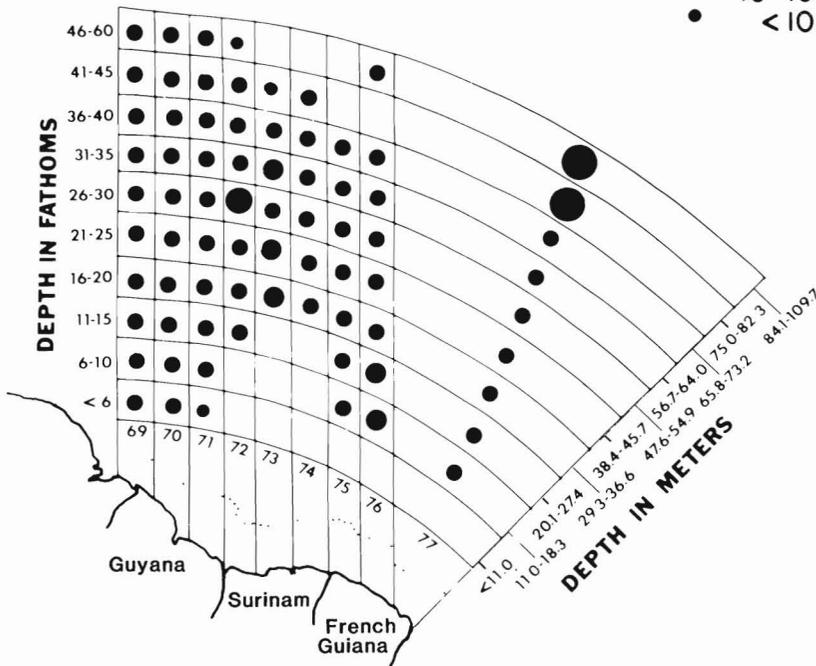


Figure 5.—Distribution of the annual catch rate of shrimp by fishing zone and depth for U.S. vessels fishing off Guyana, Surinam, and French Guiana, 1978-79.

catches, and those that included daytime and nighttime trawling were labeled as both. Resulting data were shown for each fishing zone in Figure 6 and for the 10 selected depth intervals for all fishing zones combined in Figure 7.

If we exclude the effort reported as both day and nighttime combined, then most of the fishing effort occurred during night hours. The nighttime effort in 1978 and 1979 represented 85 and 77 percent of the total daily effort, respectively. The distribution of fishing effort as related to the time of the day further shows the existence of geographic differences, as more time was spent in day fishing off Guyana than off Surinam and French Guiana and the least time was spent off Surinam. Off French Guiana, proceeding from zone 75 to 77, during both years, there was less time spent in night fishing and more in day and night fishing combined (Fig. 6). In fishing zone 77, over 70 percent of the reported fishing effort was in day and night fishing combined.

The distribution of daily fishing effort in relation to depth showed that at shallow depths, particularly at the depth range 6-15 fm, more effort was at daytime than at nighttime (Fig. 7). At the depths exceeding 16 fm, most of the fishing effort occurred during night hours. Fishing at depths up to 10 fm was mostly for white shrimp and was conducted primarily off Guyana. It is probable that the daytime shrimping in the shallow coastal waters is related to greater turbidity.

The distribution of the catch as re-

Table 3.—The mean annual catch rates (pound/hour) of shrimp for day (D), night (N), and both day and night (B) of fishing in the fishing zones of Guiana fishery.

Zones	1978			1979		
	D	N	B	D	N	B
69	17.7	13.3	11.7	19.7	15.4	13.9
70	18.4	14.1	11.3	20.4	14.8	14.6
71	16.1	12.2	11.1	20.4	15.4	13.8
72	9.7	9.9	11.4		17.6	
73	13.5	10.6	9.8	25.0	16.3	27.8
74	18.8	11.0	10.1	18.1	15.0	11.6
75	21.8	13.8	12.1	18.7	16.7	14.8
76	13.9	12.6	12.8	25.3	15.5	14.7
77	19.4	17.9	14.5	25.7	15.7	14.4

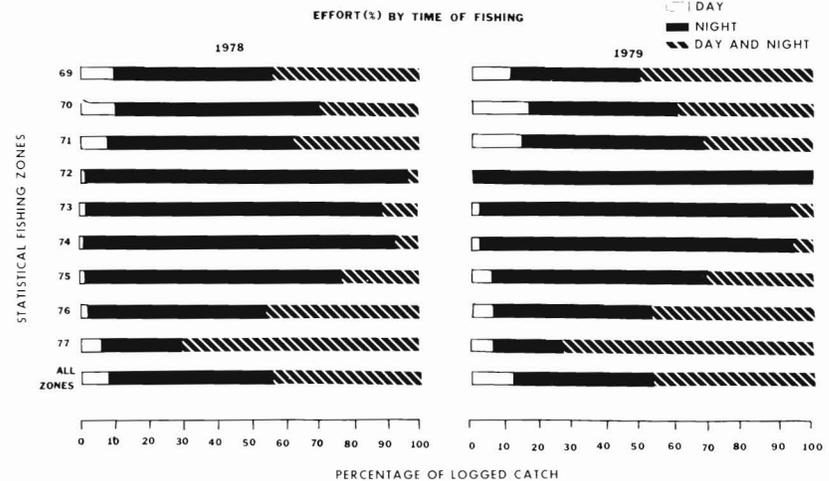


Figure 6.—Distribution of fishing effort by time of day and fishing zone in the Guianas shrimp fishery, 1978-79.

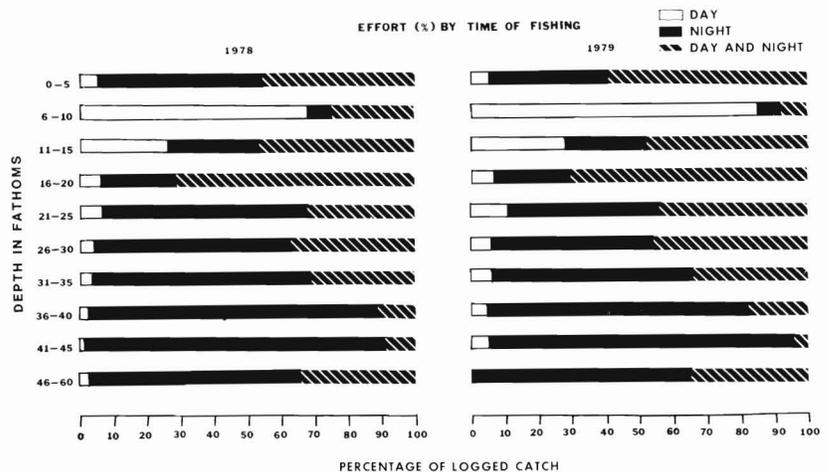


Figure 7.—Percentage distribution of fishing effort by U.S. vessels according to time of day and water depths in the Guianas-Brazil shrimp fishery, 1978-79.

lated to the time of the day was very similar to the distribution of effort (Fig. 8). Even though the total quantity of shrimp caught during night hours exceeded the daytime catches by a substantial margin, the daytime catch rates were much higher than those found at night throughout the fishery (Table 3).

Species Composition and Geographic Distribution of the Catch

Information on species composition of shrimp catches was obtained from boat captains' logbooks. Captains recorded the most abundant species in their catch, although this meth-

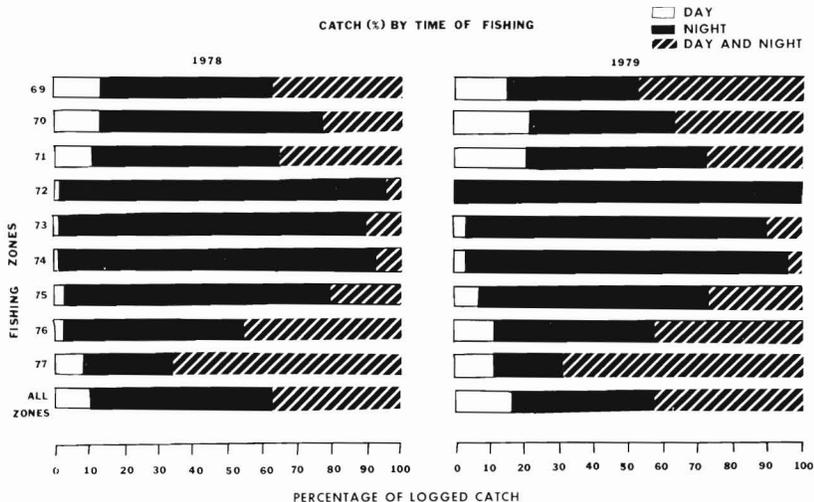


Figure 8.—Percentage distribution of catch by U.S. vessels according to time of day and statistical fishing zones in the Guianas fishery, 1978-79.

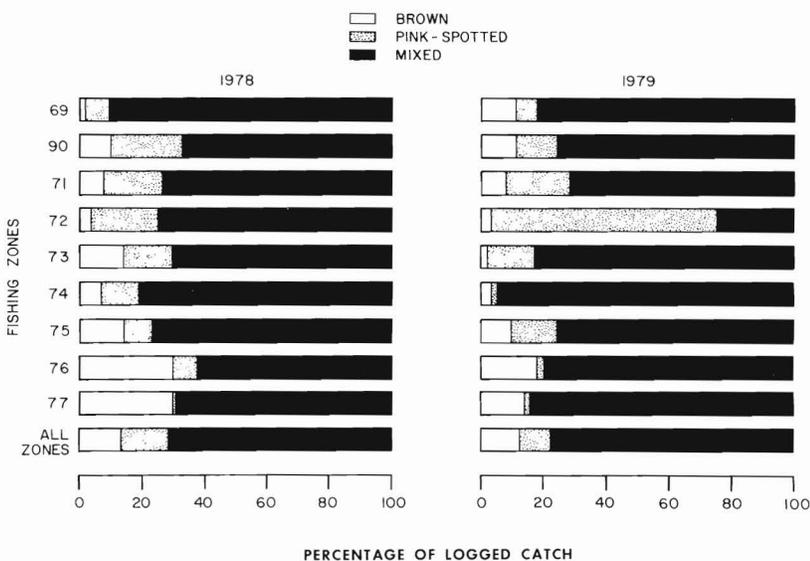


Figure 9.—Species composition of the shrimp catches of U.S. vessels off the three Guianas by statistical fishing zones. Catches were recorded as mixed if two or more species were present in about equal proportions.

od tends to overestimate the dominant species. The catch was recorded as mixed if two or more species were present in about equal proportions. The brown, pink-spotted, and white

shrimp are easily distinguishable from each other; the fourth species, pink shrimp, presents problems in identification because pink and brown shrimp are similar in appearance.

Furthermore, brown and pink-spotted shrimp are caught in large quantities throughout the fishery while pink shrimp are found in small numbers only and only off western French Guiana, off Surinam, and off Guyana.

In approximately three quarters of the logbook records (72 percent in 1978; 76 percent in 1979) the catch was recorded as mixed and in the remainder, brown shrimp and pink-spotted shrimp were recorded as single species (Fig. 9). The geographic distribution showed prevalence of brown shrimp off French Guiana and pink-spotted shrimp off Surinam (Fig. 9). Off Guyana, pink-spotted shrimp were dominant during 1978, but in 1979 there was an increase in proportion of brown shrimp which were more abundant than pink-spotted shrimp in fishing zones 69 and 70. Pink shrimp were recorded in small quantities (1.3 percent of recorded catches) and they were present in all fishing zones except 77. White shrimp were noted in catches off all three Guianas, but were present even in lesser quantities than pink shrimp. Pink and white shrimp were not included in Figure 9 because they were present in such small quantities. The reported catches of white shrimp in this paper are not representative of this species, because U.S. fishermen do not fish intensively in the shallow depths where this species is most abundant.

Brown shrimp were dominant off French Guiana and pink-spotted shrimp off Surinam in 1978-79 and Guyana in 1978. In 1979 the catches off Guyana, fishing zones 69 and 70, had more brown shrimp than pink-spotted shrimp, while in fishing zone 71, pink-spotted shrimp were predominant. Our data on species composition and their distribution for the 1978-79 period is in general agreement with our observations for the previous years (Jones and Dragovich, 1977; Dragovich and Coleman, 1980).

Size Composition of Shrimp in the Landings

Knowledge of temporal and spatial

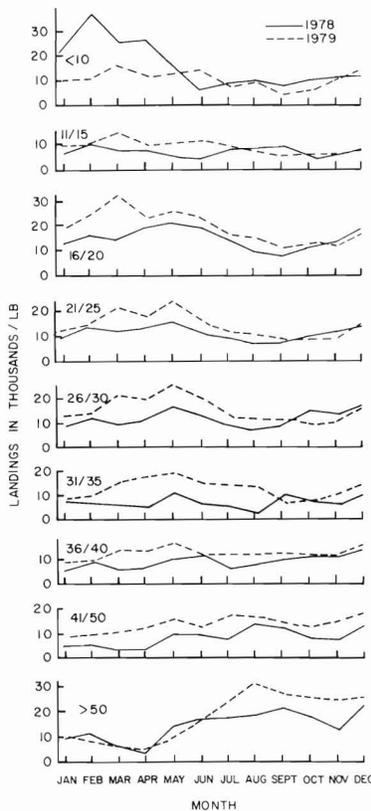


Figure 10.—Monthly distribution of size categories of shrimp from landings in Guyana, Surinam, and French Guiana combined, 1978-79.

occurrence of different sizes of penaeid species may help us to understand the area and time of recruitment and their subsequent availability to the fishermen. Our information on shrimp sizes from captains' logbooks is biased. As during the past years (Jones and Dragovich, 1977; Dragovich and Coleman, 1980) the majority of the catch recorded in the captains' logbooks for 1978 and 1979 was medium sized shrimp (16-35 headless shrimp per pound). In some instances the size of shrimp in landings may reflect selective fishing as influenced by market price of shrimp, fuel prices, feasibility of operation, skill of the crew, condition of the boat, and environmental conditions.

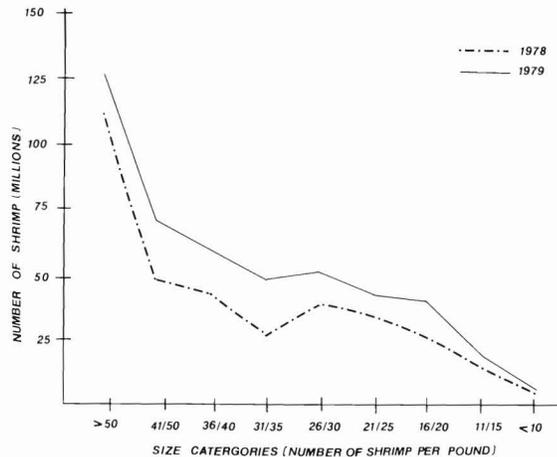


Figure 11.—Numerical size composition of shrimp landed in the three Guianas, 1978-79.

The majority of shrimp landed during 1978 and 1979 were in the 26-30, 21-25, and 16-20 tails per pound size categories and a large quantity of shrimp was in the smallest size category (>50) (Fig. 10). When the data on sizes are presented on a numerical basis (Fig. 11), it becomes apparent that the major portion of shrimp caught are in the smallest size category. If these small shrimp were allowed to grow another 2-3 months, the economic return to the commercial fisherman probably would have been considerably higher.

Based on landing records, monthly distribution of shrimp sizes in the present study was very similar during both reported years (Fig. 10). There were two modal peaks, one represented the smallest size category (>50) and the other the larger sizes (26-30 and 16-20). The principal difference in the distribution of shrimp sizes between 1978 and 1979 was that both peaks were more pronounced during 1978 than during 1979. During 1979 the variations between the size categories (16-20 to >50) were very slight. Larger shrimp (from <10 through 26-30) were landed in greater quantities during the first half of the years than during the second half of the years, while the smallest sizes (41-50 and >50) were landed in greater quantities during the

second half of the years; the monthly distribution of intermediate sizes did not follow a pattern. If we assume that these data are accurate and not reflective of selective fishing, then we can deduce that the major portion of shrimp were recruited to the fishery from June to December.

We also examined separately the areal distribution of shrimp sizes taken by fleets fishing off French Guiana and off Guyana. Landings off French Guiana had more larger sizes of shrimp than the landings off Guyana, while the smallest sizes (41-50 and >50) were much more abundant off Guyana than off French Guiana. The size data from Surinam were unavailable to us.

Based on our data, the sizes of brown, pink-spotted, and pink shrimp generally increase progressively with increasing depth. Our examination of the fishing effort off Guyana and French Guiana in relation to the depth of fishing (Fig. 4) showed that the trawlers fish more shallower depths off Guyana and consequently catch more small sizes of shrimp than off French Guiana.

Trends in the Fishery

Due to the lack of information on the inshore shrimp fishery for juveniles and inadequate species data for

the offshore shrimp fishery, estimates of maximum sustainable yield (MSY) would not be realistic. Thus, we have considered the status of this fishery only in general terms showing the total catch versus the number of boats (Fig. 12) and on the basis of gross statistics related to the fishing trends (Fig. 13). For this purpose we have viewed the fishery as supported by one stock with all species combined. Following the period of expansion of this fishery (1960-65), commercial landings by the participating nations have remained fairly constant within a range of 15,000 to 20,000 t whole weight for the period 1966-79 (Fig. 12), while the number of trawlers varied from 281 to 658. From Figure 12, it is apparent that the number of trawlers has considerably increased in recent years and that the total catch has not increased concomitantly. As in past analyses on this fishery (Jones and Villegas, 1980a), Figure 12 includes data from all other fleets that fish the Guianas-Brazil shrimp grounds.

Literature Cited

Dragovich, A. 1981. Guianas-Brazil shrimp fishery and related U.S. research activity. *Mar. Fish. Rev.* 43(2):9-18.

_____, and E. M. Coleman. 1980. The United States shrimp fishery off the coasts of northeastern Brazil, French Guiana, Suriname and Guyana (1975-77). In A. C. Jones and L. Villegas (Editors). Proceedings of the working group on shrimp fisheries of the northeastern South America. Cont. 4.3 WECAF Rep. (28):77-98.

Jones, A. C., and A. Dragovich. 1973. Investigations and management of the Guianas shrimp fishery under the U.S.-Brazil agreement. *Proc. Gulf Carib. Fish. Inst.* 25th Annu. Sess., p. 26-33.

_____, and _____. 1977. The United States shrimp fishery off northeastern South America (1972-74). *Fish. Bull.*, U.S. 75:703-16.

_____, and L. Villegas. 1980a. Proceedings of the working group on shrimp fisheries of northeastern South America, Panama City, Panama, 23-27 April 1979. WECAF Rep. 27, 89 p.

_____, and _____. 1980b. Proceedings of the working group on shrimp fisheries of northeastern South America, Panama City, Panama, 23-27 April 1979. WECAF Rep. 28, 232 p.

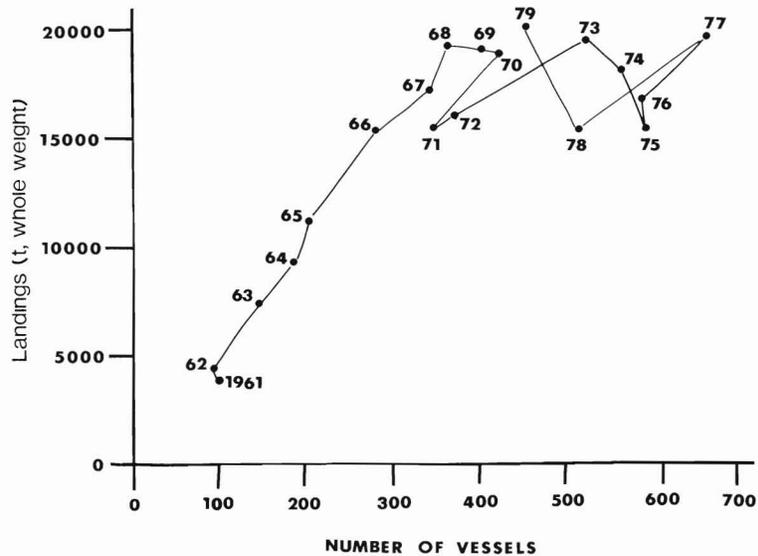


Figure 12.—Fleet size and landings from the offshore Guianas-Brazil shrimp fishery, 1961-79.

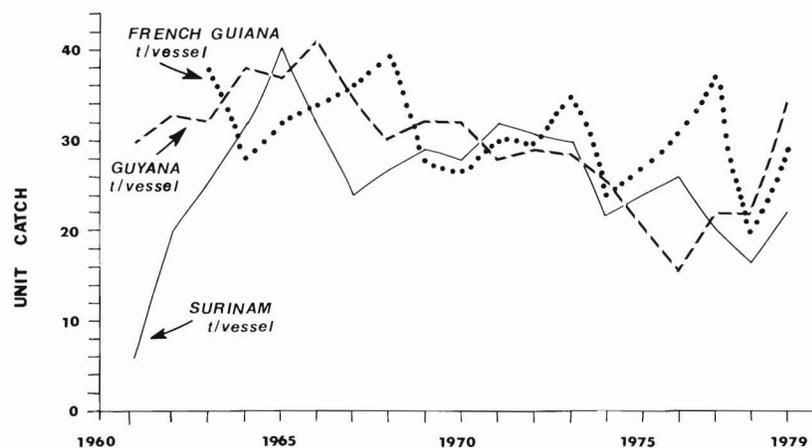


Figure 13.—Trends in catch per unit of effort of shrimp fleets based in French Guiana, Guyana, and Surinam, 1961-79.

Naidu, K. S., and L. K. Boerema. 1972. The high-seas shrimp resources off the Guyanas and northern Brazil. *FAO Fish. Circ.* 141, 18 p.

Tashiro, J., and A. Dragovich. 1980. Bibliography on the offshore shrimp fishery of northeastern South America. WECAF Rep. 35, 35 p.