

Guianas-Brazil Shrimp Fishery and Related U.S. Research Activity

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Introduction

In the 1940's and 1950's, teams of explorers, sponsored by the Caribbean Commission, Surinam Government, and U.S. Government, located large aggregations of penaeid shrimp off the northeastern coast of South America. Based on the encouraging results of these surveys, a commercial shrimp trawling operation began in the late 1950's. With the United States and the Guianas first—followed by Trinidad, Brazil, and Barbados—Japan, Korea, Venezuela, and Cuba rushed (in the 1960's and 1970's) to grab a share of this newly discovered "gold mine," known as the Guianas-Brazil offshore shrimp fishery.

The Guianas-Brazil fishery grounds extend from Trinidad south to the mouth of the Amazon River (Fig. 1). Brown shrimp, *Penaeus subtilis*, pink-spotted shrimp, *P. brasiliensis*, pink shrimp, *P. notialis*, and white shrimp, *P. schmitti*, are harvested from these grounds. A combination of factors—open season,

absence of territorial restrictions, a well-designed and rugged Florida-type shrimp trawler, inexpensive and abundant fuel, favorable market conditions, ambitious highly skilled fishermen, and cooperation by local governments—accelerated the development of this multimillion dollar fishery. Processing plants were erected in the ports of Paramaribo (Surinam), Cayenne and St. Laurent (both French Guiana), Georgetown (Guyana), Port of Spain (Trinidad), Bridgetown (Barbados), and Belem (Brazil). The shrimp processed and packed at these plants were exported primarily to the United States and Japan.

The number of trawlers and total landings for the period 1961-78 and the country where they are based are given in Table 1. The shrimp trawlers opera-

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ting in this fishery consist chiefly of Florida-type trawlers, fairly modern and uniform in size, and are equipped with fishing gear and refrigeration systems. The vessels usually range from 70 to 75 feet (21.3-22.9 m) in length. These trawlers are usually rigged to fish two trawls, 40-55 feet (12.2-13.7 m) in length with 8-10 foot (2.4-3.0 m) doors.

The present U.S. fleet operates out of Cayenne, Paramaribo, and Georgetown. In earlier years our fleets also operated out of St. Laurent, Bridgetown, and Port of Spain. The numbers of U.S. boats from 1972 through 1978 are shown in Table 2.

The "good old days" in this restriction-free fishery began to crumble in 1970, as Brazil declared a 200-mile economic zone. To fish in Brazilian waters, from 1972 to 1978, foreign vessels were issued licenses under bilateral agreements. The first in the series of 2- and 1-year agreements was signed on 9 May 1972 between the United States and Brazil. The last

ABSTRACT—United States research activity in connection with the Guianas-Brazil shrimp fishery is described. The fishery's history is reviewed and catch and effort statistics are discussed. The fishery grounds extend from Trinidad south to the mouth of the Amazon River. Brown shrimp, *Penaeus subtilis*, pink-spotted shrimp, *P. brasiliensis*; pink shrimp, *P. notialis*, and white shrimp, *P. schmitti*, compose the fishery. The analysis of catch statistics for all species combined for 1961-77 indicates that the overall catch has not increased parallel to the increase in fleet size, and that the total catch can be maintained at the 1978 level (15,000 t) or even increased slightly to a considerable increase in fleet size over the 1978 level (501 trawlers).

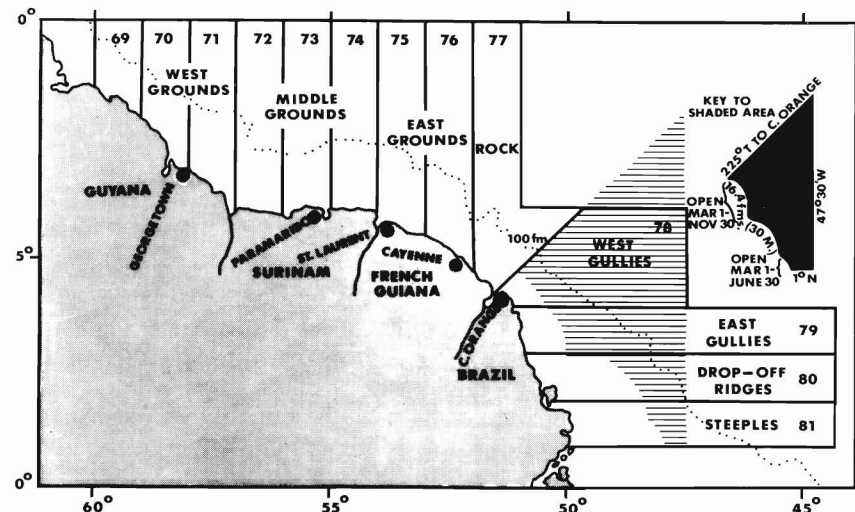


Figure 1.—The Guianas-Brazil shrimping grounds with fishing zones and their common names. The U.S. Agreement Area is shaded; the boundaries of the Area and the fishing seasons for U.S. vessels are shown in the inset

Table 1.—Number of shrimp trawlers of various flag registries in the Guianas-Brazil fishery according to country where based. Cuban vessels operate with a mothership and use Guyana as a secondary base. Total landings are also given.

Year	Barbados	Trinidad	Venezuela	Guyana	Cuba	Surinam	French Guiana	Brazil	Total	Landings (t, whole weight)
1960	Data not available									2,785
1961	—	—	—	60	—	40	—	—	100	3,095
1962	—	—	—	72	—	24	—	—	96	4,371
1963	—	—	—	89	—	25	33	—	147	7,430
1964	30	—	—	81	—	25	51	—	187	9,262
1965	24	—	—	96	—	25	58	—	203	11,230
1966	32	43	—	105	—	34	67	—	281	15,475
1967	32	58	—	113	—	50	89	—	342	17,222
1968	35	48	—	134	—	55	90	—	362	19,259
1969	36	63	—	142	—	51	110	1	403	19,136
1970	25	78	—	162	—	55	83	18	421	19,081
1971	—	60	—	160	—	45	60	21	346	15,500
1972	—	55	—	175	—	55	60	25	370	16,126
1973	6	42	107	200	—	63	68	37	523	19,606
1974	21	39	66	202	10	106	62	55	561	17,687
1975	20	50	88	209	14	140	45	¹ 25	591	15,567
1976	0	66	90	190	6	165	31	¹ 38	586	16,753
1977	0	77	129	157	—	192	42	48	645	19,361
1978	0	—	58	148	—	165	78	52	501	15,188

¹In 1975 and 1976 these vessels fished south of the Equator, outside the U.S.-Brazil Agreement Area.

Table 2.—Number of U.S. flag trawlers operating in the Guianas-Brazil shrimp fishery.

Year	Total no.	With UB no. ¹	Year	Total no.	With UB no. ¹
1972 ²	153	153	1976	134	99
1973	188	193	1977	141	90
1974	207	214	1978	122	—
1975	157	92	1979	Incomplete	—

¹UB number identifies boats that had licenses to fish the Agreement Area of Brazil (see Fig. 1).

²Half year.

bilateral fishing agreement between these countries expired on 31 December 1977. The number of fishing permits (Table 2) was limited and subjected to seasonal and other restrictions of the fishery in the Agreement Area (Fig. 1).

In 1977, Guyana, Surinam, and French Guiana initiated a licensing system parallel to the establishment of their extended national offshore fishing jurisdiction. Prior to the era of extended offshore fishing jurisdiction and licensing by Brazil and the Guianas, the geographic fishing pattern for most of the fleets was to fish Brazilian waters at the beginning of the year (up to May), then a gradual shift to French Guiana grounds (from May to July), and further shift to the grounds off Surinam (July-September) and Guyana (September-December). A portion of the fleet followed no pattern and fished oppor-

tunistically throughout the entire area.

A steep rise in fuel prices from about 12 cents to 48-50 cents a gallon in 1975 with associated inflationary prices of industrial products used by fishermen drastically changed the pattern of fishing.

These events restricted the fleets to fish only off their respective countries (a complete exclusion of Brazilian waters from the fishery in 1978 and 1979), to practice more efficient fishing with less travel, to relocate portions of their fleet within the fishery, to sell an entire fleet in some instances, to withdraw from the fishery in other instances, and to try to negotiate joint ventures with Brazilians. The number of U.S. vessels in this fishery decreased from 1974 to 1978 (Table 2).

U.S. Research Activity

United States research on the shrimp fishery off the Guianas and Brazil is aimed at providing assistance to our shrimp industries in the form of guidelines for proper management of the fishery.

Under the terms of the United States-Brazil Bilateral Fishery Agreement, we began to collect catch and effort statistics in 1972 from our vessels that fished in the Agreement Area. The entire data were submitted each month to the SUDEPE, Programa de Pesquisa e

Desenvolvimento Pesqueiro do Brasil, the Brazilian equivalent of NMFS (National Marine Fisheries Service). We also collected catch and effort statistics from our fishing fleet off the three Guianas. Catch and effort data collected from 13 statistical zones (Fig. 1), were recorded by boat captains on a logbook form designed by us. This form found wide acceptance in Surinam, French Guiana, and Guyana for their data collection.

To learn more about the species distribution of shrimp, their biology, and associated fauna and ecology of the area, we conducted, from 1972 to 1978, six research surveys of the area with the NMFS fisheries research vessel *Oregon II*.

In 1976, we also initiated a port sampling program of shrimp landings to obtain more detailed biological data on species levels, which were not available from captains' logbook forms and landings statistics.

The international character of the Guianas-Brazil shrimp fishery required a continuous liaison between participating countries. This liaison was chiefly in the form of periodic scientific conferences between the researchers of participating countries and members of the shrimp industry. Perhaps the most significant conference on this fishery was held in April 1979 in Panama City, Panama. Although this workshop was sponsored by the international project known as the Inter-regional Project for the Development of Fisheries in Western Central Atlantic (WECAF), U.S. participation in terms of people and contribution of reports clearly dominated this meeting. Our entire data base from this fishery, representing a period from 1972 to 1978, was presented at this meeting.

At the beginning of our research activity, there was little information on this fishery, and most of it was scattered and fragmented. This report is primarily concerned with U.S. catch and effort statistics for 1975-77 but also includes other data for a more complete presentation of this fishery. The following sections of this report include condensed, salient features of accomplishments of our research.

Species Composition and Geographic Distribution, With Comments on Their Biology and Ecology

The geographic distribution of the four species indicates definite patterns. Brown shrimp, the most abundant species, occurs throughout the fishery, being most common off Brazil and French Guiana. Pink-spotted shrimp is the second ranking species, occurring throughout the fishery but most abundant off Surinam and Guyana. Pink shrimp is third with verified records only off Guyana, Surinam, and the western part of French Guiana. The fishable populations (chiefly adult forms) of these three species are found mainly from 15 to 45 fm (27-82 m). White shrimp occur along the shallow portion (<37 m or 20 fm) of this fishery and are the least abundant.

In our *Oregon II* surveys of the continental slope, we found commercial concentrations of scarlet prawn, *Plesiopenaeus edwardsianus*, at 350-450 fm (640-823 m).

Based on observed depth ranges and on frequency of occurrence at different salinities, the adult forms of brown, pink, and pink-spotted shrimp may be considered as eulittoral and sublittoral marine organisms. The white shrimp may be defined as eulittoral, euryhaline organisms. The scarlet prawns may be considered as archibenthic, stenohaline organisms.

In landing records, all species are reported together according to nine size (number/pound) categories (>50; 46-50; 41-45; 36-40; 31-35; 26-30; 21-25; 15-20; and <15/pound). Similar to the observation for the 1972-74 period, the majority of shrimp landed by the U.S. fleet during 1975-77 were in the size categories 21-25, 26-30, and 31-35 counts/pound. The size data indicate a trend by the U.S. fleet and by the Japanese fleet in landing progressively more shrimp in the small size categories (>50 and 41-50) during the past few years.

The size of shrimp in landings may represent a true picture on size availability but in some instances may also reflect selective forms of fishing as influenced by market price of shrimp,

fuel prices, feasibility of operation, skill of the crew, and condition of the boat.

Similar to the 1972-74 observations, data for 1975-77 indicated a prevalence of small sizes in March 1975 and 1976 and April 1977. The largest sizes were in January, November, and December 1975 and 1976; intermediate sizes occurred during the summer months. The monthly peak of small size shrimp in March and April might be indicative of seasonal recruitment. Spatially, the largest sizes of brown, pink-spotted, and pink shrimp in 1975-76 were noted off Surinam and off eastern French Guiana.

Both Brazilian and U.S. data provide information on occurrence of juvenile brown shrimp. Brazilian reports state that juvenile brown shrimp are taken throughout the year by the artisanal shrimp fishery in Maranhao-Para, Brazil. Our data also indicate that small brown shrimp predominate in the catches off Amapa, Brazil, and eastern French Guiana, especially in March and April. A second area of occurrence of small brown shrimp is off Guyana. These observations may suggest that young shrimp are being recruited onto the fishing grounds principally for these areas. Based on information from the Surinamese Division of Fisheries, the juveniles of pink-spotted shrimp were identified in the estuarine Surinamese waters from April to June. Additional field work is required to delineate a precise spatial distribution of various sizes of shrimp.

Our Georgetown port sampling yielded information on sizes, sex ratios, and occurrence of four maturity stages of females on the species level. As in other shrimp populations, United States and Brazilian studies have shown that female brown, pink-spotted, and pink shrimp in this fishery reach larger sizes than males. The sex ratio for brown shrimp in 1976 was 1:1; in 1977 and 1978 the males outnumbered females by 2:1 and 3:1. For pink-spotted shrimp, males outnumbered females for all 3 years as the ratio progressively increased from 1.6:1 to 3.1:1 from 1976 to 1978. In 1976, male pink shrimp outnumbered females 1.6:1; in 1977 and

1978 the sex ratio was about 1:1 for both years. In white shrimp the sex ratio was about 1:1 for the 3 years.

The data on temporal occurrence of maturity stages of four species of shrimp showed irregular peaks. For proper interpretation of these peaks of abundance, additional work in the area of sampling will be necessary. The four maturity stages from I to IV indicated immature, maturing, mature, and spent condition of their gonads. All four stages of maturity for each species occurred during each month of the year, indicating year-round spawning. In 1976, all maturity stages of brown shrimp occurred each month during the entire period of observation (June-December); in 1977 stages I and II made up the bulk of samples, stage III was less numerous than stages I and II, and stage IV consisted each month of a few specimens. In 1978, stages I and II completely dominated the samples, while stages III and IV were poorly represented. The occurrence of maturity stages of pink-spotted shrimp for 1976 and 1977 lacked a pattern. In 1978, stage I of pink-spotted shrimp made up the bulk of this species. The occurrence of maturity stages of pink and white shrimp exhibited a lack of pattern.

Annual and Monthly Landings

The maximum U.S. catch of 13.6 million pounds was attained in 1973. In 1974, our catch dropped to 9.0 million pounds; in 1975 and 1976 it decreased to 6.8 and 5.9 million pounds; and in 1977 it increased to 8.2 million pounds. United States landings represented 49.8, 38.9, 35.2, 30.4, and 37.6 percent of the total international landings for 1973, 1974, 1975, 1976, and 1977. The maximum number of U.S. vessels (207) was reached in 1974 after a record harvest in 1973. During 1975, 1976, and 1977 a decline in the number of boats of 24, 35, and 32 percent was experienced. Except for 1972 and 1974, the mean annual catch of U.S. vessels was higher than the corresponding values for foreign boats combined (Fig. 2).

The monthly distributions of U.S.

landings from processing plant records and logbooks for the Guianas and Brazilian waters showed higher catches from March to July than during the remaining months of the year (Fig. 3). The mean hourly catch rates indicated higher catches during the first half of the year than during the second (Table 3). Off Brazil the catch rate for 1976 was 47 percent more during the first half than during the second, indicating that penaeids were more available to fishermen during the January-June period than the July-August period.

Catch Per Unit of Effort (CPUE)

In this report I use the mean annual catch per boat and catch per hour of actual fishing as methods of expressing CPUE. The mean annual catch rates for U.S. vessels in thousand of pounds were 72.3, 43.5, 43.4, 44.2, and 58.6 for 1973 through 1977. The highest monthly catch rates for the 3 years reported here were off Brazil (Fig. 4, 5).

The distributions of mean hourly catch rates and fishing effort of all species combined for 10 depth intervals are shown in Figures 6 and 7. The distribution of hourly catch rates for 1975 varied slightly throughout all zones and depths fished. Most of the catch rates were within the 10-30 pounds category. During 1976 the highest catch rates were off French Guiana and Brazil at depths of 20.1-36.6 m (11-20 fm). The catch rates for Brazil were higher for all fishing depths than those off Guyana, Surinam, and western French Guiana. The catch rates off Guyana, Surinam, and a part of French Guiana (zones 75 and 76) were fairly uniform. During 1977 the highest catch rates were off French Guiana and Surinam at 11.0-36.6 m (6-20 fm) depths; off Brazil high catch rates (21.0 pounds) were obtained for the entire depth range fished; off Guyana the catch rates varied slightly over the entire depth range.

Most of the effort for the entire fishery was concentrated at intermediate depths, between 36.6 and 64.0 m (21 and 35 fm)—53 percent for 1975, 59.1 percent for 1974, and 55.9 percent for 1977 (Table 4). At depths <36 m

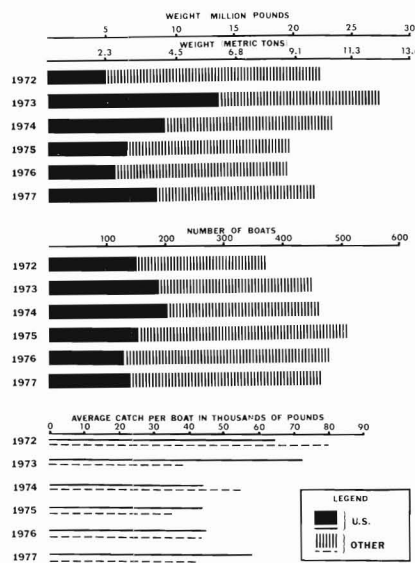


Figure 2.—Yearly landings of shrimp (heads-off weight), average number of active boats, and average catch per boat for the Guianas-Brazil fishery (1972-77).

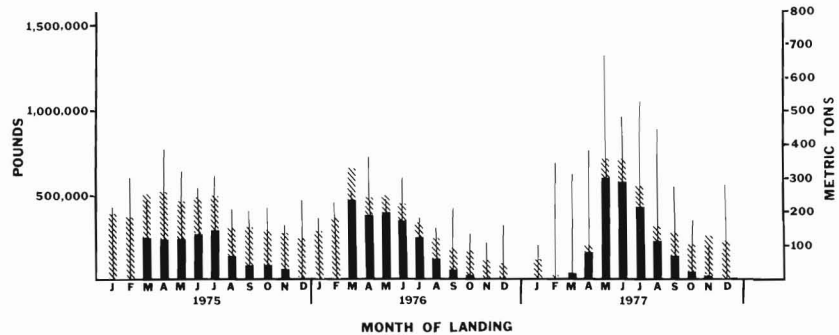


Figure 3.—Monthly shrimp catches (heads-off weight) of U.S. vessels by area for the Guianas-Brazil fishery. Vertical lines represent the total U.S. landings reported by the processing plants and are given by months in which the landings were made. Vertical bars represent the "haul" on estimated catches of U.S. vessels submitting logbooks and are reported by months of capture. The shaded area of the vertical bar represents the portion of the logged catches recorded from the U.S.-Brazil Shrimp Agreement Area.

(<20 fm), the fishing effort was 25.8 percent, 18 percent, and 14.9 percent for 1975, 1976, and 1977; at depths >64 m (>35 fm), the effort was 20.8 percent, 22.7 percent, and 29.3 percent for 1975, 1976, and 1977. The distribution of fishing effort at 10 selected

Table 3.—Mean catch of headless shrimp per hour of trawling by U.S. flag vessels of the Guianas-Brazil fishery, 1972-77. For statistical zones, see Figure 1.

Year	Zones 69-77		Zones 78-81		All zones	
	lb	kg	lb	kg	lb	kg
1972						
Jan.-June						
July-Dec.	19.09	8.7	22.16	10.0	20.00	9.1
Jan.-Dec.					24.34	11.0
1973						
Jan.-June	23.29	10.6	33.41	15.2	28.10	12.7
July-Dec.	19.83	9.0	27.05	12.3	23.67	10.7
Jan.-Dec.	21.35	9.7	31.38	14.2	25.92	11.8
1974						
Jan.-June	20.01	9.1	22.40	10.2	20.96	9.5
July-Dec.	13.89	6.3	17.52	7.9	15.22	6.9
Jan.-Dec.	17.01	7.7	20.12	9.1	18.55	8.4
1975						
Jan.-June	14.82	6.7	17.65	8.0	15.82	7.2
July-Dec.	10.46	4.7	15.86	7.2	11.87	5.4
Jan.-Dec.	12.58	5.7	16.88	7.7	13.83	6.3
1976						
Jan.-June	13.88	6.3	24.33	11.0	18.59	8.4
July-Dec.	9.48	4.3	12.95	5.9	10.63	4.8
Jan.-Dec.	11.82	5.4	20.31	9.2	15.23	6.9
1977						
Jan.-June	7.82	3.5	28.83	13.1	19.71	8.9
July-Dec.	10.21	4.6	16.18	7.3	12.40	5.6
Jan.-Dec.	9.57	4.3	22.14	10.0	15.07	6.8

¹ Estimated values.

than half of the observations. In the East Gullies, a large portion of the fishing was done during daytime.

Mean hourly catch rates of day fishing were considerably higher than those obtained at night throughout the fishery (Table 5). Examination of plots of day and night catches on the species level indicated existence of areal and diurnal differences. All four species were caught during day and night, but not in all zones. Brown shrimp were caught during day and night in all zones; pink shrimp were caught primarily during the night in all zones with the highest catches in zones 78-80 (West Gullies, East Gullies, and Drop Off Ridges). During the daytime pink shrimp were caught only in zones 69-71, 76-79, and 80. Pink-spotted shrimp were caught at night in all zones, except zone 81; daytime catches of pink-spotted shrimp were recorded in most zones (except 74, 75, and 81), with the highest catches in zones 74, 76, and 77; catch rates were much higher during the day than at night.

Stock Evaluation

Even though there are perhaps several fishable stocks of shrimp in the Guianas-Brazil fishery, data are needed to substantiate this supposition. For the purpose of assessing general trends we are considering this fishery to be represented by one fishable stock with all species combined. Based on catches from all operating fleets the conclusion on stock evaluation, as reached at the last WECAF meeting (April 1979), is presented here.

The period from 1960 to 1965 can be considered as the expansion period for this fishery. From 1965 onward the nominal commercial landings from the offshore Brazil-Guianas area remained fairly level from 15,000 to 20,000 t whole weight as the number of vessels varied from 350 to 650 (Table 1). A plot diagram of the number of vessels and the recorded catch indicates that the overall catch has not decreased in recent years parallel to the increase in fleet size and that the total catch can be maintained at the 1978 level (15,000 t)

Table 5.—Mean hourly catch rates of shrimp for day (D), night (N), and both day and night (B) of fishing in the fishing zones of the Guianas-Brazil fishery. Units are in pounds.

Zone	1975			1976			1977		
	D	N	B	D	N	B	D	N	B
60	18.2	11.8	11.7	14.8	10.1	9.5	12.9	10.3	9.3
70	17.7	11.3	10.8	13.5	10.2	9.0	20.7	9.5	9.8
71	16.6	11.3	10.2	14.1	9.7	8.7	13.9	9.2	8.0
72	15.3	11.1	10.7	15.7	9.3	10.6		8.9	8.5
73	13.8	12.1	13.3	11.2	10.9	9.8	8.5	9.8	8.4
74	18.3	12.5	13.6	12.5	10.0	10.3	19.4	9.4	8.4
75	17.6	12.4	19.3	15.0	10.3	13.4	20.6	10.0	12.7
76	17.9	13.5	15.4	18.8	11.2	21.8	18.6	11.4	12.2
77	19.0	13.8	16.6	16.8	12.7	16.8	14.8	14.8	12.0
78	17.7	14.2	13.5	20.4	17.8	14.5	26.3	26.2	18.4
79	20.9	15.0	15.5	25.0	18.5	16.5	31.8	24.4	21.7
80	19.9	17.6	16.2	24.1	21.8	22.4	27.7	22.5	21.4
81	17.0	21.3	20.4	33.0	31.6	26.1	22.8	25.9	24.7

or perhaps increased slightly with a considerable increase in fleet size over the 1978 level (Fig. 9). These statistics do not account for: 1) Possible future environmental changes of the adjacent estuaries which could effect recruitment of penaeids to offshore areas; 2) possible overfishing of juveniles, resulting in a depressed yield per recruit and thus decreased long-term yield; or 3) concomitant changes in areal abundance of shrimp on species level which may have been offset by changing patterns in areal fishing.

The statistics of several national and area-specific fleets portray different trends (Fig. 10), which may be partially attributed to the fact that these fleets fish different portions of the resource.

The Brazilian fleet fishes primarily for brown shrimp in the inshore area south of the Amazon River and the offshore area along the entire coast, north and south of the Amazon. From 1969 to 1973 the Brazilian-Belem fleet fished along the northern coast of Brazil; the number of vessels increased from 1 to 37 and vessel catch varied each day without evident trend (Fig. 10). Starting in 1974, in the area off Tutoia, located southeasterly of the Amazon, the Brazilian fleet located productive shrimp grounds and fished them, as well as the areas north of the Amazon. Catch per boat increased from 28 t in 1974 to 53 t in 1978, as the fleet size varied from 25 to 52 vessels. Catch per day also increased.

The Japanese fleet fished the en-

tire offshore fishery and their catches were dominated by adult pink-spotted shrimp (80 percent). The catch per unit of effort generally decreased from 1966 onward (Fig. 10), even though the fleet fished different locations to prevent decline in catch rates. The long-term drop suggests a decline in the abundance of pink-spotted shrimp. Prior to 1977, the U.S. fleets based in French Guiana, Guyana, and Surinam fished the entire shelf off these countries for all four species of shrimp. Most of the catch was brown shrimp; pink-spotted shrimp was second (U.S. data). The overall drop in kilograms caught per day fished from French Guiana-based vessels concomitant with decreasing effort could reflect the drop in abundance of pink-spotted shrimp as indexed by the Japanese CPUE and a general gradual decrease in overall offshore abundance of brown shrimp. That trend is corroborated by catch per vessel abundance indices of Guyana and Surinam-based fleets (Fig. 10).

Data from the Brazilian, Japanese, and U.S. fleets on species level suggests a general decreasing trend in the abundance of pink-spotted shrimp and a general gradual decrease in overall abundance of brown shrimp.

At the WECAF meeting it was also realized that the estimates of MSY would not be very meaningful because there was lack of information on: 1) The inshore fishery of juveniles in nursery areas; 2) temporal changes in species composition of offshore catches during

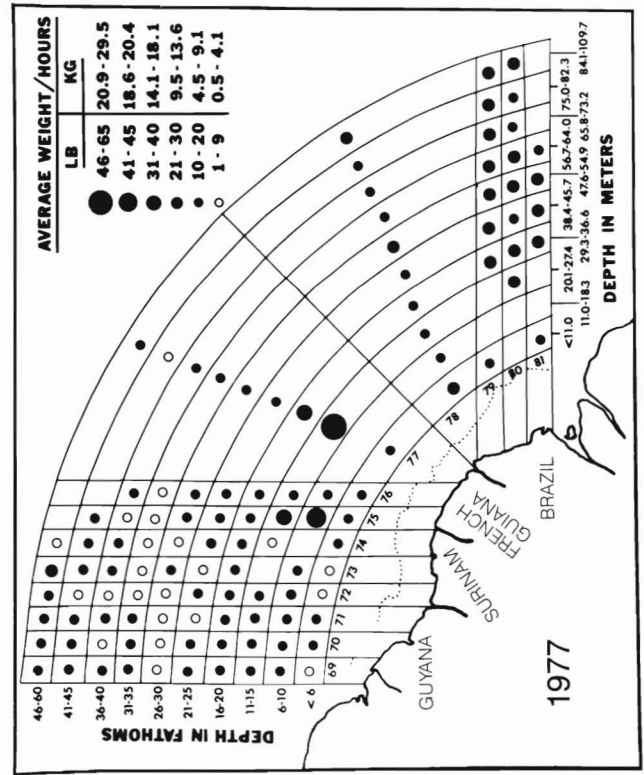
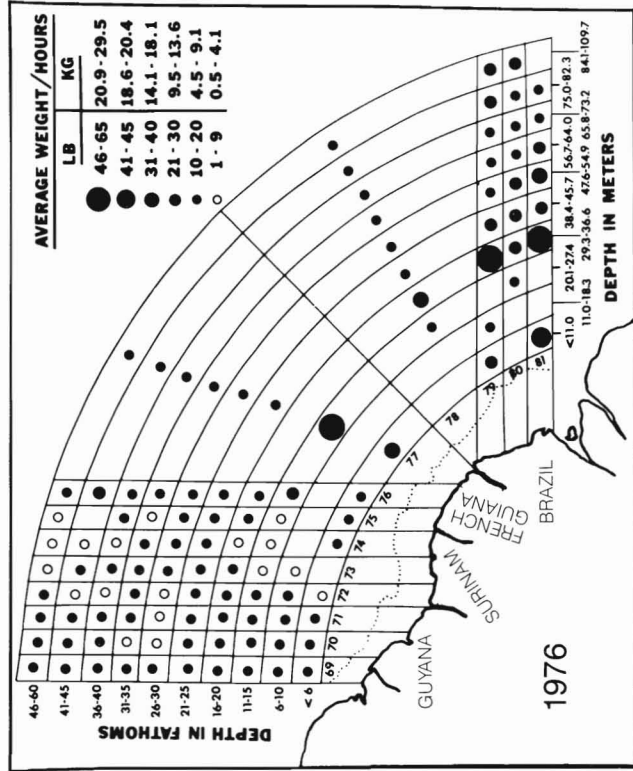
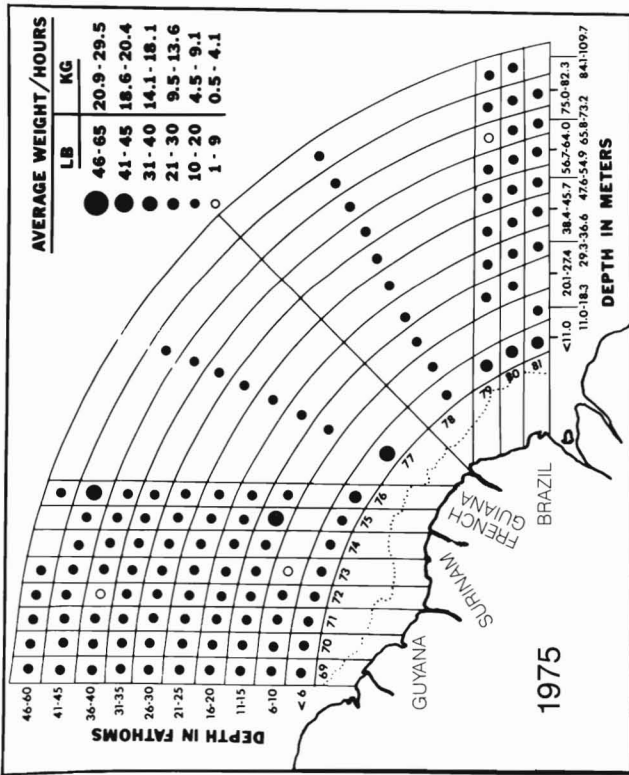


Figure 6.—Distribution of the mean hourly catch rates of shrimp (heads-off weight) by depth and fishing zone for the Guianas-Brazil fishery, 1975-77. The data are from U.S. vessel logbooks.

the period in question; and 3) species-directed effort necessary to develop accurate measures of CPUE indices of abundance for the species that are consistent throughout the time period. Gross statistics (Fig. 10) suggest that: 1) Total offshore catch declined from the maximum level of earlier years, 2) the 1978 catch level can be maintained at the current level of fishing effort, and 3) the total catch can probably be slightly increased over the 1978 level, with a moderate increase in fleet size. Statistics from

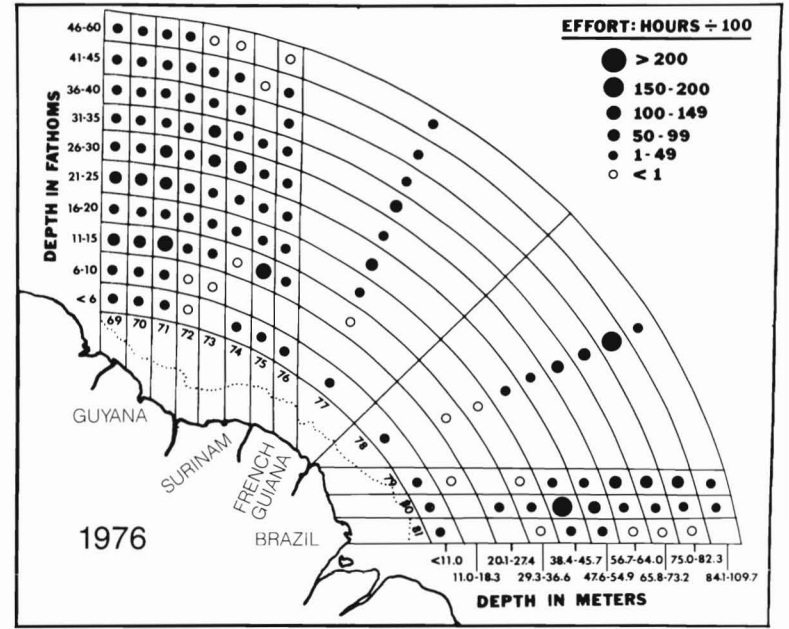
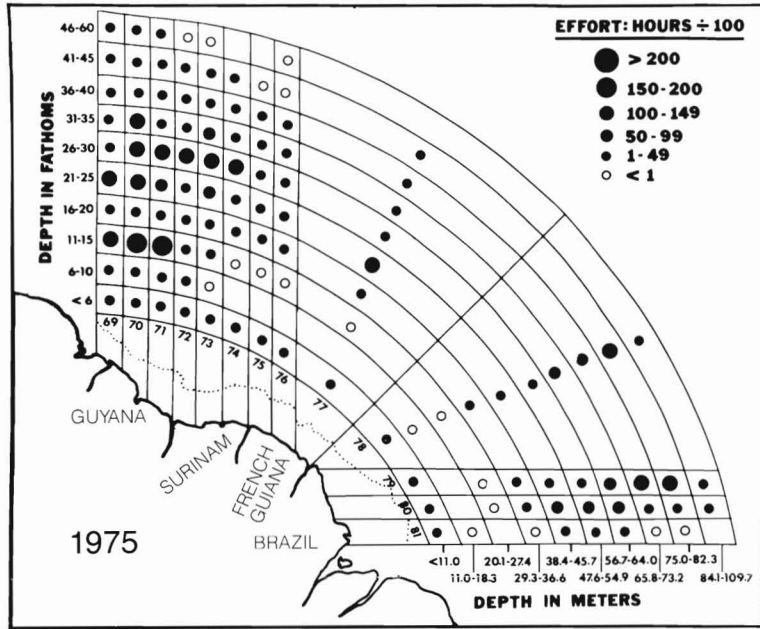
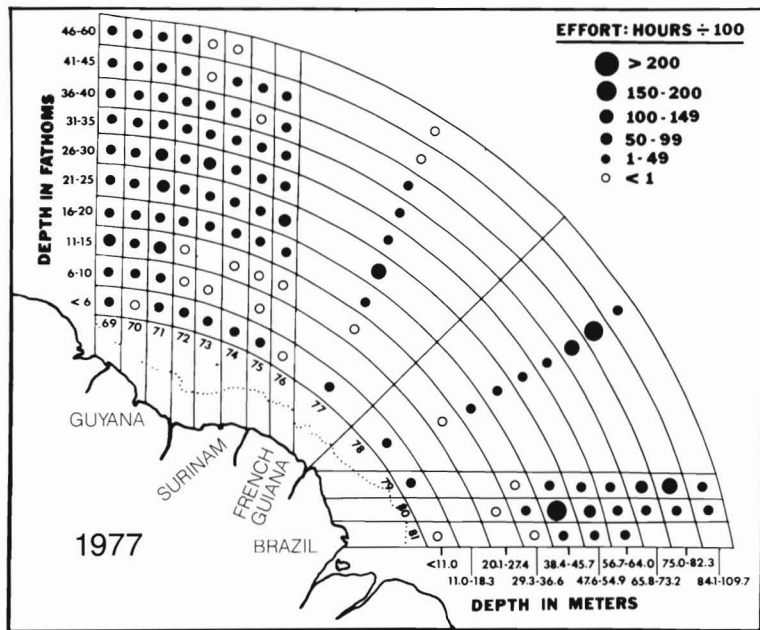


Figure 7.—Distribution of fishing efforts in the Guianas-Brazil fishery by fishing zone and water depth, 1975-77. The data are from U.S. vessel logbooks.



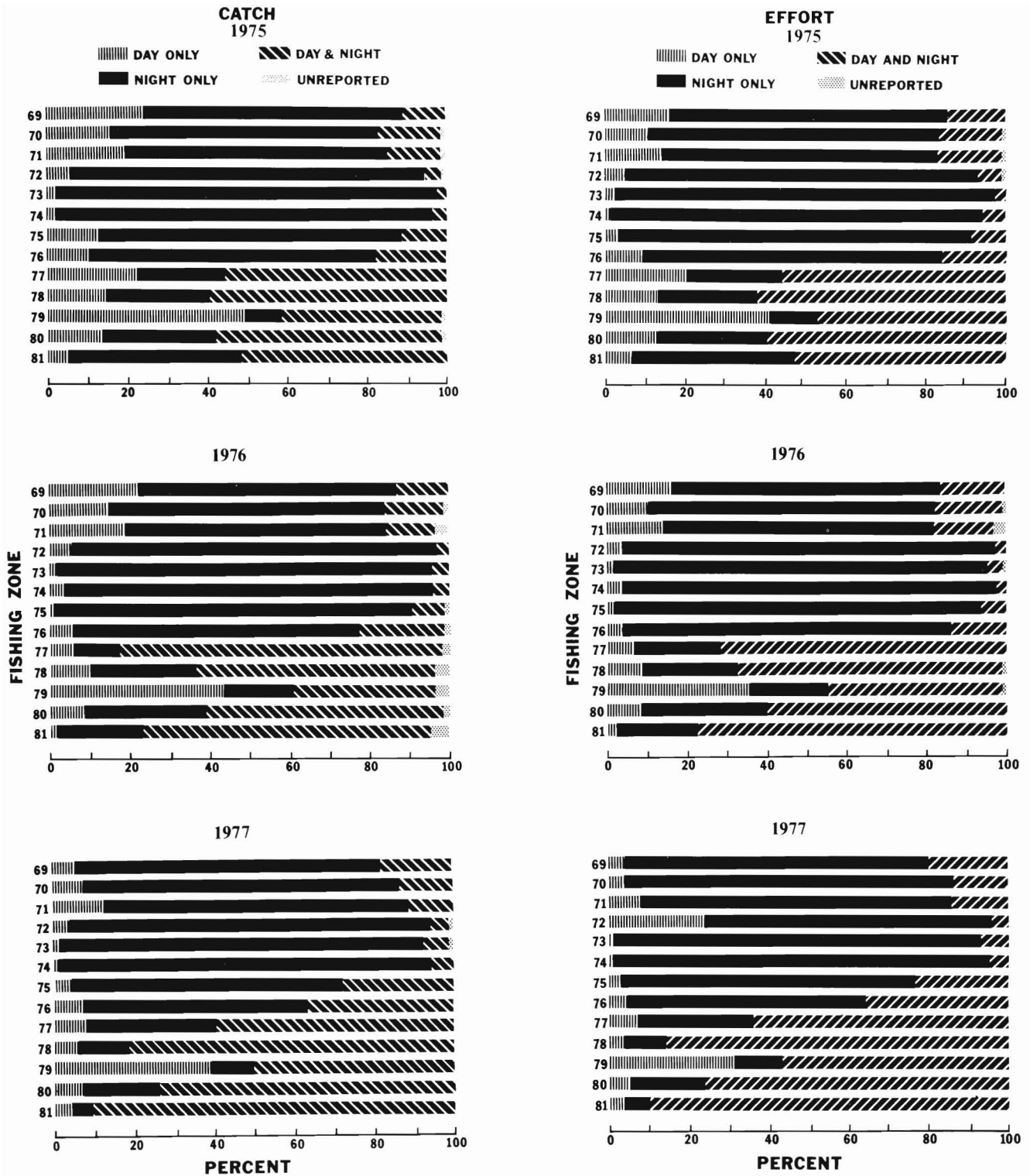


Figure 8. — Distribution of reported U.S. catch and effort (both expressed as percentage of the total) by the time of the day and fishing zone for the Guianas-Brazil fishery, 1975-77.

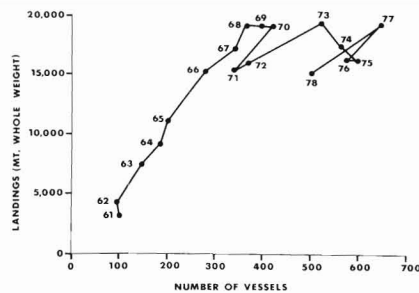


Figure 9.—Fleet size and offshore nominal catches of the Guianas-Brazil shrimp.

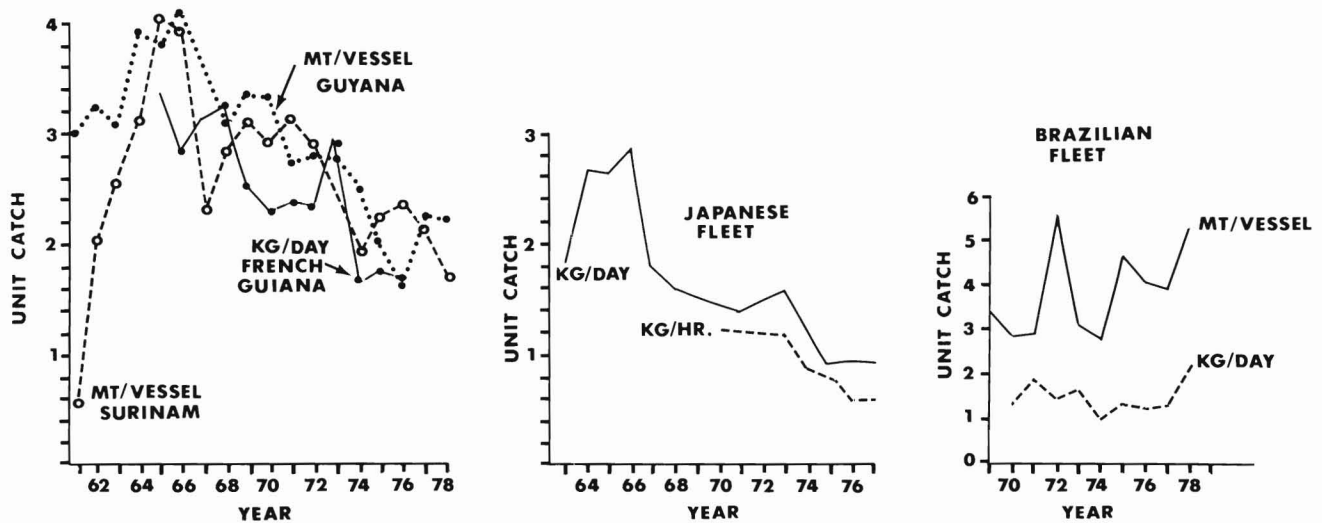


Figure 10.—Trends in catch per unit of effort by different fishing fleets.

individual national fisheries indicate: 1) The abundance of brown shrimp off Brazil has not decreased; 2) the abundance of pink-spotted shrimp off northern grounds (statistical areas 69-77) has decreased over the past few years; and 3) the abundance of brown shrimp off northern grounds (statistical areas 69-77) may have undergone a gradual decrease.

Guiana-Brazil Shrimp Research Project Publications and Manuscripts

Allen, H. B. 1973. U.S.-Brazil Shrimp Conservation Agreement. A status report. Proc. Gulf Caribb. Fish Inst. 25:23-25.

Jones, A. C., and A. Dragovich. 1973. Investigations and management of the Guianas shrimp fishery under the U.S.-Brazil Agreement. Proc. Gulf Caribb. Fish Inst. 25:26-33.

Cummins, R. C., Jr., and A. C. Jones. 1973. Distribution of commercial shrimp off the northeastern coast of South America. Mar. Fish. Rev. 35(3-4):31-35.

Jones, A. C., and A. Dragovich. 1977. The United States shrimp fishery off northeastern South America (1972-74). Fish. Bull., U.S. 75:703-716.

Collette, B. B., and K. Rutzler. 1977. Reef fishes over sponge bottoms off the mouth of the Amazon River. Proc. 3rd Int. Coral Reef Symposium, Vol 1, p. 305-310.

Brooks, J. T., T. D. Leming, and A. C. Jones. Relationship between shrimp distribution off South America and coastal turbidity patterns viewed from space. Unpubl. manusc. in the Southeast Fisheries Center, NMFS, NOAA, Miami, Fla., files.

WECAF Workshop (April 1979) Manuscripts

Dragovich, A., A. C. Jones, and G. C. Boucher. U.S. shrimp surveys off the Guianas and Northern Brazil. 60 p. Finished manuscript to be published in the WECAF-FAO proceedings of Panama City, R. P., Workshop (held April 1977).

Dragovich, A. U.S. National Report on the current status of the Guiana-Brazil fishery. Finished manuscript to be published in WECAF-FAO Proceedings.

Dragovich, A., and E. Coleman. The U.S. shrimp fishery off northeastern South America (1975-77). To be published in WECAF-FAO Proceedings.

Dragovich, A., and J. E. Tashiro. Biological sampling of the landings of the Guiana-Brazil shrimp fishery. To be published in WECAF-FAO Proceedings.