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Bait Shrimp Fishery of Biscayne Bay

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BAIT SHRIMP FISHERY OF BISCAYNE BAY

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Introduction

A small but valuable live bait shrimp fishery has existed in Biscayne Bay since at least the early 1950s. In recent years there has been increasing pressure from recreational fishing and environmental groups to eliminate this fishery from the Bay because the fishing activity is generally thought to be deleterious to the environment and/or destructive to juvenile game fish.

Opposition to this fishery is as old as the fishery itself. In 1952, the Florida State Board of Conservation initiated a study of the commercial fisheries of Biscayne Bay (Siebenaler, 1953). According to the author, "the need for the study arose from a fear that commercial fishing was harmful to the fish stock and the general ecology of the bay. Agitation to close the bay to commercial fishing has been insistent over a period of years, but no information has hitherto been available on which to judge the merits and consequences of such action." Woodburn et al. (1957) discuss the impact of the live bait shrimp fishery on the environment and on game fish in the Cedar Key-Naples area in response to concern being voiced at that time by sports fishing and conservation interests. Tabb (1958) presents results of a study by the Florida State Board of Conservation to investigate "reports of damage to grass flats and destruction of sport and forage fishes caused by bait shrimp operations in Biscayne Bay." Tabb and Kenny (1969) discuss the history of Florida's live bait shrimp fishery and again cite the concern of anglers that the fishery causes habitat damage and juvenile fish mortality. The studies cited above all concluded that: 1) bait shrimp trawling is not deleterious to sea grass; 2) the mortality of food and/or game fish due to bait shrimp fishing is negligible. However, these studies discuss the fishery as it existed 20 or 30 years ago, after only a few years of operation. As demand for live bait shrimp increased, so did the size of the fleet and the pressure on the resource. Thus, many of the concerns presently being voiced need to be examined once again. This study was initiated to update the existing knowledge of the bait shrimp fishery in Biscayne Bay and document historical trends in number of participants, fishing methods, fishing area, seasonality, total catch, catch-per-unit-effort, disposition of the catch, and economics of the industry.

The data base consists of: a) individual vessel logbooks containing information on number of shrimp caught per boat per night; b) by-catch species compostion from two years (1982-1983) of data collected aboard commercial bait shrimp vessels in Biscayne Bay; c) interview of commercial bait shrimpers and bait shrimp distributors; and d) some additional information from a two year (1982-1983) fisheries assessment program in Biscayne Bay.

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Description of the Gear

A brief description of the gear and fishing methods is given in the sections which follow. A more complete discussion can be found in Tabb and Kenny (1969). The roller-frame trawl used today in the Biscayne Bay live bait shrimp fishery evolved over many years, but has changed relatively little since at least the 1960s (Tabb, 1958; Tabb and Kenny, 1969). Otter trawls were used during the early years of the fishery but because they were believed to be destructive to the habitat (particularly seagrass beds) an alternative gear was sought. The roller-frame trawl was developed specifically in response to this need as a non-destructive alternative to the otter trawl, which was then prohibited. The roller-frame trawl proved to be more efficient than the otter trawl and was readily accepted by fishermen. The roller-frame trawl, as the descriptive name implies, consists of a net attached to a metal frame with a slotted roller along the entire lower portion of the frame (Figure 1). Metal or fiberglass finger bars are placed 1½-2 inches apart vertically along the front of the frame to prevent clogging of the net with seagrass, algae or debris and to protect the live shrimp catch by excluding large objects. The roller is the contact point with the bottom and, therefore, the trawl rolls over seagrasses without uprooting it.

Bait shrimp vessels are between 25 and 40 feet in length and are rigged with a boom on each side to tow two nets simultaneously. Each trawl is attached to the vessel by a galvanized wire or nylon tow line which runs from the tow yoke on the trawl, through a block at the end of each boom and then to a winch mounted on the deck or top of the wheel house. The winch is used to raise and lower the booms as well as haul the nets. Trawl frames are typically 12 feet wide but range between 10 and 16 feet. The nets are approximately 25 feet long, and are generally made of 3/4 to 1 inch stretched mesh nylon or dacron bulk netting. Trawling is done at night due to the nocturnal nature of pink shrimp, the primary target species. Tows are short, averaging 25 minutes, to minimize mortality.

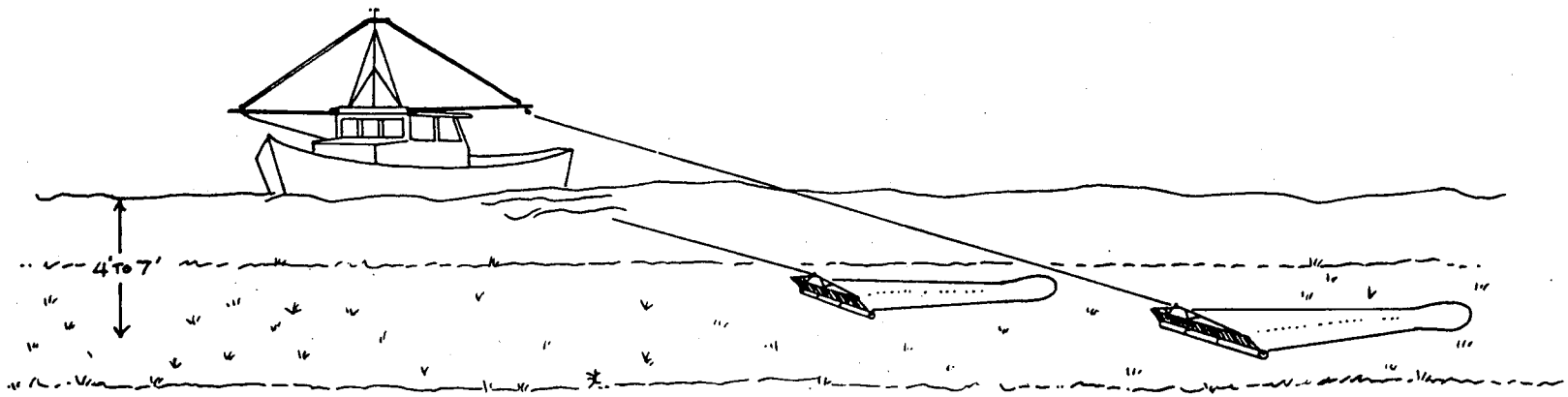
The catch is either dumped into a screened-off area in the live well or onto sorting tables. The practice of holding the catch in the live well until shrimp are culled out is believed to decrease mortality of the incidental species. Shrimp are sorted out and placed in live wells, and incidental species returned overboard. Sorting is done quickly to minimize shrimp mortality.

The boats, upon returning, are met by wholesale buyers (truckers). Shrimp are offloaded into specially built trucks equipped with partitioned tanks and recirculating pumps, and delivered to retail bait and tackle shops throughout South Florida. Deliveries are usually completed by 8:30 a.m. The distribution process is accomplished as quickly as possible to keep mortality at a minimum.

Description of the Fishery

Past and present shrimp fishing grounds in Biscayne Bay are shown in Figure 2. Little shrimping is now done in the deeper central parts of the bay as was the case in the 1960's (Tabb and Kenny, 1969). It is not entirely clear why the major fishing area shifted to the west, although this is possibly explained by the previous existence of a closed area. The near-shore area from Rickenbacker Causeway south to Snapper Creek Canal (Figure 2) was closed to shrimp trawling at one time because this area was believed to be a spotted sea trout nursery ground (Tabb and Kenny, 1969). The prohibition against shrimping in this area was repealed when the special acts of local application were repealed in the early 1970s.

Fig. 1. Typical roller frame trawl used in Biscayne Bay bait shrimp fishery.



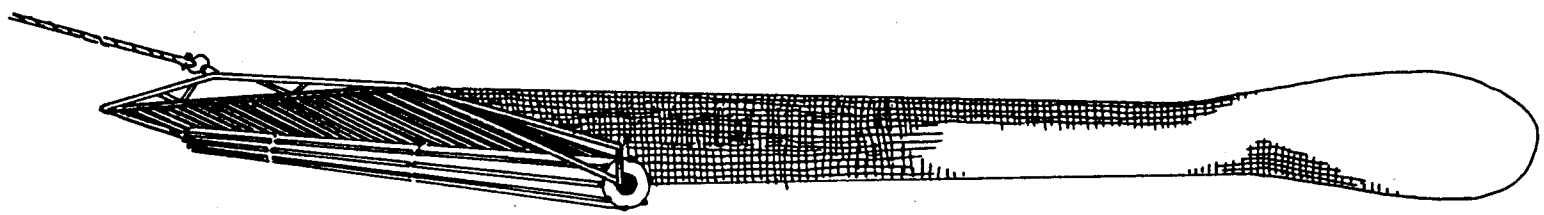
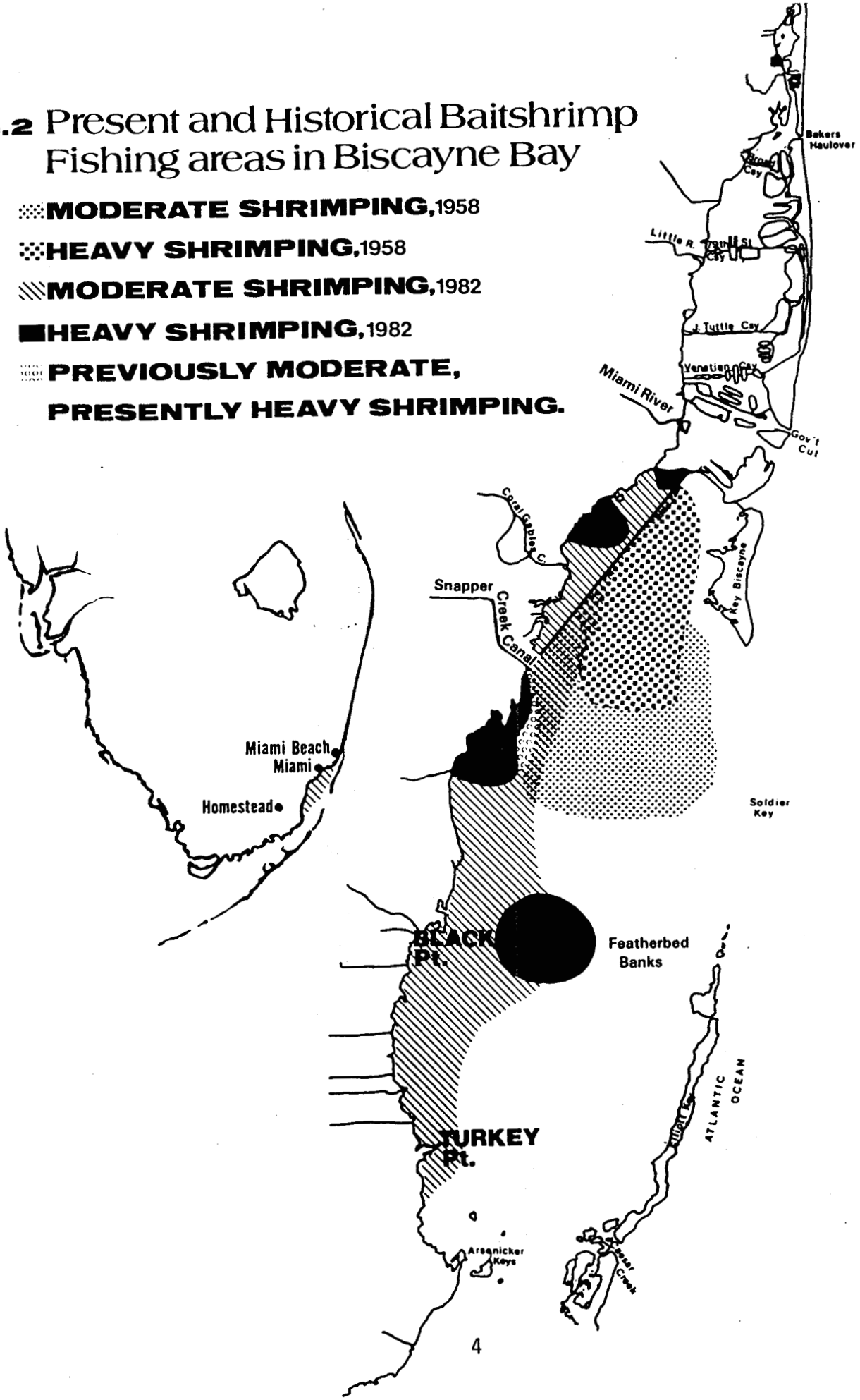


FIG.2 Present and Historical Baitshrimp Fishing areas in Biscayne Bay



In 1952-1953 there were 3 bait shrimp trawlers in Biscayne Bay (Siebenaler, 1953). In 1958 there were 12 boats fishing year-round (Tabb, 1958) and by 1966, there were 46 vessels fishing in Biscayne Bay (Tabb and Kenny, 1969). The number of boats now fishing in the Bay varies seasonally but never exceeded 28 boats at any one time during 1983. From a series of boat counts over the year, it was estimated that in 1983 there were 22-23 bait shrimp boats operating in Biscayne Bay on average.

The fishery is conducted on a per-order basis. Each captain knows, prior to leaving the dock, what his order is for the night. The working hours of each boat is thus dependent on the amount ordered and the abundance of shrimp.

The table below shows historical changes in prices paid for bait shrimp at each marketing step. Figures are means derived primarily from interviews.

	1950s	1960s	1970s	1983-84	1985
Ex-vessel (owner-captain)[1]	$12.00	$15.00	$22.00	$30.00	$34.00
Driver-distributor[1]	-	-	$37.00	$51.00	$55.00
Retail bait & tackle store[2]	$ 0.35	$ 0.50	$ 0.60	$ 0.75-$ 1.25	$ 0.79-$ 1.75

Prices vary seasonally and also reflect transportation costs from the area of capture. Interviews with 4 distributors (truck drivers) who buy from 15 boats indicated that 52% of the catch is sold outside Dade County.

Historical Trends in Shrimp Landings and Abundance

Data on the commercial fishery were obtained from log books and interviews. Log books contained information on number of shrimp caught per trip (boat-night). Records of 12,407 boat-nights between 1971 and 1983 were obtained. Mean and standard error of the number of shrimp per boat-night were calculated by month and year.

Mean catch (numbers) per boat-night from 1971-1983 is shown in Table 1. Catches have been relatively stable, varying from a low of 5,300 shrimp per boat-night in 1971 to a high of 7,448 in 1973 with no particular trend (Figure 3). The mean catch per boat-night from 1971-1983 was 6,182 shrimp.

Shrimp are an annual crop. They enter the Bay in summer as post-larvae, and by late summer or fall they begin entering the fishery. Prior to the onset of maturation, they migrate outside the Bay. Although it is not known where the shrimp from Biscayne Bay end up or even if they survive to spawn, pelagic post-larvae, probably from shrimp spawning elsewhere, enter the Bay in the next summer, settle out of the plankton and begin the cycle again.

Reflecting this cycle, bait shrimp catches are lowest in summer and begin to increase as shrimp are recruited into the fishery (Figure 4). Highest catches are in winter, after which shrimp begin leaving the Bay. Catches decline, reflecting this

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[1]Per 1,000 shrimp
[2]Approximate per dozen shrimp--from various sources

Table 1. Yearly mean catch of bait shrimp per boat-night in the Biscayne Bay commercial bait shrimp fishery, 1971-1983.*

Year	Mean number per boat night	Sample size (boat-night)	Standard deviation	Standard error
1983	5554	1110	2637	79
1982	5865	1013	3231	102
1981	6735	832	4166	144
1980	5767	1059	2719	84
1979	5911	1057	2882	89
1978	6278	975	3364	108
1977	5572	1067	2977	91
1976	6091	1398	3033	81
1975	6553	1320	3653	101
1974	6607	1108	2737	82
1973	7448	692	3052	116
1972	6691	631	3207	128
1971	5300	145	1874	156

Grand Mean = 6182 Total = 12407

*obtained from log books

Fig. 3. Mean yearly bait shrimp catch per boat-night, 1971-1983.

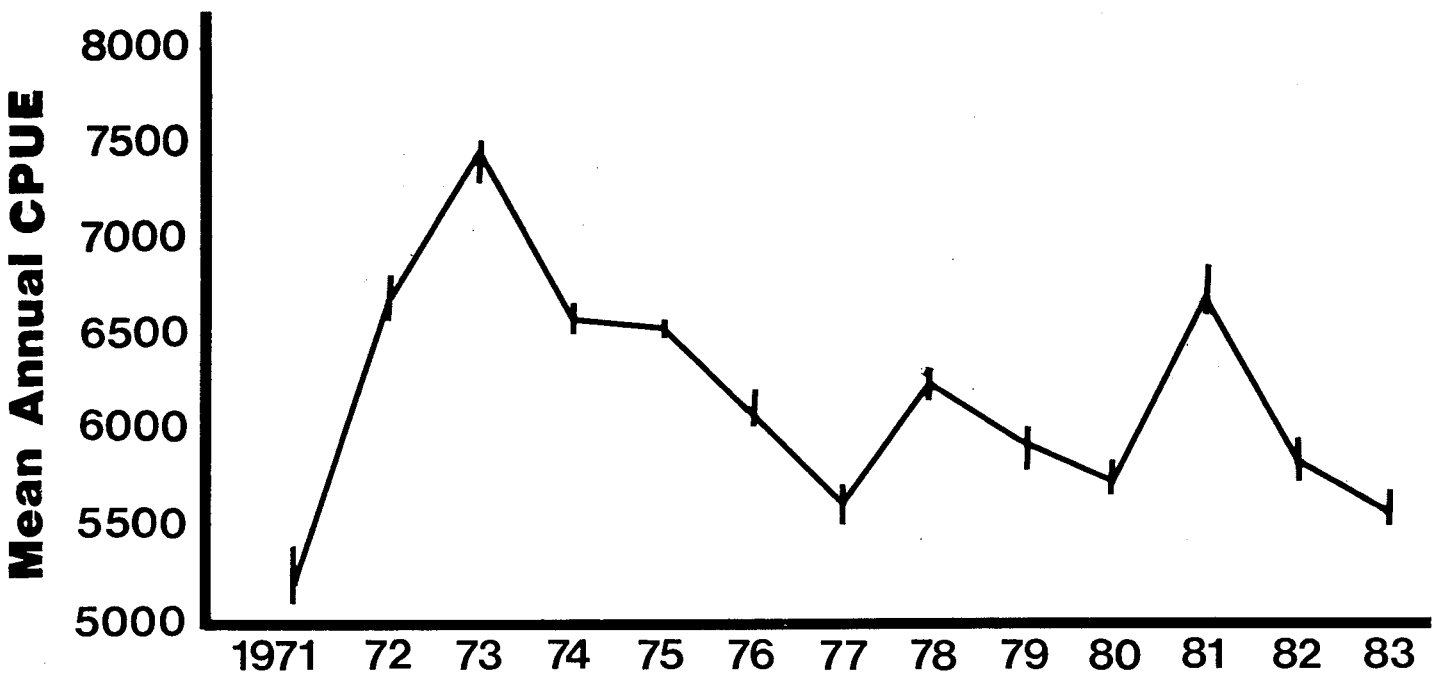
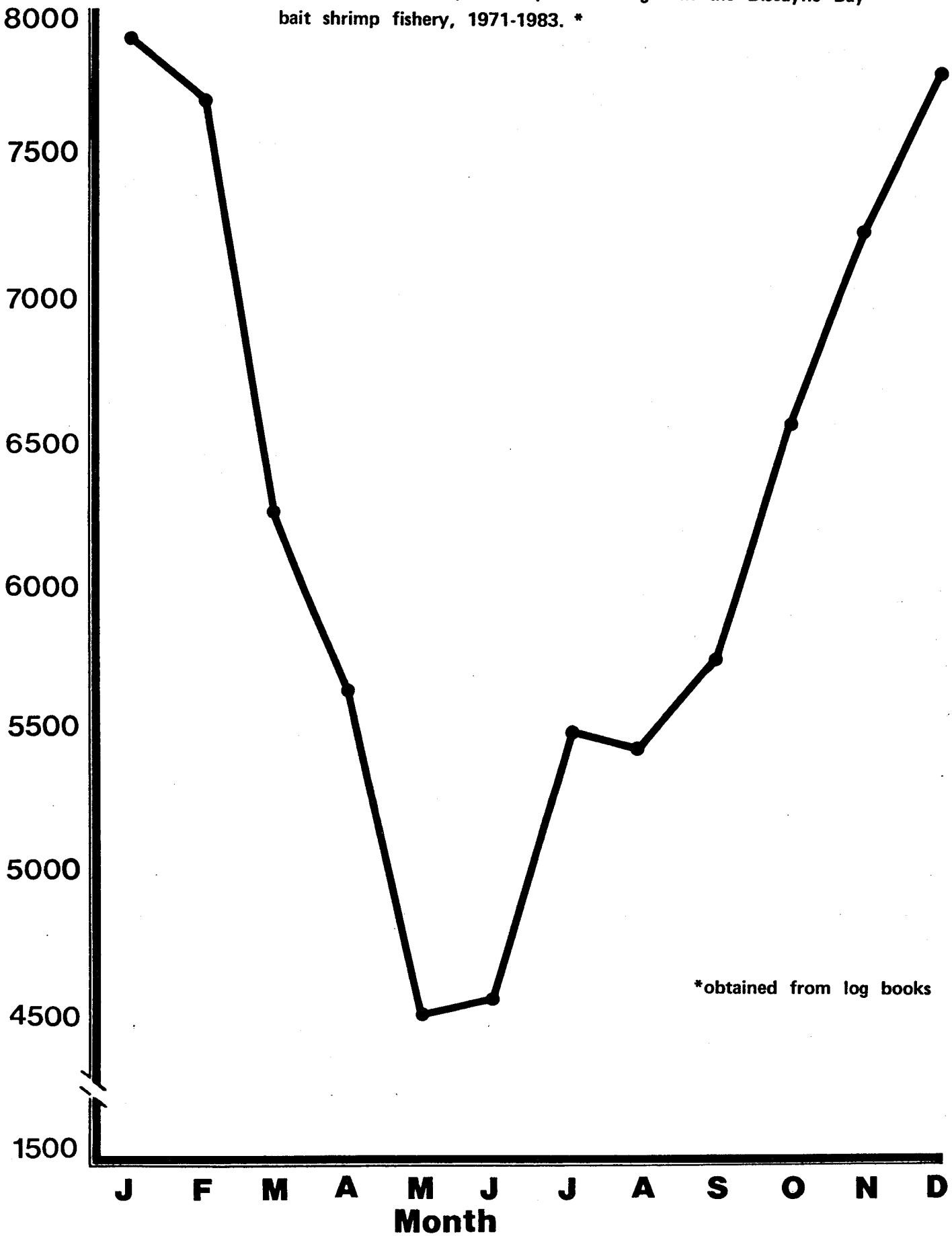


Fig. 4. Monthly bait shrimp catch per boat-night in the Biscayne Bay bait shrimp fishery, 1971-1983. *



migration, and generally do not increase again until a new year class enters the fishery in fall. In the 13 years for which log book records were available, January had the highest landings in number of shrimp per boat night (7,940) and May had the lowest (4,548).

Catch-per-unit-effort (CPUE) expressed as numbers per boat per night, reflects year class strength or local recruitment levels if effort remains relatively stable. However, landings and even CPUE will not necessarily reflect high shrimp abundance because total effort reflects both market demand and trends in abundance of shrimp. During part of the year, particularly during years of high shrimp abundance, boats fish to fill orders; when they have done so, they stop fishing. The result is that during times of high abundance, catches remain much the same but the time spent fishing decreases. However, since we expressed CPUE as catch per night, increased abundance would not necessarily be detected from our CPUE data. A substantial decline in abundance would be reflected in a decreased CPUE, though, since boats normally fish the entire night.

Historical trends in the fishery were determined from interviews with fishermen and distributors. A copy of the questionnaire filled out by the interviewer is attached (Appendix 1). Ten fishermen and 5 distributors (drivers) were interviewed during this study. Interviews indicated little agreement among fishermen on trends in the fishery. Most boats fish the same general areas as they did years ago, although some areas were cited as having declined in recent years (most notably the Featherbed Bank area in winter). The area south of Black Point was noted by a number of bait shrimp fishermen as having declined recently. Water quality and/or fresh water discharge from Black Creek and Gould's Canal is hypothesized by the fishermen as the cause.

Because the two commercially fished shrimp species in Biscayne Bay, Penaeus duorarum and P. brasiliensis, are an annual crop and are almost certainly recruited from adult populations originating elsewhere, it is doubtful that total catch will decline in response to increased effort.

Fluctuations in annual mean CPUE probably largely reflect fluctuations in recruitment to the bay which results from the variability of wind, current and other environmental factors affecting larval transport and/or survival. The relatively stable CPUE's from 1971-1983 must be considered in this context. Since 1971, the lowest mean CPUE was only 10% less than the 13 year grand mean suggesting that there have been no major recruitment failures during this period. It also suggests that there have been no major perturbations to the system that were reflected in declining shrimp densities.

Percentage of bay bottom trawled by the bait shrimp fleet was estimated by extrapolating information gleaned from a fisheries assessment program recently completed (Berkeley, 1984). In this study, trawl sampling was conducted aboard the University of Miami research vessel R/V Gale using roller-frame trawls differing only in size from commercial bait shrimp gear. Trawls used in this study were 8 feet wide, while the mean width of commercial shrimp trawls is 12.5 feet (3.8 m) (n = 10). The mean linear distance traveled during trawling operations by R/V Gale in 5 minutes was 287.3 m. Thus, if bait shrimp boats tow at this same speed, then, in 5 minutes towing, the mean area covered = (287.3 m) (3.8 m) = 1100 m^2/5 min. - net.

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[1]Catches were expressed per 5-minute tow for standardization. Actual towing time varies between 15 and 40 minutes. Because two nets are fished simultaneously, a 5-minute tow results in two 5-minute net tows.

The mean catch of shrimp per boat night (1982 and 1983 combined) calculated from log book records was 5,702. The mean catch from 72 sampled commercial tows was 47.8 shrimp per net per 5 minutes[1]. Thus,

$$\frac{5{,}702 \text{ shrimp/night}}{48 \text{ shrimp/5 minutes}} = 119 \text{ 5-min. net tows/night}$$

and area covered per boat per night =

$$(1100 \text{ m}^2\text{/5 min. net})\ (119 \text{ 5-min. net/night}) =$$

$$130{,}900 \text{ m}^2$$

Mean number of boats fishing per night is approximately 18. Thus, area covered by the entire fleet per night =

$$(130{,}900 \text{ m}^2\text{/boat})\ (18 \text{ boats}) =$$

$$2.36 \text{ km}^2 \text{ (0.91 sq. miles)}$$

In one year, the area covered by all boats = 861.4 km^2 (332.3 sq. miles). The general fishing area in which the vessels operate is approximately 207.4 km^2 (80.1 sq. miles) (Berkeley, 1984). Thus, 1.1% of the fishing area is trawled per day and on average, the entire bottom is swept by trawlers about 4 times per year.

Although this project did not attempt to document directly the physical impact of roller-frame trawls on the habitat, some inferences can be made. In one year, each m^2 of bay bottom within the present fishing area is trawled four times on average. If the gear destroyed or uprooted sea grass or was otherwise destructive to the habitat, a decline in the abundance of organisms, including shrimp, or a change in community structure might be expected. Since no such decline in shrimp abundance was apparent, it appears that the impact is not severe. Likewise, the results of several studies dating back from the mid-1960's to the present (Roessler, 1964; Low, 1973; Sogard, 1982; Campos, 1985), show that the species composition and patterns of spatial and seasonal abundance of fish in the Bay have remained essentially unchanged. This does not mean that the impact is non-existent, however. Some physical damage could certainly occur and not be detectable with CPUE or species composition data. Certain communities could be severely impacted but go undetected if they constituted a small fraction of the total bay bottom community.

Shrimp Landings and By-Catch of Juvenile Gamefish

Gamefish, as referred to in this study, includes species of recreational and/or commercial importance and those used as baitfish. Data on shrimp and by-catch of juvenile gamefish were collected during a previous 2-year (1982-83) study of the fisheries of Biscayne Bay. In this study, an observer was placed aboard a commercial bait shrimp

vessel at least once per month for 2 years. Data was collected on shrimp catch, effort (towing time), and by-catch from a representative sample of tows preserved and returned to the laboratory for sorting, identification and measurement. All catches were then standardized to number of a species per 5-minute tow.

Total annual catch of bait shrimp was calculated by multiplying the mean catch per boat-night by total effort in boat-nights for the year. Total fleet size was estimated from boat counts made during thrice-monthly aerial overflights of the Bay. Mean daily effort in boat-nights was estimated from a series of evening boat counts (n = 59 counts) made at the three commercial bait shrimp docks: Black Point, Dinner Key, and Virginia Key. Counts were made after dark to insure that all boats fishing that night would be out. The difference between total fleet count and number of boats in port after dark was used to estimate number of boats actually fishing. The mean number of boats fishing per night was 17.5. For one year (365 nights), this translates to a total effort of 6380 boat nights. The estimated mean catch per boat-night during the years 1982-83 (log book information) was 5702 shrimp. Thus, the total annual catch of bait shrimp from Biscayne Bay in 1983 was =

(5702 shrimp/boat-night) (6380 boat-nights) =
36,381,312 shrimp

at an average of 125 shrimp per pound, this equates to 291,050 lbs.

Catches of gamefish species per 5-minute tow were multiplied by the number of tows in a typical boat-night (119; see previous section) to estimate catch per boat-night. Mean catch per boat-night for each species was then calculated based on 72 samples (24 months x 3 samples/mo.). Total annual catch for each species was calculated by multiplying mean catch per boat-night by the total effort in boat-nights (6380). Catch by species was also expressed as numbers caught per 1000 shrimp. Annual catch in weight was estimated by multiplying mean individual weight for each species sampled by the estimated total number caught.

Twenty-seven species of "gamefish" were recorded at least once in 72 sampled commercial net tows (Table 2). Pinfish (Lagodon rhomboides) was the most abundant species of fish in the by-catch. This species, while not of recreational or commercial importance, is included in this table because it is commonly used as live bait. Two species of grunts, white grunt (Haemulon plumieri) and bluestriped grunt (H. sciurus) were the next most abundant species. Gray snapper (Lutjanus griseus) was the fourth most abundant game fish species with 243,612 estimated caught annually. An estimated 45,997 juvenile spotted sea trout (Cynoscion nebulosus) were caught. From the previous Biscayne Bay fisheries assessment study (Berkeley, 1984), it appeared that spotted sea trout are most abundant in the shallowest inshore grassbeds. During the present study, the locations fished by vessels on which sampling was performed showed that these inshore grassbeds were overrepresented. Because of this, the estimated by-catch of species abundant in these areas (e.g. spotted sea trout) may likewise be overrepresented.

Expressed relative to the shrimp catch, 131.1 pinfish, 16.1 white grunts, 11.4 bluestriped grunts, 6.7 gray snapper, and 1.3 spotted sea trout were caught per 1,000 shrimp. Summing the 24 species of fish and 3 species of crustaceans considered recreationally important, a total of 6,350,104 individuals weighing an estimated 73,320 kg (161,641 lbs) were caught in 1983 by the bait shrimp fleet. If pinfish are excluded, then 19,237 kg (42,410 lbs) of food and/or game species were caught. The gamefish by-catch, excluding pinfish, is 14.6% of the shrimp catch by weight or 55.5% including pinfish.

Table 2. Recreationally and/or commercially important species caught by commercial bait shrimp vessels in Biscayne Bay: Estimated annual catch by the entire fleet in numbers and weight and mean number caught by entire fleet per 1,000 shrimp.

Species	Estimated annual catch (numbers)	Estimated annual catch (weight in kg)	Number caught per 1,000 shrimp
Haemulon plumieri, White grunt	586,823	4,324.9	16.13
Haemulon sciurus, Blue striped grunt	415,222	4,372.3	11.41
Haemulon parrai, Sailor's choice	13,003	84.3	0.36
Haemulon aurolineatum, Tomtate	5,710	31.6	0.16
Haemulon flavolineatum, French grunt	10,788	79.0	0.30
Haemulon spp; unident. grunts	2,855	47.6	0.08
Orthopristis chrysoptera, Pigfish	26,964	1,898.8	0.74
Lutjanus griseus, Gray Snapper	243,612	2,241.2	6.70
Lutjanus synagris, Lane snapper	16,178	175.1	0.44
Lutjanus analis, Mutton snapper	5,078	37.6	0.14
Lutjanus spp; unident. snappers	5,390	76.1	0.15
Ocyurus chrysurus, Yellowtail snapper	8,884	102.2	0.24
Diplectrum formosum, Sand perch	10,788	339.9	0.30
Epinephelus striatus, Nassau grouper	952	24.5	0.03
Mycteroperca microlepis, Gag grouper	632	66.7	0.02
Cynoscion nebulosus, Spotted sea trout	45,997	468.7	1.26
Lachnolaimus maximus, Hogfish	10,148	325.3	0.28
Paralichthys albigutta, Gulf flounder	2,224	165.7	0.06
Caranx bartholomaei, Yellow jack	1,903	9.9	0.05
Caranx ruber, Bar jack	952	3.7	0.03
Calamus arctifrons, Grass porgy	8,245	185.5	0.23
Calamus penna, Sheepshead porgy	2,855	7.0	0.08
Lagodon rhomboides, Pinfish	4,768,197	54,083.0	131.06
Panulirus argus, Spiny lobster	84,061	2,688.2	2.31
Menippe mercenaria, Stone crab	2,855	15.3	0.08
Callinectes sapidus, Blue crab	69,788	1,466.3	1.92
TOTAL	6,350,104	73,320.4	174.54
Penaeus spp., Bait shrimp	36,381,312	132,020.5	

The minimum, maximum, and mean size of the species caught by bait shrimp vessels are presented in Table 3. Even the maximum sizes are generally well below the size normally caught on hook and line. The largest specimen recorded was a 15 inch (38.0 cm) gulf flounder, Paralichthys albigutta.

A high percentage of most species is returned to the water alive (Tabb and Kenny, 1969). Thus, estimates of numbers caught are considerably higher than the number killed. The mortality due to capture and handling of species comprising the incidental catch is not known, but is believed to vary considerably among species. Crustaceans (stone crab, blue crab, lobster) appear to suffer little mortality from having been caught. A high percentage of some fishes such as pinfish, flounder and gray snapper apparently survive. However, the mortality rate for other species appears to be high. Yellowtail snapper, sea trout and hogfish are among the more important recreational species in this category. The significance of this source of mortality is not known.

Summary and Conclusions

The value of the Biscayne Bay bait shrimp fishery is considerable. In 1983 the estimated total commercial bait shrimp harvest from the Bay was 36.4 million shrimp worth $1.1 million at dock side* or approximately $3.0 million at retail.** The availability of live bait for sale makes the existence of retail bait and tackle stores possible and provides a valuable support service for the local tourist industry. However, while the economic and social value of the fishery is undeniable, the possible detrimental effects of the fishery on the biota or the environment are potentially of greater consequence and must be considered in evaluating the future of the fishery.

Annual mean CPUE's from 1971-1983 have remained relatively stable, suggesting that the fishery has not significantly affected the habitat's ability to function as a shrimp nursery.

Species composition and community structure of juvenile fish in Biscayne Bay appears to have remained unchanged since the mid 1960's. However, it does not follow that effects of the bait shrimp fishing operations are non-existent. While natural mortality is undoubtedly quite high among these small juvenile fishes, and the estimated total catch of these species by the bait shrimp fleet is relatively small, the effect of the fishery on subsequent gamefish recruitment cannot be evaluated without knowing the magnitude of fishing mortality relative to all other sources of natural mortality. In addition to estimates of natural and fishing mortality, ecological information, such as habitat and trophic interactions between juvenile fishes and shrimp, would be necessary to evaluate and quantify the impact of this fishery on the fish populations in the Bay.

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*Assuming an average ex-vessel price of $30 per 1,000.

**Assuming an average retail price of $1.00 per dozen.

Table 3. Recreational and/or commercial species caught by commercial bait shrimp vessels in Biscayne Bay: mean and minimum-maximum sizes (fork length) recorded.

	Mean Size in cm (in.)		Min/Max Size in cm (in.)	
Haemulon plumieri, White grunt	7.2	(2.8)	3.7-18.0	(1.5-7.1)
Haemulon sciurus, Blue striped grunt	8.4	(3.3)	3.1-19.2	(1.2-7.6)
Haemulon parrai, Sailor's choice	6.1	(2.4)	2.7-12.1	(1.1-4.8)
Haemulon aurolineatum, Tomtate	6.4	(2.5)	3.3-10.5	(1.3-4.1)
Haemulon flavolineatum, French grunt	6.8	(2.7)	4.7-14.5	(1.8-5.7)
Haemulon spp., unident. grunts	9.4	(3.7)	8.2-10.2	(3.2-4.0)
Orthopristis chrysoptera, Pigfish	16.2	(6.4)	4.0-22.5	(1.6-8.9)
Lutjanus griseus, Gray snapper	8.2	(3.2)	3.2-19.4	(1.3-7.6)
Lutjanus synagris, Lane snapper	8.6	(3.4)	5.6-16.7	(2.2-6.6)
Lutjanus analis, Mutton snapper	7.5	(2.9)	5.9-9.3	(2.3-3.7)
Lutjanus spp., unident. snappers	8.0	(3.2)	4.6-12.2	(1.8-4.8)
Ocyurus chrysurus, Yellowtail snapper	9.0	(3.5)	6.5-12.2	(2.6-4.8)
Diplectrum formosum, Sand perch	13.0	(5.1)	7.0-17.5	(2.8-6.9)
Epinephelus striatus, Nassau grouper	12.7	(5.0)	—o—	—o—
Mycteroperca microlepis, Gag grouper	17.2	(6.8)	—o—	—o—
Cynoscion nebulosus, Spotted sea trout	9.7	(3.8)	5.1-20.0	(2.0-7.9)
Lachnolaimus maximus, Hogfish	11.7	(4.6)	4.4-14.2	(1.7-5.6)
Paralichthys albigutta, Gulf flounder	21.9	(8.6)	13.3-38.0	(5.2-15.0)
Caranx bartholomaei, Yellow jack	7.1	(2.8)	—o—	—o—
Caranx ruber, Bar jack	6.3	(2.5)	—o—	—o—
Calamus arctifrons, Grass porgy	6.2	(2.4)	2.9-12.3	(1.1-4.8)
Calamus penna, Sheepshead porgy	6.5	(2.6)	—o—	—o—
Lagodon rhomboides, Pinfish	8.5	(3.4)	2.7-17.5	(1.1-6.9)
Panulirus argus, Spiny lobster	3.2	(1.3)*	1.0-6.0	(0.4-2.4)
Menippe mercenaria, Stone crab	2.5	(1.0)*	2.2-2.8	(0.9-1.1)
Callinectes sapidus, Blue crab	6.4	(2.5)*	3.3-14.3	(1.3-5.6)

* carapace length

—o— only one specimen recorded

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Appendix I
Bait Shrimp Fishery Questionnnaire

1. Boat name, size nets.

2. Dock.

3. Log book available?

4. How many years fished bait shrimp in Biscayne Bay?

5. What general areas do you fish?

6. Is it seasonal?

7. Have these areas changed over the years? Do these change seasonally?

8. What is average catch-by season?

9. How many hours fished/night?

10. Has this changed over the years?

11. How many days/week, days/year do you fish-(seasonal)?

12. Do you fish outside Biscayne Bay?

13. If yes, more or less than previous years?
14. Disposition of the catch -- name of wholesaler or driver.

15. Price paid -- seasonally.

16. How has this changed?

17. Any other historical information -- long term trends in catch, effort, gear, size of shrimp, etc.

Drivers or wholesalers

1. How many boats in Biscayne Bay do you buy shrimp from?

2. Do you have records we can see on number of shrimp handled?

3. How long have you been buying Biscayne Bay shrimp?

4. Where do you deliver to -- how much do you handle per week, per month, per year?

5. How much is sold outside Dade County?

6. Historical trends in demand, price, % sold outside county, size, number, etc.