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PRELIMINARY STOCK ASSESSMENT, NORTH CAROLINA: ROCK SHRIMP (*Sicyonia brevirostris*)

by

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ABSTRACT

During October, 1979 the R/V DAN MOORE utilized a conventional shrimp trawl at 22 locations offshore North Carolina from south of Cape Hatteras to southwest of Cape Fear in search of rock shrimp (*Sicyonia brevirostris*). Data were compiled on distribution, relative abundance, size and sex composition, and cull rates. Rock shrimp were found to be more abundant in Long Bay than in Onslow and Raleigh Bays, and it was evident that catches decreased in numbers as latitude increased. Although the vast majority (94.8%) of rock shrimp captured were of commercial size, nowhere were they located in commercially significant concentrations. Males averaged slightly smaller in total length than females and females became more numerous than males in the larger size categories. Sex ratio did not vary significantly from 1:1.

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INTRODUCTION

Rock shrimp (*Sicyonia brevirostris*) are found in US coastal waters in the Gulf of Mexico and in the Atlantic Ocean from the Florida Keys to Chesapeake Bay entrance (Williams, 1965). The area of maximum abundance on the east coast, hence the area of most importance to North Carolina fishermen, is from Cape Hatteras, NC to Cape Canaveral, FL (Cobb *et al.* 1973). The life history and biology of rock shrimp was reviewed by Cobb *et al.* (1973).

Rock shrimp, about which little is known by North Carolina fishermen, have supported a small fishery in Florida and Georgia since the early 1970s (Kennedy *et al.* 1977). Because of the recent decline in North Carolina's penaeid shrimp fishery, interest has been generated among NC fishermen in what may or may not be an underutilized resource offshore North Carolina.

The R/V DAN MOORE has occasionally encountered rock shrimp in scallop dredges and fish and shrimp trawls in depths from 14.5 to 181.9 m all along the North Carolina coast. During 1977 and 1978, the Division of Marine Fisheries conducted a general trawl survey in Long Bay, NC (west of Cape Fear). Significant concentrations of rock shrimp were encountered in depths of 20 to 145.5 m where the bottom consisted of hard sand/shell substrate. These findings agree with work conducted off the east and west coasts of Florida Department of Natural Resources (Cobb *et al.* 1973; Kennedy *et al.* 1977).

Since that time the R/V DAN MOORE has completed the general trawl survey of Long, Onslow and Raleigh Bays. In these Bays, large areas of hard sand/shell bottom have been located, indicating suitable habitat for rock shrimp and the possibility of the existence of an underutilized resource that could compliment the penaeid shrimp fishery. Determination of fishable stocks of rock shrimp in these areas would benefit the commercial fishing industry.

The Division of Marine Fisheries proposed a study to conduct a preliminary assessment of rock shrimp stocks offshore North Carolina. The primary objectives of the study were:

1. To investigate the relative abundance, distribution, size and sex composition, and cull rates of rock shrimp,
2. To determine if rock shrimp occur in sufficient quantities to support a commercial fishery,
3. To provide the Division of Marine Fisheries with a data base for comparison in future stock assessment activities, and
4. To prepare a report on these findings.

METHODS AND MATERIALS

From 15 to 24 October, and from 29 to 31 October 1979, the R/V DAN MOORE conducted trawling operations in search of rock shrimp. Effort was concentrated in areas previously determined to have suitable habitat. Sampling was conducted within grids of 10 minutes latitude and longitude in three general areas: Long Bay (southwest of Cape Fear), Onslow Bay (south of Cape Lookout), and Raleigh Bay (south of Cape Hatteras) (Figure 1). Samples were stratified by depth and distance from shore within these three general areas. Following the example of Kennedy *et al.* (1977), the study area was divided into four depth zones: Zone I from 18.0 to 20.0 m, Zone II from 21.0 to 33.0 m, Zone III from 34.0 to 55.0 m, and Zone IV from 56.0 to 74.0 m. Exact station localities appear in Figure 1.

A conventional 23.3 m (77 ft) shrimp trawl equipped with a 25.0 m (86 ft) sweep was utilized at all stations. Seventeen link lengths of 0.63 cm chain tied at every fifteenth link were positioned on both wings of the trawl with four loops of chain in the back. The 4.4 cm stretched mesh trawl was equipped with a 0.63 cm tickler chain and 2.4 m x 1.0 m chain doors.

All tows were conducted during the hours of darkness and varied in duration from 30 to 107 minutes, depending upon the type of bottom encountered. Initially, a 30-minute tow was to be considered as a standard sample, however, due to the paucity of rock shrimp, 60-minute tows were considered as standard.

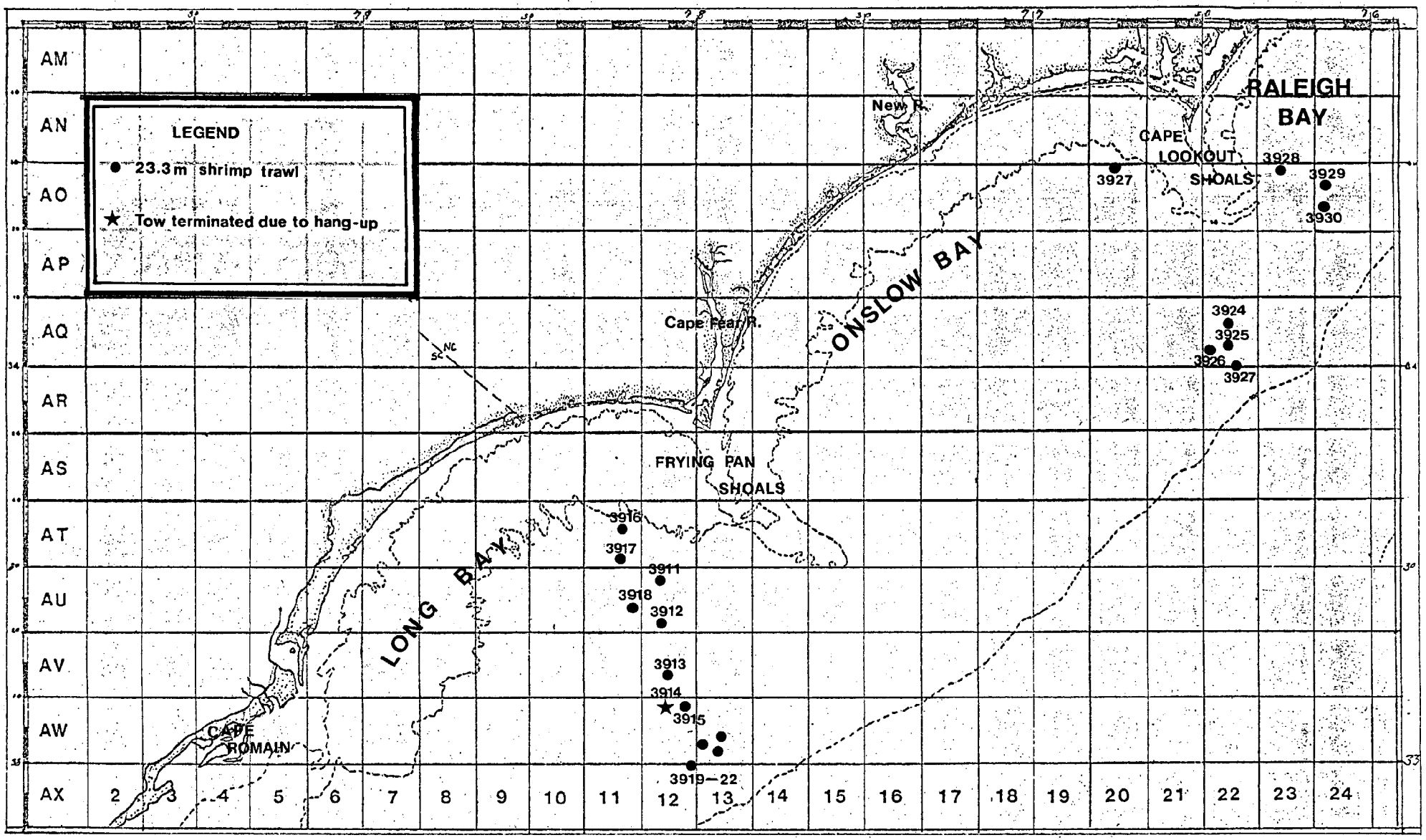

Figure 1. Cape Lookout, NC to Cape Romain, SC. Exact localities, within 10 minute latitude and longitude grids, of stations occupied during October, 1979 rock shrimp cruise.

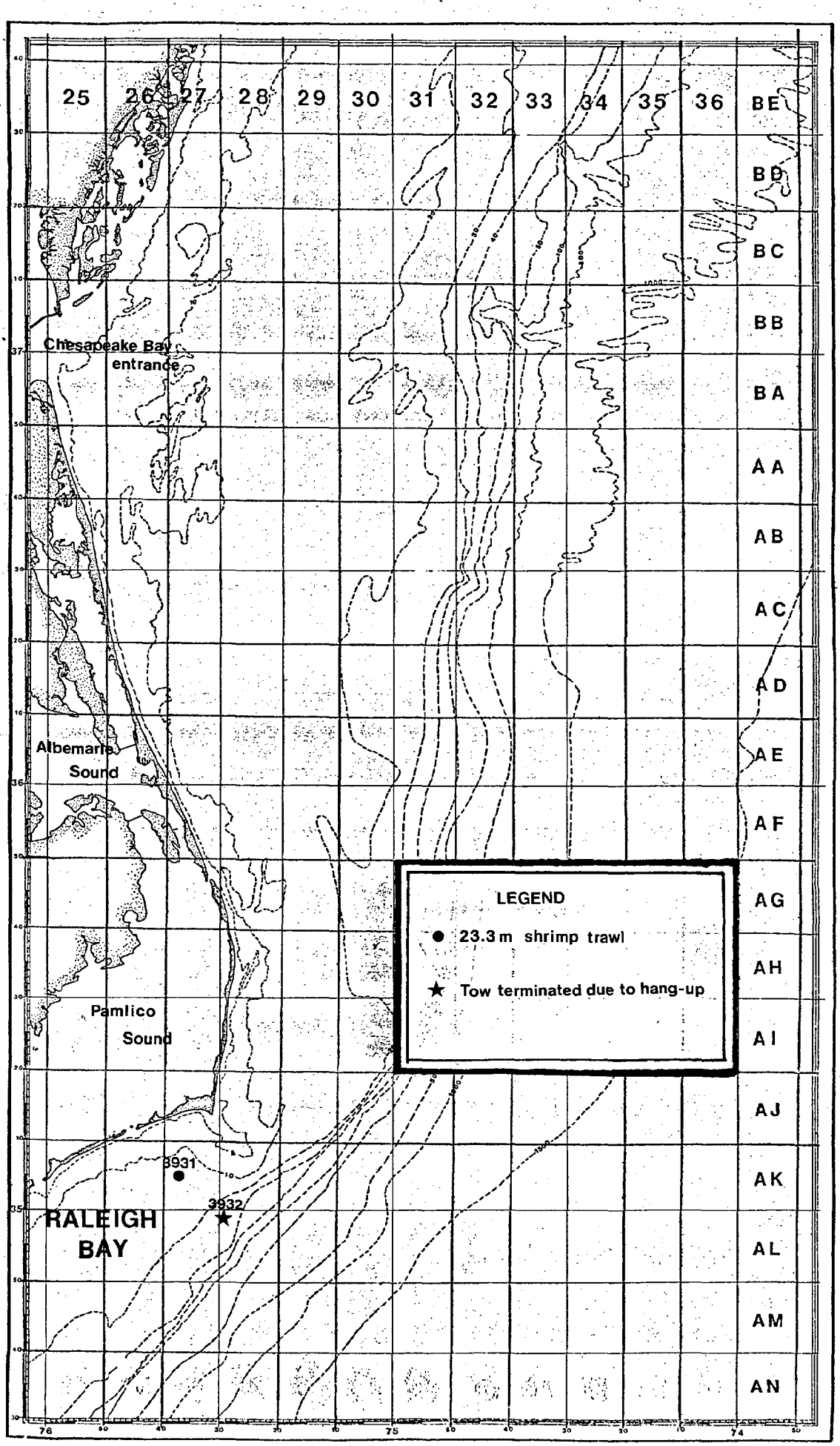

Figure 1.-continued. Ocracoke Inlet to Chesapeake Bay entrance.

When rock shrimp were present in sufficient quantities, at least 50 individuals were measured to the nearest mm (TL) and sex was determined. Total catch was determined by counting and weighing. When catches of several pounds or more of rock shrimp were made, count and heads-on weight were determined. All species captured were recorded.

Cull rate was estimated by determining the proportion of rock shrimp 85 mm TL and under (55 count, heads-off), which is currently the minimum acceptable market size. Finally, percent weight loss by heading was also calculated.

RESULTS AND DISCUSSION

Distribution and Relative Abundance

Rock shrimp were found to be more abundant in Long Bay than in Onslow and Raleigh Bays, although not in concentrations that could be considered commercially-significant. A total of 1,976 rock shrimp were captured in Long Bay compared with 393 in Onslow Bay and 335 in Raleigh Bay. Even though more fishing effort was expended in Long Bay than in the other areas, it was evident that rock shrimp catches decreased in numbers as latitude increased (Table 1).

In Long Bay, Zone II yielded more rock shrimp (973 individuals) than any other zone. Zone I was the least productive in Long Bay, with 126 shrimp captured, and Zone III produced a total of 424 rock shrimp. A good sign of rock shrimp was encountered at the one offshore station (Zone IV) at which 453 rock shrimp were captured. Rough seas, which made it impossible to determine the bottom type at that depth, precluded more quantitive sampling in this zone.

In Onslow Bay, Zone II yielded only 14 individuals while Zone III yielded 379 rock shrimp. Sampling was limited in Onslow Bay due to the paucity of suitable hard sand/shell substrate.

Zone II in Raleigh Bay produced only 13 rock shrimp while 322 were captured in Zone III. Again rough seas precluded extensive trawling from offshore Drum Inlet to Hatteras Bight and effort was concentrated east of Cape Lookout and south of Cape Hatteras.

Ta[redacted] 1. [redacted]ati[redacted]oca[redacted]es [redacted] ot[redacted]per[redacted]nt [redacted]a co[redacted]rni[redacted]orth [redacted]aro[redacted] ro[redacted] [redacted]hri[redacted]amp[redacted], 1[redacted] Oc[redacted]er 1[redacted]. [redacted]

Station Number	Date	Grid	Latitude	Longitude	Loran "A" Bearings 3H6	3L1	Depth (m)	Length of tow (min)	Total Weight (kg)	Total Number	Headed Weight (kg)	Count Per Pound	Discard Ratio Discards/Total
Long Bay Area													
3911	10-15-79	12AU	33°27'	78°07'	3054	4926	24	60	5.5	278	3.9	33	0
3912	10-16-79	12AU	33°21'	78°07'	3099	4906	27	60	4.3	177	2.5	32	0.04
3913	10-16-79	12AV	33°14'	78°06'	3130	4879	31	60	6.4	288	4.0	33	0.02
3914	10-16-79	12AW	33°09'	78°06'	3167	4860	33	15	Net severely damaged				
*3915	10-17-79	12AW	33°09'	78°04'	3149	4849	35	52	1.3	56	0.6	40	0.20
3916	10-18-79	11AT	33°36'	78°13'	3048	4972	20	60	2.3	126	1.5	39	0.02
3917	10-18-79	11AT	33°32'	78°13'	3075	4962	24	60	3.6	161	2.3	32	0.02
*3918	10-18-79	11AU	33°24'	78°12'	3124	4933	25	37	1.8	69	0.9	34	0.02
3919	10-20-79	13AW	33°04'	78°59'	3142	4813	40	60	3.4	169	2.0	36	0.02
3920	10-20-79	12AX	33°00'	78°02'	3183	4801	56	60	9.5	453	5.5	38	0.02
*3921	10-20-79	13AW	33°02'	77°58'	3142	4797	51	30	0.9	44	0.6	35	0.05
3922	10-21-79	13AW	33°04'	77°58'	3126	4807	42	107	2.7	164	1.9	39	0.08
Onslow Bay Area													
3923	10-21-79	22AQ	34°00'	76°24'	1989	4740	47	60	2.3	171	1.4	57	0.28
3924	10-22-79	22AQ	34°07'	76°26'	1951	4762	40	60	1.4	54	0.9	27	0.04
3925	10-22-79	22AQ	34°03'	76°27'	1981	4753	40	60	1.8	92	1.1	23	0
3926	10-22-79	22AQ	34°03'	76°29'	2004	4761	40	60	1.3	62	0.7	41	0.06
3927	10-23-79	20AO	34°30'	76°45	1925	4869	22	60	0.3	14	Insufficient number for analysis		
Raleigh Bay Area													
3928	10-29-79	23AO	34°29'	76°16'	1698	4800	35	60	0.05	1	Insufficient number for analysis		
3929	10-29-79	24AO	34°28	76°08	1652	4781	40	60	2.9	146	1.8	36	0
3930	10-29-79	24AO	34°34'	76°08	1687	4769	44	60	3.2	175	1.8	44	0
3931	10-31-79	27AK	35°03'	75°37'	1132	4798	31	60	0.2	13	Insufficient number for analysis		
3932	10-31-79	27AL	34°59	75°30'	1136	4776	55	25	Net severely damaged				

*Tow terminated early due to rough bottom.

Bottom water temperatures over the entire study area ranged from 21° to 24°C with an average of 23°C and were not considered as a significant factor influencing rock shrimp distribution.

Few problems were encountered in negotiating the predominantly sand bottom, however at three stations (3915, 3918 and 3921) tows were terminated early due to rough bottom appearing on the fathometer. Major net damage was sustained at stations 3914 and 3932 due to obstructions that did not show up on the fathometer tracing.

SIZE COMPOSITION

During the study period, total lengths were taken and sex was determined for 844 rock shrimp. The majority (800 or 94.8%) of the rock shrimp were of commercial size, greater than 85 mm or 55 count. Heads-off count per pound ranged from 23 to 57 with an average count of 36.

Length frequency distributions, by sex, for rock shrimp captured in Long, Onslow and Raleigh Bays with a combined length frequency of all rock shrimp, sexes combined, appear in Figures 2-5 respectively. A t-test revealed a significant difference at the 5% level of the mean lengths of males from Long Bay compared with those from Onslow and Raleigh Bays. No significant differences were found for females. In all three areas, the majority of the rock shrimp captured ranged in total length from 100 to 110 mm. Males were found to average slightly smaller in length than females overall, and females became more numerous at lengths greater than 110 mm.

SEX COMPOSITION

Sex was actually determined for 843 rock shrimp. The sex of one juvenile (46 mm) was impossible to determine upon gross examination and was not used in the calculation of sex ratios. Of the 843 shrimp captured which were sexed, 419 were female and 424 were male for a sex ratio (♀/♂) of 0.99 (Table 2). In Long and Raleigh Bays, males were more abundant than females, but females outnumbered males in Onslow Bay.

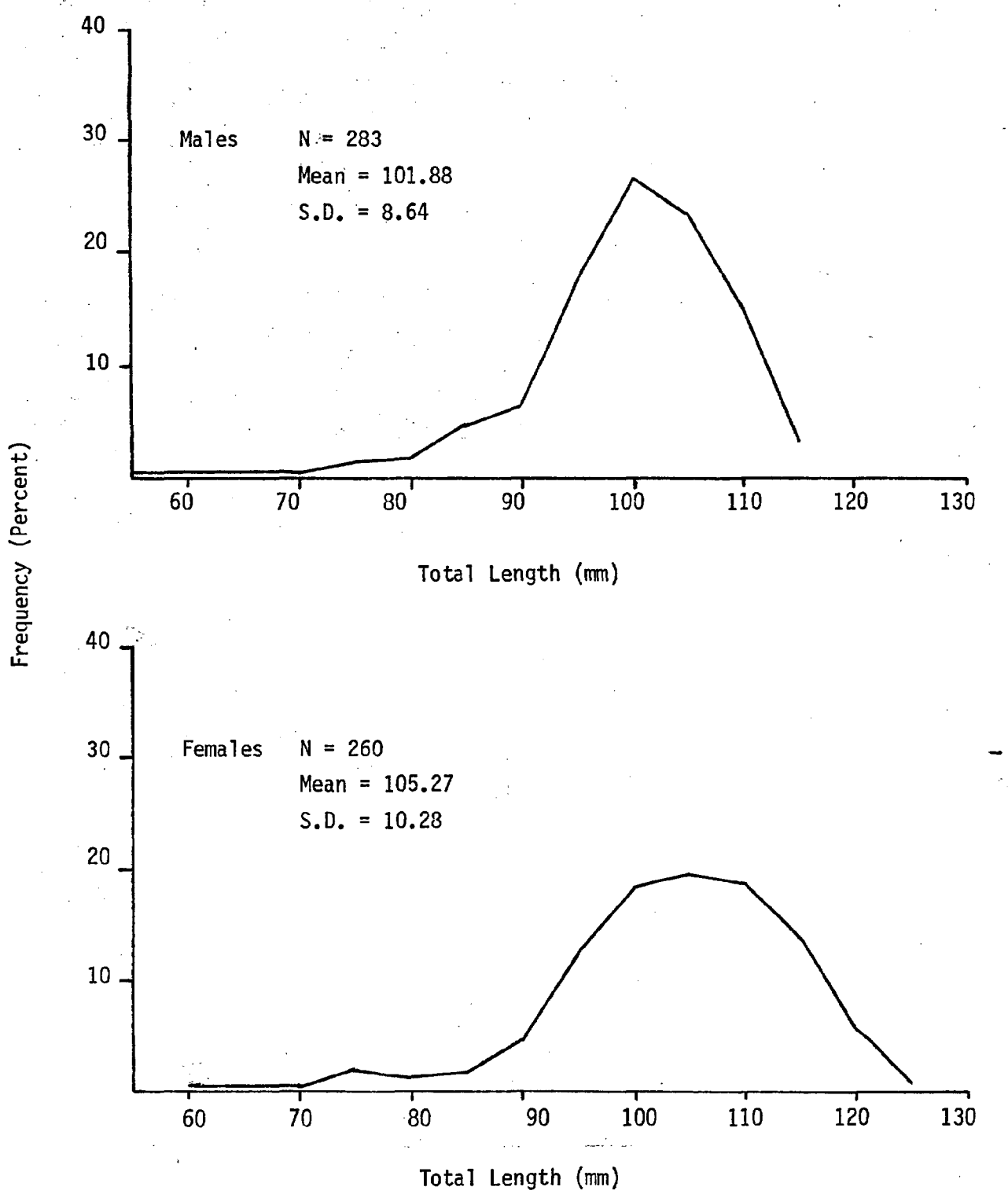

Figure 2. Length frequency distributions, by sex, of rock shrimp captured in Long Bay, NC October 1979.

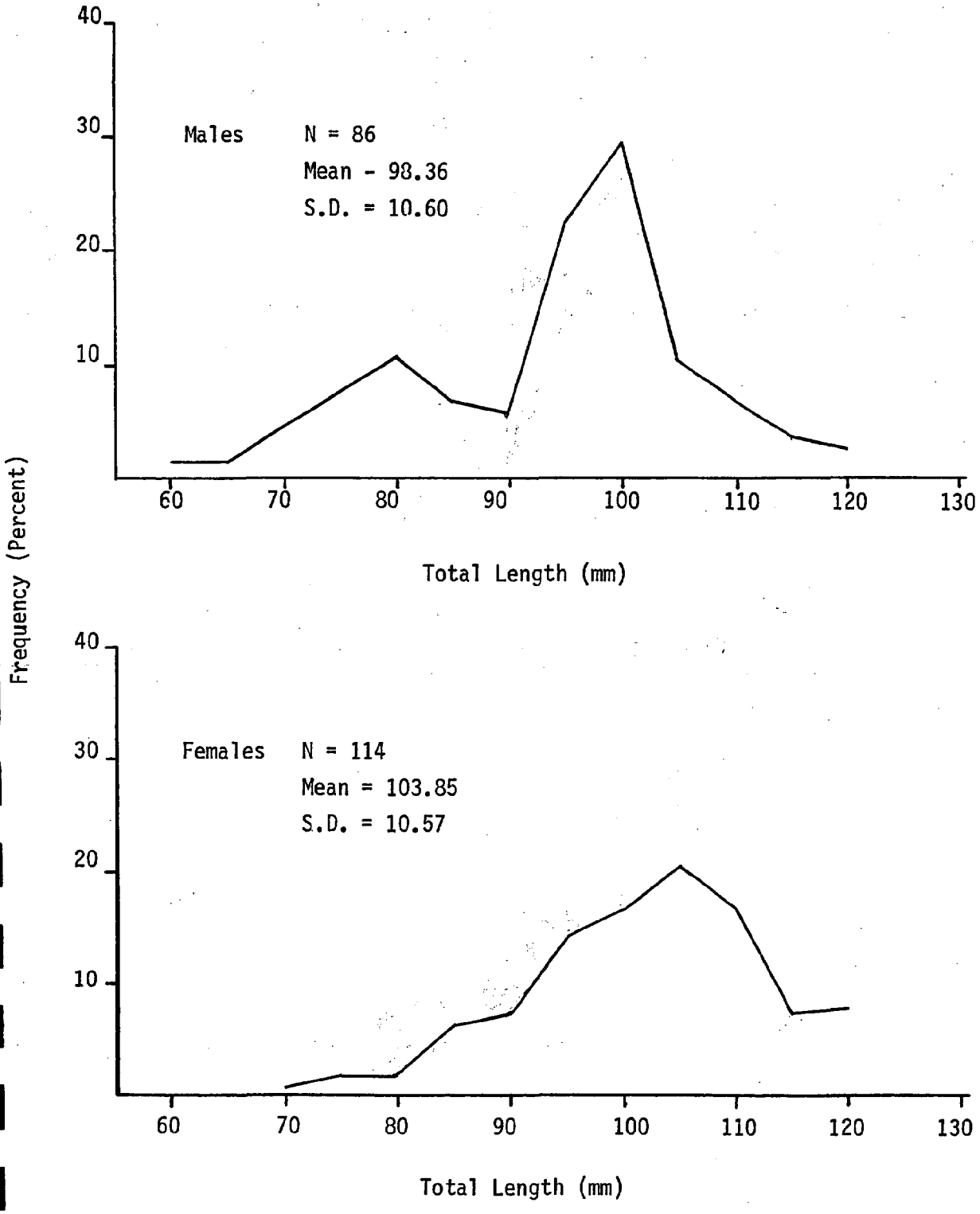

Figure 3. Length frequency distributions, by sex, of rock shrimp captured in Onslow Bay, NC October 1979.

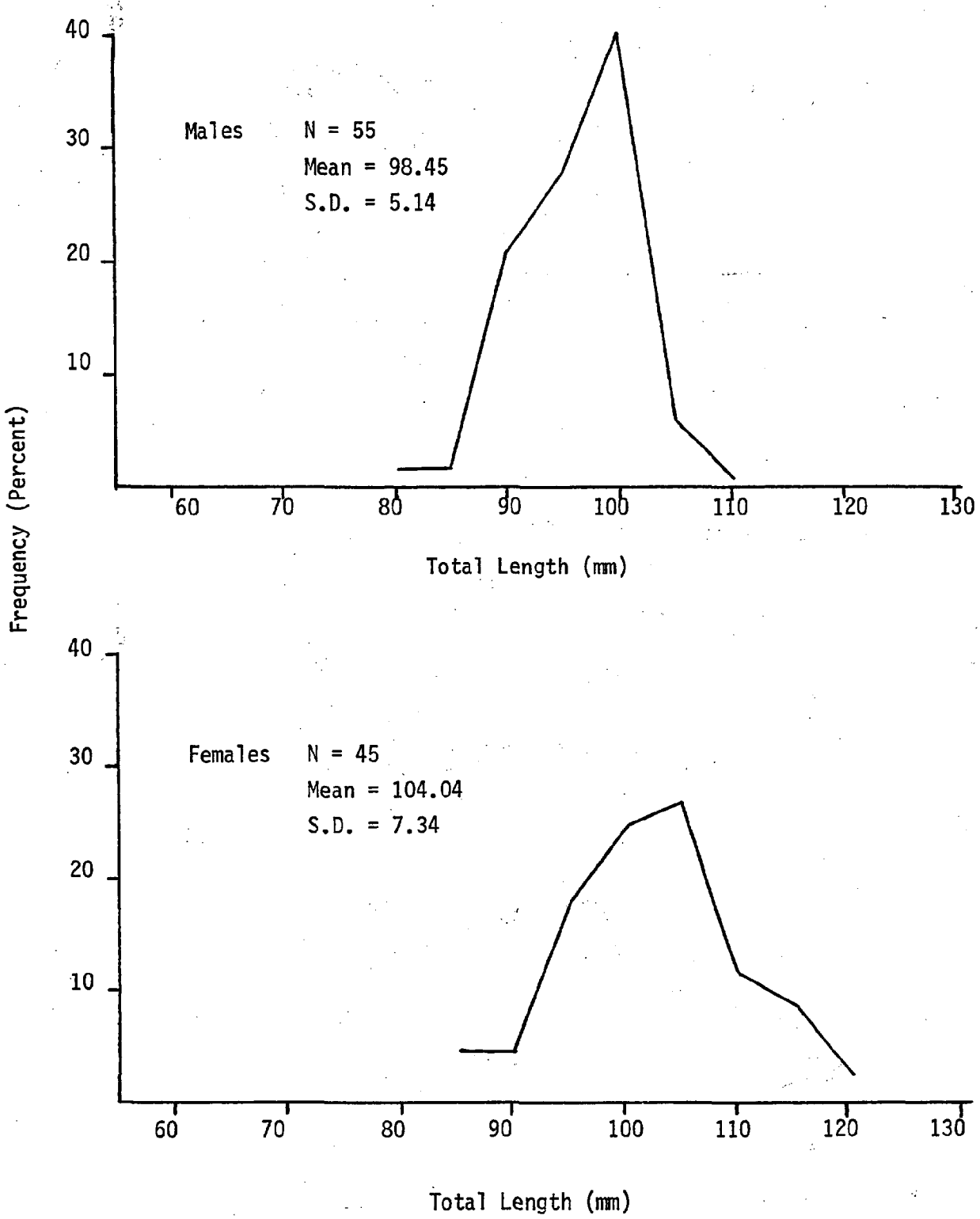

Figure 4. Length frequency distribution, by sex, of rock shrimp captured in Raleigh Bay, NC October 1979.

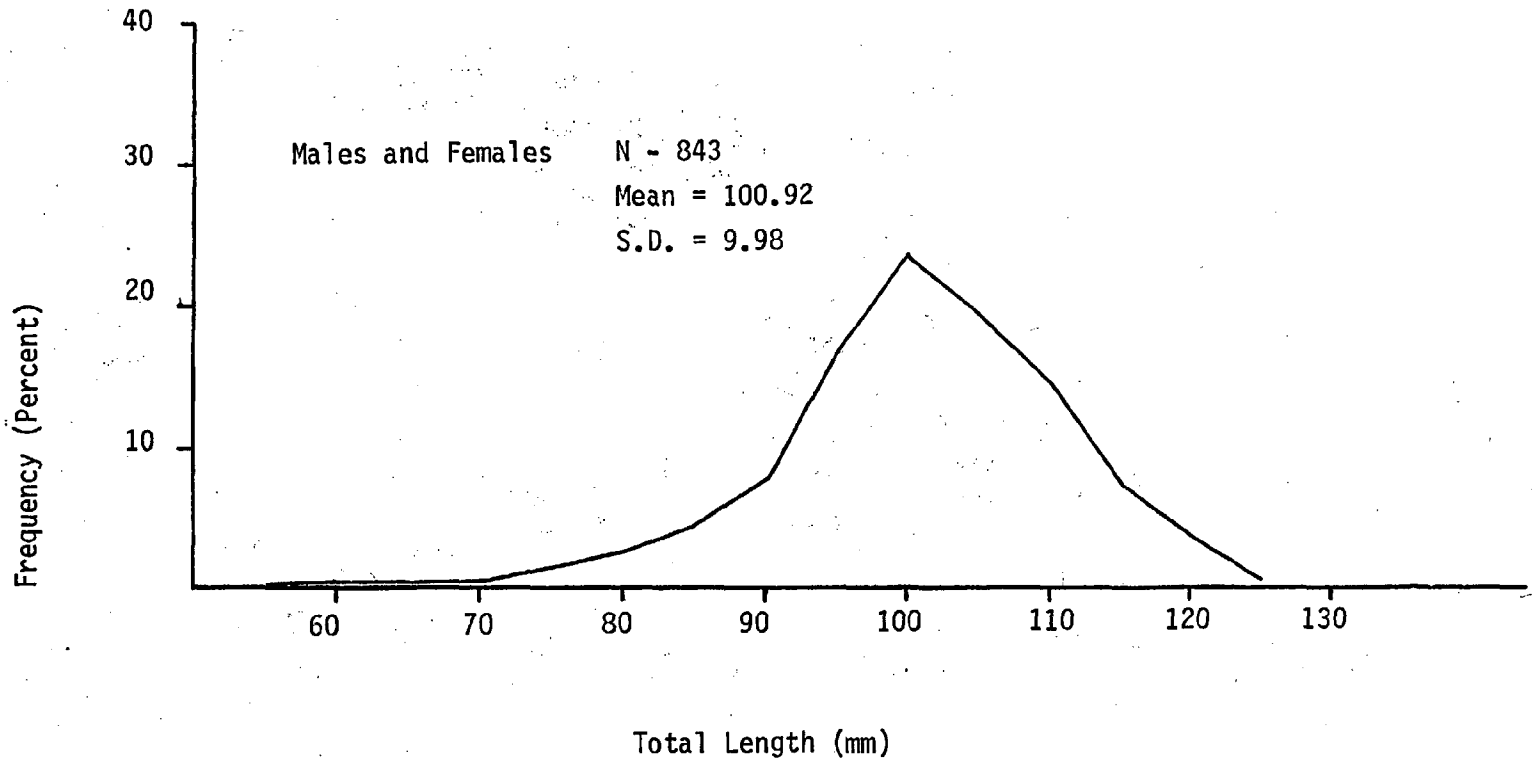

Figure 5. Length frequency distribution, sexes combined, of 843 rock shrimp captured in Long, Onslow and Raleigh Bays, NC October 1979.

Table 2. Sex composition, by area, for 843 rock shrimp, offshore North Carolina, October, 1979.

AREA	TOTAL	NO. FEMALES	PERCENT	NO. MALES	PERCENT	SEX RATIO
Long Bay	543	260	47.9	283	52.1	0.92
Onslow Bay	200	114	57.0	86	43.0	1.33
Raleigh Bay	100	45	45.0	55	55.0	0.82
Total	843	419	49.7	424	50.3	0.99

CULL RATES

Cull rates (discard ratios) were calculated for each tow and appear in Table 1. Very few noncommercial sized rock shrimp were encountered anywhere during the study period. Only 44 (5.2%) of the 844 shrimp measured were less than or equal to 85 mm. The most discards per tow occurred in Onslow Bay. At station 3923 for example, 14 of the 50 shrimp captured were culled for a discard ratio of 0.28, the highest of the cruise.

Percent weight loss after heading was 38.8% which agrees with work conducted off Cape Canaveral, FL by the Florida Department of Natural Resources (Cobb *et al.* 1973).

RECOMMENDATIONS

Even though rock shrimp of commercial size were captured throughout the study area, they were not present in sufficient quantities to warrant any extensive commercial effort by North Carolina fishermen at this time.

More exploratory work of this nature needs to be conducted in the future to locate and delineate areas in which commercial concentrations of rock shrimp do occur. It is recommended that these efforts take place during the summer and winter months, traditional periods of maximum abundance.

It may be that the use of heavier chain and doors in conjunction with the 23.3 m trawl would obtain more successful results by allowing deeper penetration of the sand substrate, but this is only speculation.

ACKNOWLEDGEMENTS

I greatly appreciate the assistance of biologists B. F. Holland, Jr. and John W. Gillikin, and the entire crew of the R/V DAN MOORE during the field sampling portion of this study. I would also like to thank Michael W. Street for his advice and critical review of the report.

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APPENDIX

Associated species which were most numerous in the trawl catches were scorpionfish (*Scorpaena spp.*), dusky flounder (*Scyacium papillosum*), and sand perch (*Diplectrum formosum*), all of which are known to prey upon rock shrimp (Cobb *et al.* 1973). The northern searobin (*Prionotus carolinus*) and Atlantic longfinned squid (*Loligo pealei*) were also abundant in most catches. Associated species were merely noted as present; they were not counted, measured, or weighed.

A few commercially important finfish such as spot (*Leiostomus xanthurus*), croaker (*Micropogonias undulatus*) and weakfish (*Cynoscion regalis*) were captured during the study period. Those captured were of non-commercial size.

A few seed calico scallops (*Argopecten gibbus*) were present at stations 3919, 3928, and 3932, however, they were too small and too few in number to warrant any commercial effort. A few large pink shrimp (*Penaeus duorarum*), which ranged from 20 to 25 per pound, were also captured in Long and Onslow Bays, but again in insignificant quantities.

Appendix Table 1 lists all species taken during the project in addition to rock shrimp and the stations at which they were taken.

Appendix Table 1. - Phylogenetically ordered list of all species (except rock shrimp) captured offshore North Carolina during the October 1979 cruise and the stations at which they were captured.

SPECIES	STATION NUMBER
Atlantic torpedo *(Torpedo nobiliana)*	3917
Clearnose skate *(Raja eglanteria)*	3911, 3912, 3915, 3917, 3922, 3926, 3931
Southern stingray *(Dasyatis americanus)*	3915, 3932
Blackedge moray *(Gymnothorax nigromarginatus)*	3913, 3922, 3923, 3924, 3926
Margintail conger *(Paraconger caudilimbatus)*	3920
Palespotted eel *(Ophichthus ocellatus)*	3924
Spotted snake eel *(Ophichthus ophis)*	3922
Spanish sardine *(Sardinella anchovia)*	3917, 3922
Inshore lizardfish *(Synodus foetens)*	3911, 3912, 3913, 3915, 3916, 3917, 3927, 3929
Sand diver *(Synodus intermedius)*	3926
Offshore lizardfish *(Synodus poeyi)*	3932
Snakefish *(Trachinocephalus myops)*	3912, 3913, 3915, 3919, 3922, 3923, 3924, 3925, 3926, 3929, 3930
Atlantic midshipman *(Porichthys porosissimus)*	3912, 3916, 3919, 3920, 3922, 3923, 3925
Splitlure frogfish *(Antennarius scaber)*	3920, 3923
Pancake batfish *(Halieutichthys aculeatus)*	3925
Batfish *(Ogcocephalus spp.)*	3918, 3920, 3921, 3915
Blackedge cusk-eel *(Lepophidium graellsi)*	3916
Blotched cusk-eel *(Ophidion grayi)*	3913, 3917, 3918, 3919, 3927
Bank cusk-eel *(Ophidion holbrooki)*	3911, 3912, 3915, 3919, 3920, 3921, 3925, 3928, 3930
Striped cusk-eel *(Rissola marginata)*	3918
Red cornetfish *(Fistularia petimba)*	3922, 3929, 3930
Lined seahorse *(Hippocampus erectus)*	3911, 3918, 3921
Bank sea bass *(Centropristis ocyurus)*	3913, 3915, 3918, 3922, 3925, 3926, 3928, 3929, 3930, 3931
Black sea bass *(Centropristis striata)*	3913, 3917, 3932
Sand perch *(Diplectrum formosum)*	3911, 3912, 3913, 3915, 3916, 3917, 3919, 3920, 3921, 3922, 3926, 3927, 3928, 3929, 3931, 3932

Tattler *(Serranus phoebe)*	3922
Bigeye *(Priacanthus arenatus)*	3917, 3918, 3922, 3923, 3931
Short bigeye *(Pristigenys alta)*	3915
Twospot cardinalfish *(Apogon pseudomaculatus)*	3918
Round scad *(Decapterus punctatus)*	3923, 3929
Vermilion snapper *(Rhomboplites aurorubens)*	3912, 3913, 3932
Tomtate *(Haemulon aurolineatum)*	3913, 3915, 3917, 3918
White grunt *(Haemulon plumieri)*	3917
Pigfish *(Orthopristis chrysoptera)*	3927
Whitebone porgy *(Calamus leucosteus)*	3915, 3918, 3922
Knobbed porgy *(Calamus nodosus)*	3922
Spottail pinfish *(Diplodus holbrooki)*	3917
Red porgy *(Pagrus pagrus)*	3918, 3922
Longspine porgy *(Stenotomus caprinus)*	3911, 3912, 3913, 3917, 3928, 3929, 3931, 3932
Weakfish *(Cynascion regalis)*	3927
Jackknife-fish *(Equetus lanceolatus)*	3917, 3922
Cubbyu *(Paraques umbrosus)*	3913, 3922
Spot *(Leiostomus xanthurus)*	3927
Southern kingfish *(Menticirrhus americanus)*	3916
Atlantic croaker *(Micropagonias undulatus)*	3916
Red goatfish *(Mullus auratus)*	3912, 3930
Spotted goatfish *(Pseudupeneus maculatus)*	3925
Reef butterflyfish *(Chaetodon sedentarius)*	3922
Blue angelfish *(Holocanthus bermudensis)*	3922
Yellowtail reeffish *(Chromis enchrysurus)*	3922
Lancer stargazer *(Kathetostoma albigutta)*	3915, 3920
Scorpionfish *(Scorpaena spp.)*	3911, 3912, 3913, 3915, 3916, 3918 3920, 3922, 3923, 3924, 3925, 3926, 3927, 3928, 3929, 3930
Horned searobin *(Bellator militaris)*	3923, 3930
Northern searobin *(Prionotus carolinus)*	3911, 3912, 3913, 3915, 3916, 3917, 3918, 3919, 3920, 3923, 3924, 3926, 3927, 3928, 3929, 3931
Striped searobin *(Prionatus evolans)*	3927
Bandtail searobin *(Prionotus ophryas)*	3911, 3915, 3922, 3923
Flying gurnard *(Dactylopterus volitans)*	3922
Ocellated flounder *(Ancylopsetta quadrocellata)*	

Flounder *(Bothus robinsi)*	3925, 3926, 3930
Eyed flounder *(Bothus ocellatus)*	3920, 3921, 3922, 3923, 3924, 3925, 3926
Spotted whiff *(Citharichthys macrops)*	3911, 3913, 3915, 3916, 3918
Spotfin flounder *(Cyclopsetta fimbriata)*	3911, 3912, 3915, 3924, 3932
Flounder *(Etropus sp.)*	3917, 3918
Shrimp flounder *(Gastropsetta frontalis)*	3920, 3922
Gulf flounder *(Paralichthys albigutta)*	3912
Summer flounder *(Paralichthys dentatus)*	3917, 3927
Southern flounder *(Paralichthys lethostigma)*	3912
Windowpane *(Scopthalmus aquosus)*	3927
Dusky flounder *(Syacium papillosum)*	3911, 3912, 3913, 3916, 3918, 3920 3922, 3923, 3924, 3925, 3927, 3928 3929, 3930, 3931
Naked sole *(Gymnachirus melas)*	3911, 3912, 3913, 3915, 3920, 3921 3922
Spottail tonguefish *(Symphurus urospilus)*	3911, 3912, 3913, 3920, 3927
Dotterel filefish *(Aluterus heudeloti)*	3922
Orange filefish *(Aluterus schoepfi)*	3918, 3922
Planehead filefish *(Monocanthus hispidus)*	3911, 3913, 3918, 3920, 3922, 3928, 3929
Honeycomb cowfish *(Lactophrys polygonia)*	3917
Scrawled cowfish *(Lactophrys quadricornis)*	3922
Smooth puffer *(Lagocephalus laevigatus)*	3931
Marbled puffer *(Sphoeroides dorsalis)*	3915, 3919, 3921, 3922, 3923, 3924 3925, 3926
Northern puffer *(Sphoeroides maculatus)*	3911, 3921

Invertebrates

Calico scallop *(Argopecten gibbus)*	3919, 3928, 3922
Atlantic longfinned squid *(Loligo pealei)*	3911, 3916, 3918, 3919, 3920, 3922, 3923, 3928, 3929, 3930, 3931, 3932
Octopus *(Octopus sp.)*	3911, 3912, 3915
Horseshoe crab *(Limilus polyphemus)*	3928, 3931
Mantis shrimp *(Squilla sp.)*	3916, 3917
Pink shrimp *(Penaeus duorarum)*	3911, 3912, 3917, 3918, 3927, 3928 3931
Spanish lobster *(Scyllarus americanus)*	3912, 3913, 3932

Sand crab *(Albunea gibbesii)*	3911, 3912, 3916, 3927, 3928
Calico crab *(Calappa flammea)*	3911, 3912, 3913, 3916, 3917, 3918 3920
Portunid crab *(Portunis gibbesi)*	3912, 3916, 3927, 3928
Portunid crab *(Portunis spinimanus)*	3911, 3912, 3916, 3917
Lady crab *(Ovalipes quadulpensis)*	3916
Spider crab *(Libinia sp.)*	3912
Sea urchin *(Arbacia sp.)*	3920
Sand dollar *(Clypeaster sp.)*	3913

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