FINAL REPORT

A SURVEY OF TURTLE POPULATIONS IN THE CHARLESTON HARBOR ENTRANCE CHANNEL

by

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EXECUTIVE SUMMARY

A 16 month survey of turtle populations was initiated in the Charleston Harbor entrance channel beginning in September, 1990 in order to (1) document the seasonal and diurnal variability in turtle densities within a portion of the channel, and (2) evaluate the distribution of turtles within the survey area.

Turtles were sampled by making paired trawl tows in four 1.5 km zones located within a 7.5 km section of the channel seaward of the jetties. This section corresponded to U.S. Army Corps of Engineers acceptance zones 6 through 12. Each sampling zone was subdivided into three subzones representing the northern, central and southern sections of the channel width. All 12 subzones were sampled at least once per month, both during the day and at night. Bottom characteristics in the survey area were assessed through grab sampling, underwater television reconnaissance, and through an evaluation of the trawl bycatch.

Trawl sampling conducted in the survey area resulted in the capture of 53 loggerhead turtles (*Caretta caretta*), and one Kemp's Ridley turtle (*Lepidochelys kempi*). Loggerhead turtle densities varied seasonally, with highest densities observed during the summer months, and lower densities observed during the spring and fall. No turtles were captured during the winter months when water temperature was below 16°C. When turtles were present, densities appeared to be correlated with water temperature. The relative abundance of turtles captured during the survey period varied significantly among the four zones representing different segments of the channel length (zones A-D), but not among the subzones representing different portions of the channel width. Highest densities were collected from zone D (Corps acceptance zones 7-8), which contained both mud bottom and hard bottom habitats. Lowest densities were found in zone A which was closest to the seaward end of the jetties. Over the entire study period, approximately 60% of the turtles were captured at night, and 40% were captured during the day. However, diurnal differences observed in catch rates were not statistically significant. Eight of the 53 loggerhead turtles collected in this study represented recaptured specimens, and most of these turtles had been at large for several months.

The study results suggest that turtle mortality from hopper dredges can be reduced or eliminated if dredging is accomplished during the winter months, and that the probable incidence of turtle entrainment will be greater in certain portions of the channel compared to others. Turtle densities in the Charleston channel during the spring, summer and early fall months were sufficiently high enough to warrant concern over mortality from dredging operations. Additional studies are recommended to determine whether distribution patterns noted during this survey are consistently observed during other years, especially since bottom characteristics in the Charleston Channel have been altered by the dredging operation.

INTRODUCTION

The entrance channels to most commercial and military ports in the southeastern United States require periodic dredging to maintain navigational depths. Several of these channels have also been widened and deepened to accommodate larger vessels. Because the primary method of dredging entrance channels involves the use of hopper dredges, concerns have been raised about the incidental take of threatened and endangered sea turtles by these dredges (for reviews, see Dickerson et al., 1991; National Marine Fisheries Service, 1991). Of the five turtle species present in the southeastern region, three species are at risk to dredging operations due to their life cycle or behavioral patterns (Studt, 1987). These include the loggerhead (*Caretta caretta*), the Kemp's ridley (*Lepidochelys kempi*), and the green sea turtle (*Chelonia mydas*).

Sea turtle mortalities due to hopper dredges were first documented in 1980 at Port Canaveral, Florida (Dickerson et al. 1991). The large number of loggerhead turtle deaths resulting from this operation prompted a survey in 1981-82 to evaluate the relative abundance of turtles in several channels along the Florida coast (Butler et al., 1987). Loggerhead turtles were observed in all of the channels during that survey, but only the Port Canaveral channel harbored significant concentrations of this species. In 1979, Richardson and Hillestad (1979) also conducted a trawl survey in six shipping channels along the South Carolina-Georgia coast to determine whether turtles were overwintering in those channels. No turtles were captured during their February-March survey period, which suggested that sea turtles may be absent or rare in these channels during colder periods of the year. However, data on the abundance and distribution of turtle populations in these channels were lacking for other seasons.

In South Carolina, sections of the entrance channel to Charleston Harbor require annual maintenance dredging, and a project to expand and deepen the Charleston channel is currently in progress. Because of concerns that this dredging program could cause high turtle mortalities similar to those observed in other southeastern channels (Richardson and Ferris, 1989, Dickerson et al., 1991), more information was needed to resolve the spatial and temporal distribution of turtles in the Charleston Harbor entrance channel.

This report describes the results obtained from a survey of turtle populations in the Charleston Harbor channel over a 16 month period. The major objectives of this survey were to:

1. characterize the seasonal and diurnal variability in turtle densities within the Charleston channel seaward of the jetties, and
2. evaluate the spatial distribution of turtles captured within this segment of the channel.

METHODS

Turtle populations were sampled in the entrance channel through an intensive trawl survey of four 1.5 km zones (A,B,D,E) located within a 7.5 km section of the channel beginning seaward of the jetties (Figure 1). Two other zones (C,F) were also proposed for inclusion in the survey, but hard bottom outcroppings resulted in major net damage and these areas were not sampled further. The four zones which could be trawled encompassed approximately 77% of the channel area outside the jetties that was scheduled for dredging in 1991-92. Trawl zones A and B were located within the U.S. Army Corps of Engineers (USACOE) acceptance areas 9-12, and trawl zones D and E were located in acceptance dredging areas 6-8.

Each trawl zone was divided into three subzones representing the northern, central and southern portions of the channel to provide a total of 12 trawling stations (Figure 1). Trawling was conducted at all 12 stations (subzones) during each survey period using a systematic sampling procedure designed to minimize the effects of trawl disturbance in adjacent subzones. This procedure involved randomly selecting the order of subzones to be trawled and alternating trawling among the four larger zones (A,B,D,E) so that adjacent subzones were not trawled consecutively. Loran-C was used to position the vessel during all sampling periods.

Monthly trawling was conducted from September, 1990 through December, 1991. During the first 12 months of that period, all four zones were sampled. Zone E was dropped for the remainder of the study period because dredging activities were initiated in that area. Sampling frequency was increased to twice per month during April 1991 and November 1991 to better characterize the seasonal changes in the presence of turtles within the channel. Sampling frequency was also increased to twice per month in September 1990 and 1991 to compare catch variability within a month. Each sampling effort was completed within a 5-day period, with all stations sampled during the day and during the night.

Sampling within the subzones was accomplished by simultaneously towing two 18-m mongoose-style trawl nets equipped with mud rollers and having a stretch mesh

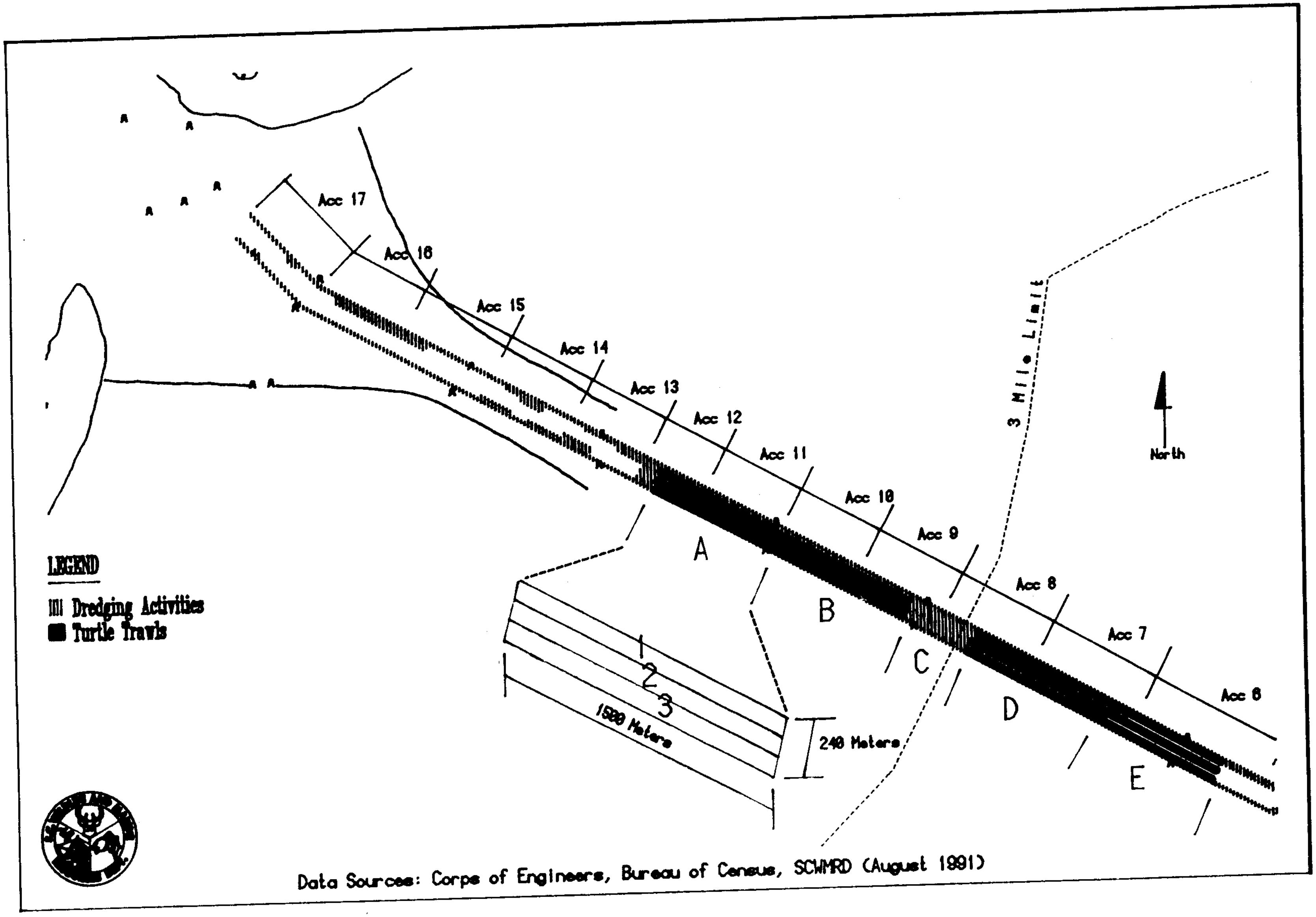

Figure 1. Sampling site and areas dredged within the Charleston Harbor entrance channel.

dimension of 10 cm throughout the length of the net. Each net was spread with 2.4 x 1-m trawl doors and pulled using the *R/V Lady Lisa*, a 22.9-m double-rigged St. Augustine shrimp trawler. Trawl speeds were standardized so that the total bottom towing time was approximately 15-20 min/tow.

Data obtained from all captured sea turtles included species identification, sex of mature individuals, standard straight-line carapace length and width, and condition (eg. injuries). The turtles were tagged on the posterior edge of the right front flipper with an inconel tag provided by the National Marine Fisheries Service before being released approximately 1.8 km (1 nau.mi.) from the channel (generally to the south). Basic hydrographic measurements were taken at high and low tide periods during each cruise using a Hydrolab® Surveyor®II System to provide information on bottom water temperature, salinity, and dissolved oxygen.

Statistical comparisons of turtle catches were completed to evaluate both spatial and temporal (day/night) patterns in the number of turtles captured per trawl (CPUE). Spatial comparisons were made using a two-way analysis of variance test (without replication) on the mean CPUE values derived for each station over the 12 month study period beginning September 1990 through August 1991. Samples collected from September through December, 1991 were not included in this analysis because bottom habitat was altered within zone E, and dredging activities during this period may have altered turtle behavior. Day-night comparisons were made using a paired t-test on mean CPUE values (all stations combined) obtained for day versus night tows during each month. Linear regression was used to compare the relationship between bottom water temperatures and turtle densities using mean CPUE estimates obtained for each period. Data used for the paired t-test and regression analysis were also limited to the first 12 months of the study.

Bottom characteristics in the survey area were evaluated using three methods. These included examination of trawl bycatch, collection of bottom sediments using a Ponar grab, and visual reconnaissance using an underwater television system.

The trawl bycatch evaluation involved examining the contents of each net for fish, invertebrate, and non-biological material. Catches were then coded by the following categories: (1) no evidence of hard bottom, (2) rock rubble, (3) reef fish and/or sessile invertebrates, (4) rock rubble with reef fish and/or sessile invertebrates.

Bottom sediments were sampled in the channel at ten stations during July, 1991. These stations were located along the center of the channel at the approximate beginning, middle, and end of each zone (Figure 2). Surficial sediments were collected with a Ponar grab and processed in the laboratory using standardized procedures described by Pequegnat et al. (1981).

An underwater television camera system was deployed in the channel during August 1991 to provide visual evaluation of bottom characteristics in each zone. The camera was towed along the bottom on a sled to keep camera height and angle constant. The sled was towed through a portion of the channel in zones B,D, and E.

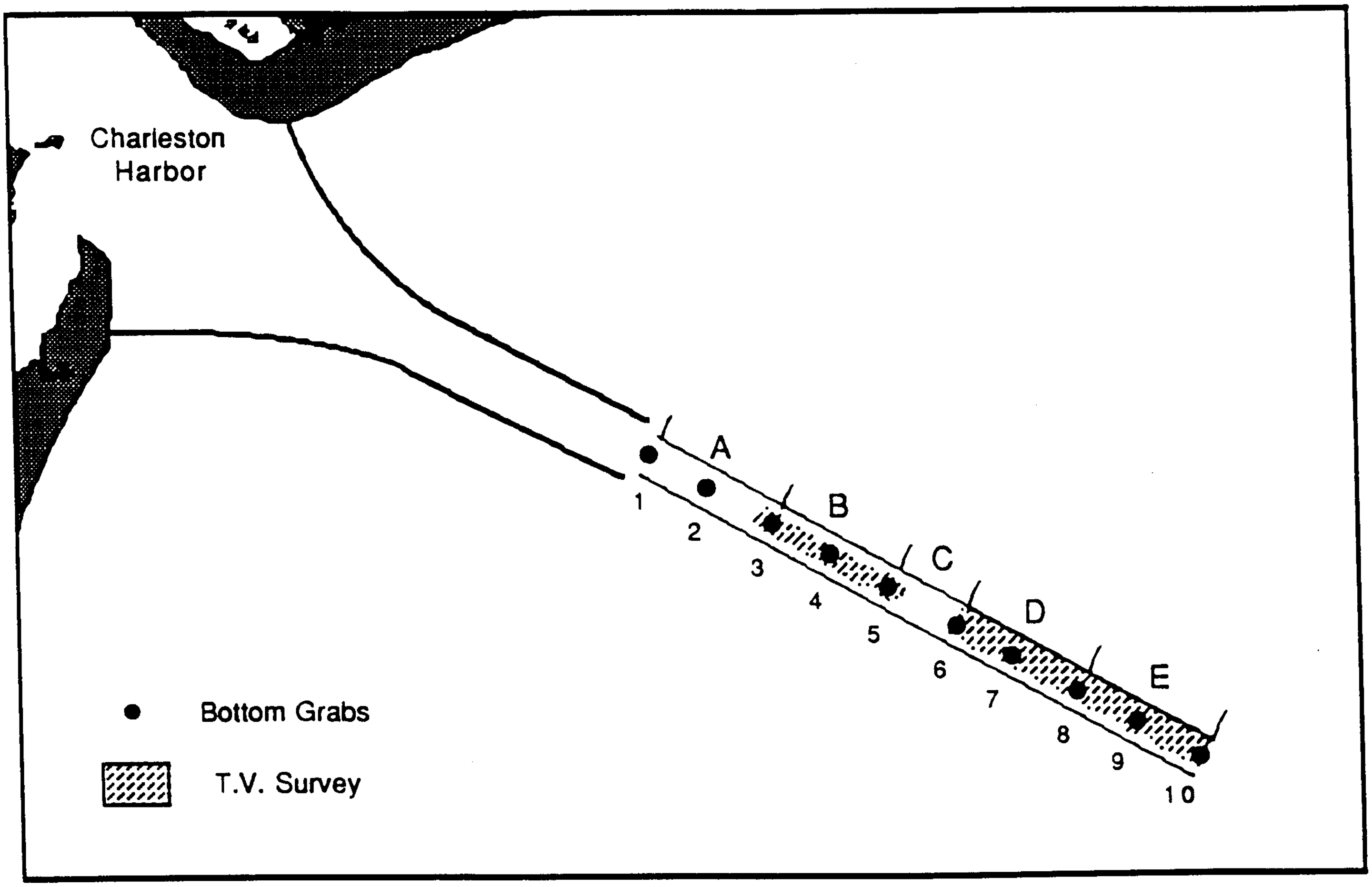

Figure 2. Location of stations sampled with a grab and an underwater television system in order to determine bottom sediment characteristics.

A limited experimental effort was attempted in September, 1991 to determine whether loggerhead turtles could be detected using a Hummingbird Dimension 3 sonar system. For this test, three turtles were collected on September 10, 1991 and brought to the laboratory, where they were maintained for five days in a large tank until testing could be conducted. The turtles were then taken offshore in a small boat to a sand bottom area located approximately 3 km southwest of the channel, where water depths were approximately 10 m. A small hole was drilled through the posterior edge of the carapace of the largest turtle (an 88 cm SL subadult) through which a tether was attached. The tether consisted of a 15-m length of rope tied to a small buoy so that the turtle's movements could be monitored. The turtle was then released overboard and the boat was repeatedly maneuvered adjacent to the turtle while it was submerged. Due to the lack of conclusive detection records this procedure was abandoned and the two smaller turtles were released without further study.

RESULTS

During the 16 month study, 53 loggerhead turtles (*Caretta caretta*) and one Kemp's Ridley turtle (*Lepidochelys kempi*) were captured by trawl in the Charleston Harbor entrance channel. Standard lengths (SL) of the loggerhead turtles ranged from 47.5 to 95.5 cm, but most were in the 50-70 cm size range (Figure 3). Only one of the loggerheads was classified as an adult, and this specimen was a 95.5 cm male. The Kemp's Ridley turtle captured was considered to be a subadult (36 cm).

Turtle capture rates changed seasonally and appeared to be correlated with water temperature (Figure 4). Turtles were only collected when bottom water temperatures were greater than 16°C. When turtles were present, densities were generally higher during the months with warmer water temperatures. During the relatively mild winter of 1990, turtles were captured through early December (bottom temperature=16.40°C). However, no turtles were captured in January, February and March of 1991. Turtles had

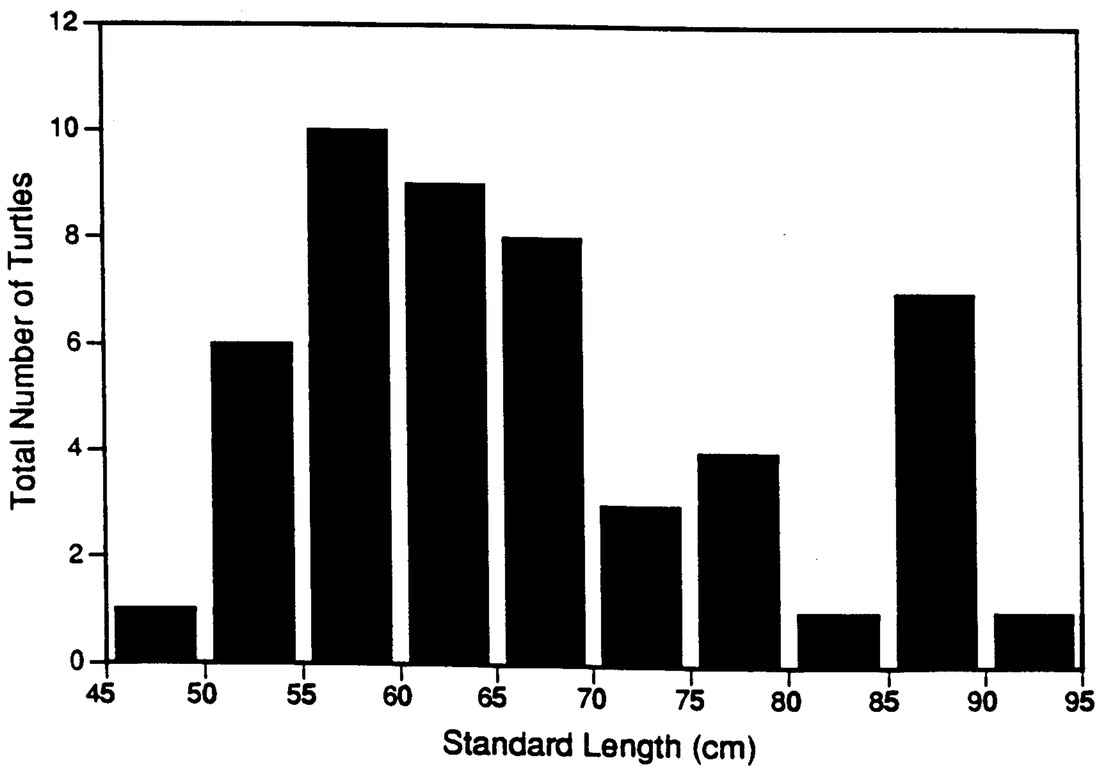

Figure 3. Size-frequency distribution of loggerhead turtles captured by trawl in the Charleston entrance channel. Bars represent the total number of turtles captured from all zones during the 16 month sampling period.

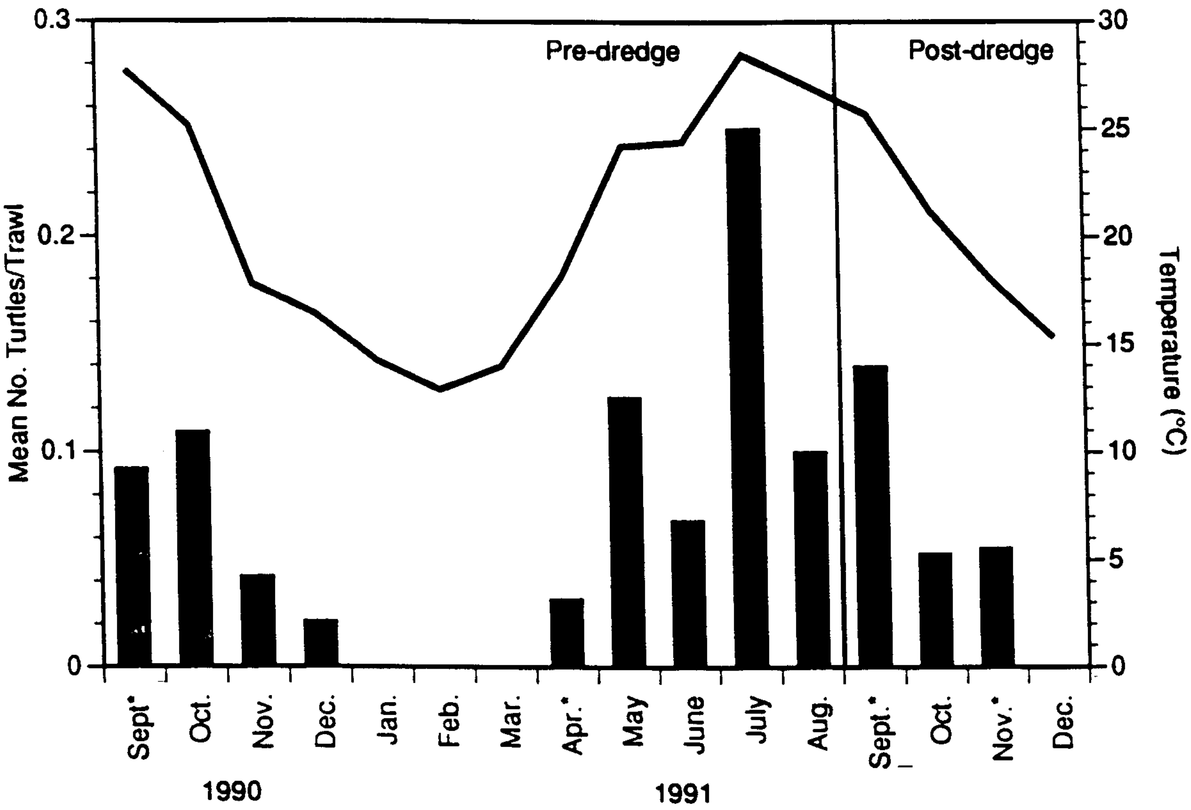

Figure 4. Mean number of turtles captured per trawl in the Charleston entrance channel (all zones combined), and average bottom water temperatures observed during each month. Months with * included two cruises.

returned to the channel by early April, 1991 and were present through November. No turtles were captured during the December 1991 cruise, when temperatures were 14.1°C. Regression analysis of water temperature versus CPUE showed a moderate correlation between these variables (Figure 5).

Differences in the density of loggerhead turtles among stations suggested that this species preferred certain portions of the channel (Figure 6). Turtle catch rates were significantly different among the zones sampled (p=.017), but they were not significantly different across the width of the channel (p=0.19). Of the 45 loggerheads collected during the pre-dredge period, most were collected within Zone D (57.8%) while substantially fewer were collected in zones E (17.7%), B (15.6%), and A (8.9%).

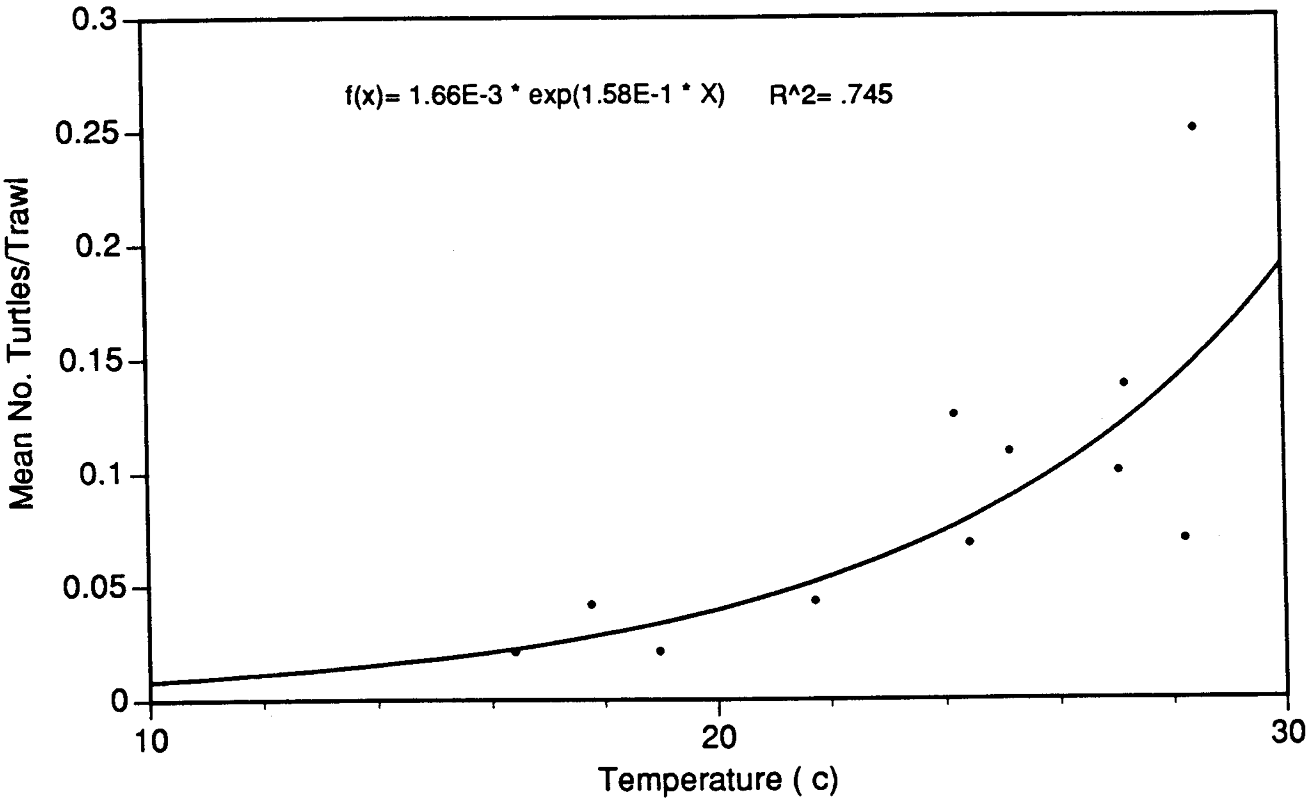

Figure 5. Regression of the mean number of turtles per trawl versus bottom water temperature during months when turtles were present.

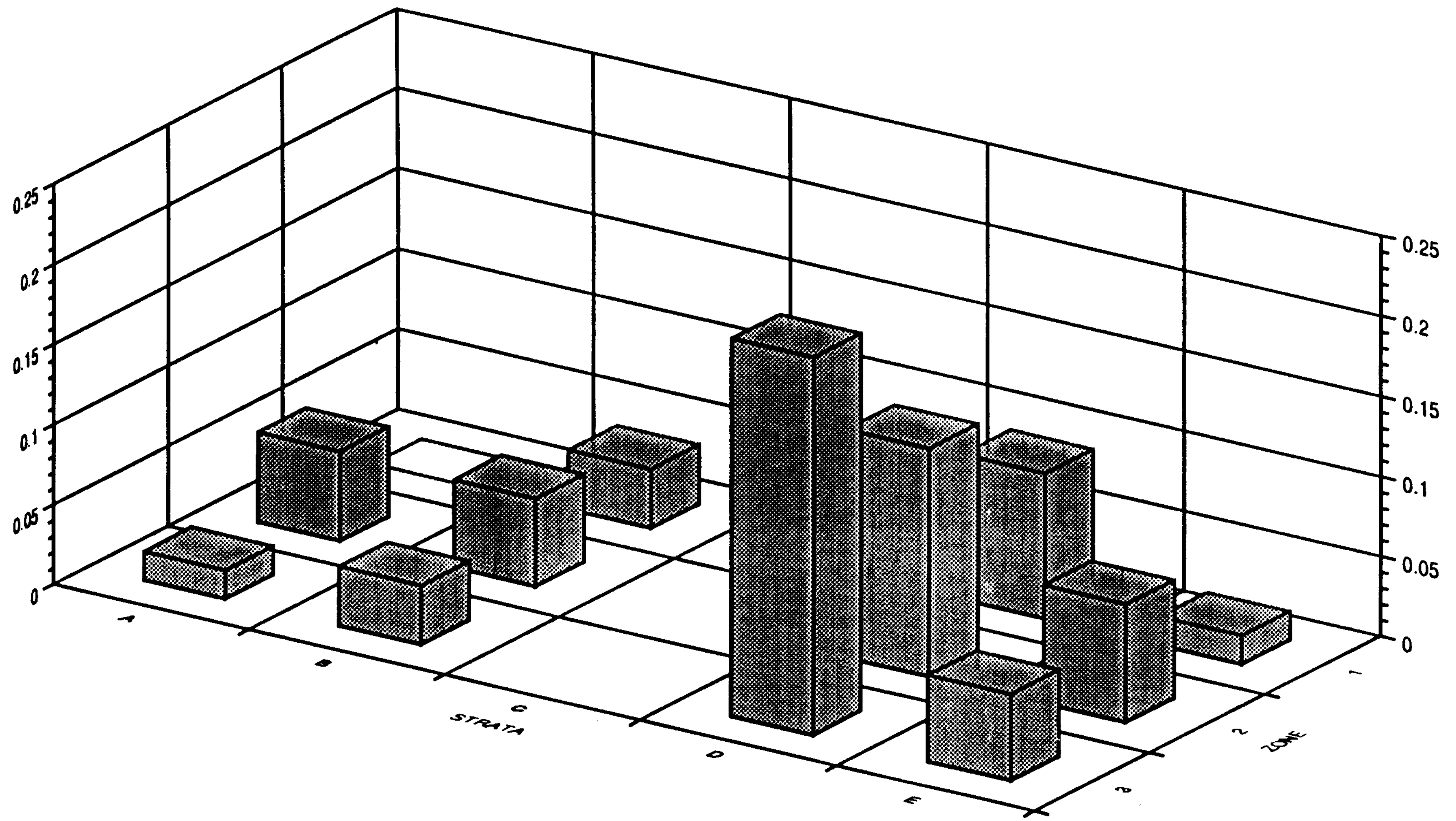

Figure 6. Mean number of turtles captured per trawl in each subzone of the Charleston entrance channel from September 1990 to September 1991. Catch rates represent day and night trawls combined.

Over the entire study period, turtle capture rates were slightly greater during the night versus the day (Night/Day CPUE= 0.094/0.051). However, these differences were not statistically significant (p=.097) based on the paired t-test of mean densities captured each month. Comparison of turtle capture rates by the hour (all seasons combined) also showed no consistent CPUE patterns, although only a small percentage of the tows made during any hour contained turtles (Figures 7a,b).

Eight turtles were recaptured during the study (Table 1). Seven of these had originally been tagged during our sampling efforts. The other turtle was first collected by J. Richardson (pers. comm.) during an independent trawling effort in the channel seaward of our zone E during September 1991. Although three of the turtles were recaptured within one month of their release, most of the recaptured specimens were collected during the following year after a winter absence.

Methods used to evaluate bottom characteristics within the study area provided evidence that the physical characteristics of each zone were different. Live (hard) bottom appeared to be prevalent in the offshore blocks, particularly within zone E, based on the presence of reef fish and/or sessile invertebrates and rock rubble in the trawl catches (Figure 8). Trawl samples from other zones also contained evidence of hard bottom habitat, but the frequency of reef fish, sessile invertebrates or rocks in the trawls was much lower in these zones compared to zone E. Bottom characteristics observed using the television system indicated that zone E had a sandy bottom interspersed with hard bottom outcroppings. Although visibility was severely restricted in the other zones, the presence of mud on the camera lens and sled indicated that bottom sediments in those areas included unconsolidated fine-grained material. Sediment analysis from the grab samples also indicated that the inner zones contained a high percentage of clay and silt (Table 2), which may have contributed to the lack of visibility in these areas. In contrast, the sample from Zone E (#9) was primarily composed of sand. Despite numerous attempts, no sample was collected at Station 10 (outer end of Zone E) which suggests that hard bottom may have been present at this site.

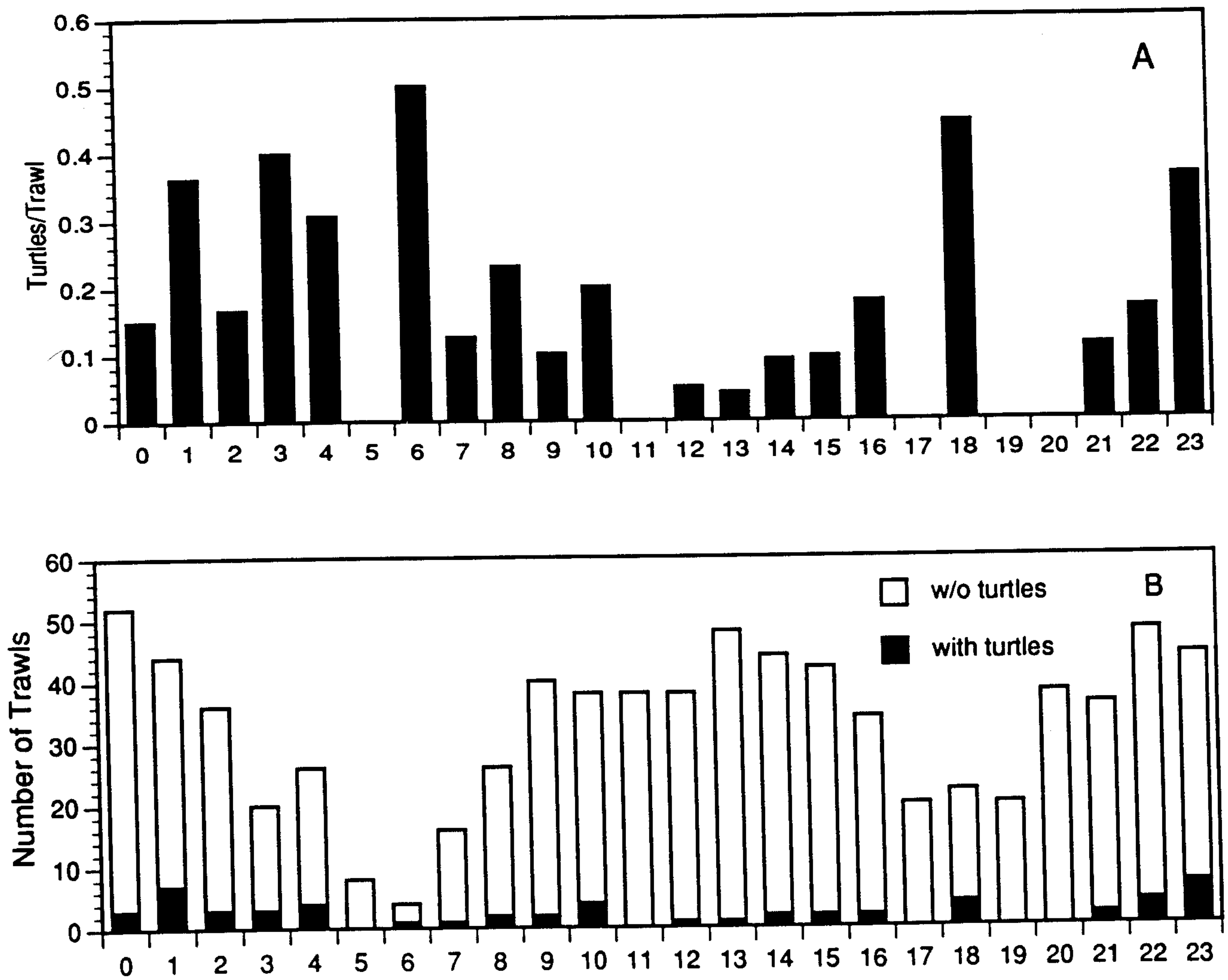

Figure 7. Mean number of turtles captured per paired trawl (A) and total number of trawls made (B) in Charleston harbor entrance channel for each hour of the day for the twelve month period from September 1990 to September 1991. Bars represent all zones combined.

Turtle Tag Number	Date of Capture	Recapture	Days at Large	2nd Recapture	Days at Large
PPV892	9/19/90	9/20/90	1		
PPV897	9/19/90	5/14/91	237	9/9/91	118
PPV898	9/19/90	6/10/91	264		
PPV895	10/3/90	7/9/91	279		
PPV900	11/18/90	5/15/91	178		
QQH512	7/9/91	8/13/91	35		
QQH574	9/10/91	9/23/91	13		
QQR143/QQR144	9/23/91	9/25/91	2		

Table 1. Listing of loggerhead turtles which were recaptured in the Charleston entrance channel during the survey period.

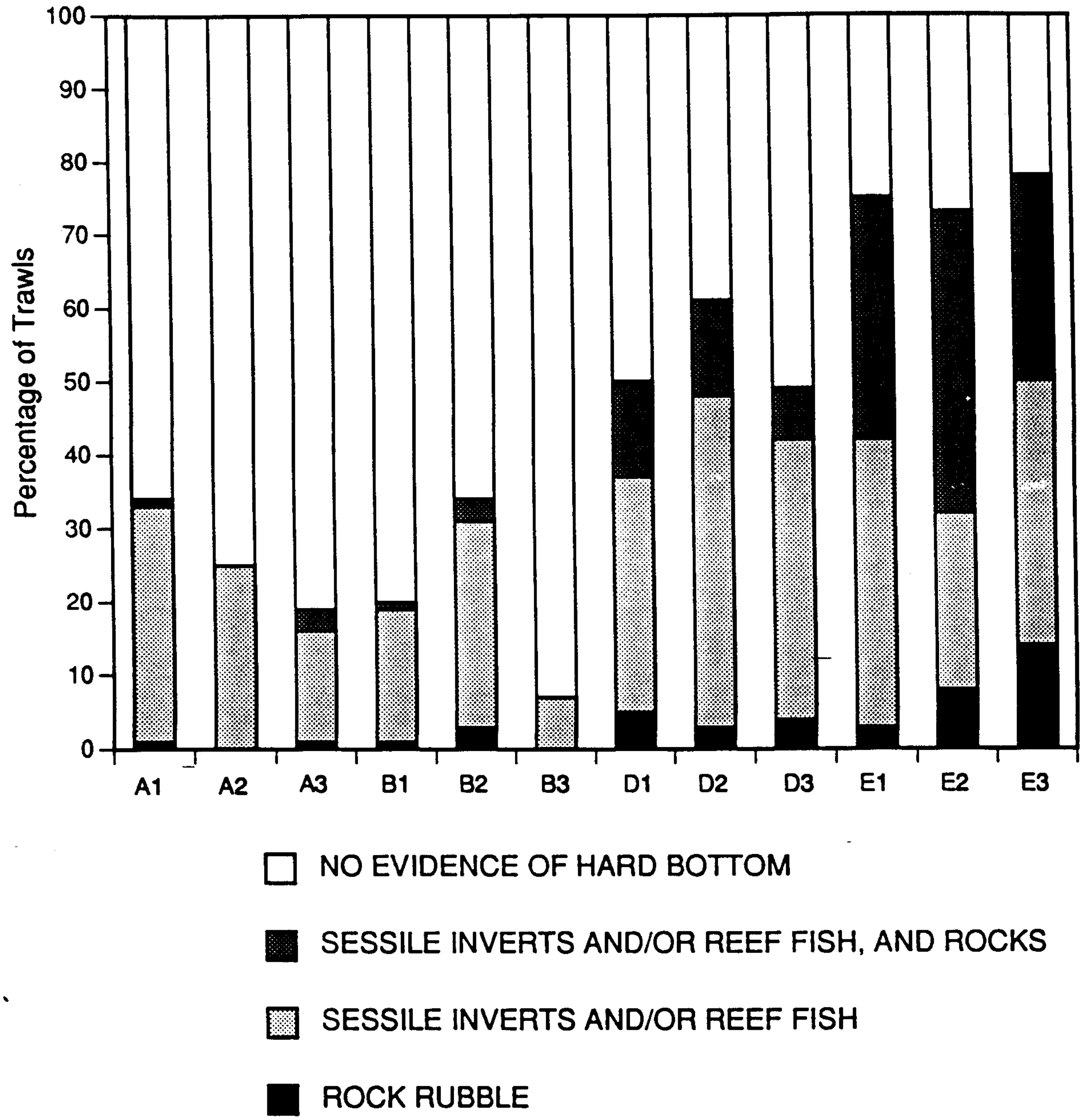

Figure 8. Proportion of trawl tows made in the Charleston entrance channel with various types of catch.

Zone	Station	SEDIMENT COMPOSITION (%)					Sand
		Sand	Silt	Clay	CaCo3	Organic	Grain Size
	1	49.05	40.02	5.36	5.57	9.59	2.85
A	2	42.34	47.08	6.05	4.53	9.64	2.84
	3	31.65	56.57	7.68	4.11	12.13	3.10
B	4	31.37	54.82	6.90	6.91	10.64	3.29
	5	12.31	73.80	11.68	2.21	15.11	3.39
C							
	6	48.96	38.23	6.23	6.57	8.19	3.07
D	7	89.72	1.56	3.89	4.83	1.73	2.89
	8	26.42	57.14	8.97	7.47	18.17	3.41
E	9	91.04	0.00	2.49	6.47	1.07	2.50
	10	*	*	*	*	*	*

Table 2. Sediment characteristics at stations within the Charleston Harbor entrance channel.
* indicate no sample obtained

DISCUSSION

The incidence of turtles captured during this survey indicates that the outer portion of the Charleston Harbor entrance channel supports a substantial population of *Caretta caretta* during the spring, summer and fall months. Based on the results of Butler et al. (1987) it is likely that actual densities of turtles in the study area were higher than we collected. That study sampled turtle populations in the Port Canaveral channel using similar trawl gear and trawling methods, and documented an estimated mean probability of turtle capture of only 0.28.

Average catch rates of loggerhead turtles in our study area from May through September were comparable to loggerhead turtle densities collected in the Savannah and Brunswick channels during the same months using similar gear (Nelson, USACOE Waterways Experiment Station, unpublished data). During the cooler months turtle catch rates were much lower in the Charleston channel than they were during the summer. The lower abundance of *Caretta caretta* observed during the fall was presumably due to a southerly or offshore migration of this species to warmer waters where they overwinter (Thompson, 1988). The absence of turtles in trawl samples taken during the winter supports Richardson and Hillstead's (1979) conclusions that turtles are absent or rare along the South Carolina-Georgia coastline during this time period. Lutcavage and Musick (l985) also observed that loggerhead turtles were only present from May-November in the Chesapeake Bay area.

No turtles were captured during the winter months in the Charleston Channel, when water temperatures were below 16° C. It is possible that turtles were present in the study area when water temperatures were slightly lower than 16° C, but it is unlikely that any turtles overwintered in this channel since none were collected in the 107 paired trawl tows taken during months when water temperatures were below 16° C. Additional data are needed to more precisely determine the minimum water temperature at which loggerhead turtles are found in this channel, and resolve the consistency of those distribution patterns among years.

Relatively little is know about the seasonal distribution and movements of juvenile

Caretta caretta, which comprised most of our catch. The general size range of turtles we captured is similar to the size ranges observed in other channels surveyed along the east coast (Erhart, 1983,1987; Nelson, USACOE Waterways Experiment Station, unpublished data) It is interesting to note that four of the eight juveniles recaptured in this study were originally caught during the fall of 1990, and were not recaptured until the spring or summer of 1991. If these turtles migrated south during the fall to overwinter in warmer waters, their return during the following year suggests that at least some juvenile loggerheads return to the same areas.

Average turtle catches in the Charleston entrance channel were much greater than catch rates observed in trawls collected from non-channel habitats off South Carolina in similar water depths. For example, during the summer months (July, August), the average turtle density in our day trawls was 0.125 loggerheads/trawl sample (ave. of 48 trawl samples). During the same months, the South Atlantic SEAMAP Program only collected an average of 0.043 loggerhead turtles/trawl at 46 stations sampled off South Carolina using the same research vessel and larger (23 m) mongoose trawl nets (Beatty et al., 1992). Their average turtle catch rates off Georgia were also much lower than turtle CPUE estimates obtained in the Savannah, Brunswick, and Kings Bay channels during the fall of 1991 (Beatty et al., 1992; Nelson, USACOE Waterways Experiment Station, unpublished data). Thus, it appears that loggerhead turtles are congregating in channel habitats along the southeastern United States during summer and fall months.

The spatial distribution of turtles in the Charleston channel clearly indicated that *Caretta caretta* were more concentrated in some areas of this channel. Evaluation of bottom characteristics in zone D, where they were most abundant, indicated the presence of both mud bottom and hard bottom habitat. Carr et al. (1980), and Butler et al. (1987) also observed that loggerhead turtles were more abundant in certain portions of the Port Canaveral channel, where muddy sediments occurred. Carr et al. (l980) noted that turtles were often imbedded in the mud and may have been hibernating there. We did not find any evidence that turtles collected from the Charleston channel were burying in the mud. While it is possible that loggerhead turtles prefer muddy habitats over others, trawl samples collected in zones D and E also contained evidence of hard bottom habitat based on the incidental catch of sessile sponges and corals, reef fish species, and/or rock rubble. Turtle catch rates were greater in these zones than in zones A and B, where there appeared to be little if any hard bottom present. Therefore, it is possible that the greater loggerhead turtle densities in zones D and E are related to the distribution of hard bottom habitat in these areas. Using satellite tracking, Stoneburner (1982) documented the association of loggerhead turtles with live bottom habitats during internesting intervals and suggested that they may be using these areas as feeding grounds. The presence of multiple bottom types in the zones where most of the turtles occurred during our study precludes identification of preference for a particular bottom type. Further research is needed to determine which bottom types are preferred by juveniles turtles.

Our attempts to trawl in the channel seaward of zone E resulted in bottom hangs and net damage that was most likely due to hard bottom outcroppings based on the incidental catch. Although we obtained no data on the relative density of turtles in this portion of the channel, USACOE trawling was conducted seaward of zone E during August and September. Turtles were captured during the September cruise period, but the average number of turtles captured per paired trawl tow was only 0.06 (Nelson, USACOE Waterways Experiment Station, unpublished data). In contrast, the average number of turtles we captured in zones A-E during the same time period was 0.25 turtles per paired trawl tow. Therefore it is likely that turtle densities are lower in the outer portion of the Charleston entrance channel compared to the area we surveyed.

The difference in turtle catch rates during the day versus the night was not statistically significant, and we observed no clear patterns in turtle capture rates during various hours of the day or night when samples from all months were considered together. Trawl sampling conducted in the Brunswick, Georgia entrance channel has also not shown any clear patterns in turtle capture rates during the day versus the night (Nelson; USACOE Waterways Experiment Station, unpublished data). The slightly higher CPUE estimates obtained from our night tows in the Charleston channel may be related to turtle resting behavior. Nelson et al. (l987) observed that *Caretta caretta* were at the surface approximately 8% of the time during the day and only 4% of the time at night. Hopkins and Murphy (l981) also observed reduced activity of adult turtles during the night. If turtles were on the bottom for longer periods of time during the night, they may be more susceptible to capture by trawls or a dredge. More sampling is needed to determine whether there are diurnal differences in turtle capture rates in other channels.

In conclusion, data obtained from this survey indicates that turtle densities in the Charleston entrance channel are sufficient to warrant concern over mortality from dredging operations. The seasonal changes in abundance of *Caretta caretta* in the survey area, which encompasses the area where most maintenance dredging occurs, indicates that turtle mortalities could be reduced or avoided if dredging is restricted to periods when water bottom temperatures are below 16° C. Further studies are required to resolve how variable turtle densities are in this channel among years, especially since the bottom characteristics have been altered significantly by the deepening project. Additional sampling may also resolve whether the window of dredging opportunity could be expanded based on turtle densities relative to water temperature. The regional trawl survey planned for several major entrance channels throughout the southeast should address many of the research needs identified in this study.

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Appendix 1. Summary of trawling activity conducted in the Charleston Harbor entrance channe and average bottom water temperatures during each cruise.

Month	Total Number of Turtles	Total Number of Trawls	Total Minutes Trawled	Average No. Turtles/ Trawl	Average No. Turtles/ Paired Trawl	Average Water Temp. (celcius)
September 5-6, 1990	3	42	822	0.07	0.14	28.2
September 19-20	5	35	571	0.14	0.29	27.2
October 1-4	5	46	828	0.11	0.22	25.1
November 19-20	2	48	826	0.04	0.08	17.8
December 5-6	1	48	832	0.02	0.04	16.4
January 3-4, 1991	0	46	836	0.00	0.00	14.2
February 25-26	0	48	836	0.00	0.00	12.9
March 19-21	0	48	824	0.00	0.00	13.9
April 2-5	2	47	812	0.04	0.09	17.3
April 23-25	1	48	794	0.02	0.04	18.9
May 14-16	6	48	824	0.13	0.25	24.2
June 10-12	3	44	712	0.07	0.14	24.4
July 9-11	12	48	842	0.25	0.50	28.5
August 12-14	5	50	860	0.10	0.20	27.1
September 9-11	6	48	840	0.13	0.25	26.8
September 23-25	6	38	642	0.16	0.32	24.5
October 21-22	2	36	656	0.06	0.11	21.2
Nov-07	2	18	154	0.11	0.22	17.9
November 19-21	0	54	604	0.00	0.00	15.3
December 5-6	0	36	610	0.00	0.00	14.1
Total	61	876	14725	0.07	0.14	

Appendix 2. Summary of turtles captured in the Charleston Harbor entrance channel from September, 1990 through December 1991. * identifies turtles which were recaptured.

Date	Light Phase	Strata	Species	Sex	S. L. Length	S. L. Width	O. C. Length	O. C. Width	Tag Number	Release (Loran	Location Coords.)
9/5/90	D	D1	C. caretta	I	47.5	41.0	51.0	49.5	NMC899	45480.5	60494.3
9/7/90	N	A3	C. caretta	I	57.0	47.0	61.0	58.0	NMC900	45490.3	60494.3
9/7/90	N	D3	C. caretta	I	66.0	53.0	68.0	63.0	PPV890	45470.9	60476.7
9/19/90	D	D2	C. caretta	I	65.0	55.0	71.5	69.0	PPV897	45487.9	60488.2
9/19/90	D	D2	C. caretta	I	56.0	54.0	65.0	66.0	PPV898	45487.9	60488.2
9/19/90	N	D1	C. caretta	I	60.0	50.0	66.0	62.0	PPV892	45475.9	60477.4
9/20/90	N	D3	C. caretta	I	55.0	54.0	61.0	70.0	PPV896		
9/20/90	N	D3	C. caretta	I	86.0	68.0	92.0	92.0	14341		
9/20/90	N	E3	C. caretta*	I	60.0	50.0	66.0	62.0	PPV892		
10/1/90	D	D3	C. caretta	I	65.0	51.0			PPV893	45485.6	60480.9
10/3/90	N	D2	C. caretta	I	55.0	44.0	56.0	51.0	PPV895	45473.0	60485.8
10/3/90	N	E3	C. caretta	I	60.0	49.0	61.0	56.0	PPV899	45476.3	60492.9
10/3/90	N	D3	C. caretta	I	77.0	60.0	80.0	73.0	AAC280	45476.3	60492.5
10/3/90	N	E2	C. caretta	I	79.0	59.0	80.0	75.0	AAC281	45476.3	60492.5
11/18/90	D	D1	C. caretta	I	66.0	54.5	71.0	63.0	PPV900	45470.0	60484.2
11/20/90	D	E2	C. caretta	I	67.0	64.0	70.5	65.0	QQH525		
12/6/90	N	D3	C. caretta	I	57.0	48.0	64.0	61.5	QQH501	45483.1	60497.2
4/2/91	D	B3	C. caretta	I	85.5	66.0	91.0	84.0	AAC282	45481.0	60495.9
4/5/91	N	E1	C. caretta	I	52.0	44.5	59.0	54.0	QQH502	45479.2	60482.6
4/5/91	D	D2	C. caretta	I	61.3	50.0	66.0	62.0	QQH503	45476.7	60480.6
5/14/91	D	B1	C. caretta*	I	64.0	54.5	73.0	69.5	PPV897	45488.3	60489.0
5/15/91	N	B1	C. caretta*	I	64.0	52.0	69.5	64.5	PPV900	45488.6	60488.8
5/16/91	N	B2	C. caretta	I	88.5	69.0	96.5	87.5	AAC300	45483.7	60481.6
5/16/91	N	B2	C. caretta								
5/16/91	N	D3	C. caretta	I	70.0	58.0	77.5	74.5	AAC299	45472.1	60475.2
5/16/91	N	D2	C. caretta	M	95.5	75.5	101.0	92.0	QQH505	45481.3	60483.5
6/10/91	D	D1	C. caretta*	I	57.0	52.5	66.0	64.0	PPV898	45472.3	60475.2
6/10/91	D	A2	C. caretta	I	61.5	49.2	68.0	60.5	QQH524	45484.8	60494.8
6/12/91	N	D3	C. caretta	I	53.0	43.0	70.5	52.5	QQH508	45470.9	60473.4
7/9/91	D	D2	C. caretta								
7/9/91	D	D2	C. caretta	I	87.0	65.5	92.0	85.0	QQH509	45469.3	60480.1
7/9/91	D	D2	C. caretta	I	69.0	57.0	74.0	67.0	QQH510	45469.3	60480.1
7/9/91	D	E3	C. caretta	I	56.0	47.5	60.5	56.5	QQH511	45471.0	60481.6
7/9/91	D	D1	C. caretta*	I	54.0	44.0	58.0	55.0	PPV895	45470.8	60476.1
7/9/91	D	E2	C. caretta	I	57.5	47.0	62.0	60.5	QQH512	45478.2	60477.1
7/10/91	N	D3	C. caretta	I	87.0	70.0	95.0	91.0	QQH516	45468.0	60477.3
7/10/91	N	D3	C. caretta	I	70.0	53.0	76.0	69.5	QQH513	45468.1	60477.1
7/11/91	N	B2	C. caretta	I	56.0	46.0	61.0	57.5	QQH517	45486.9	60497.4
7/10/91	N	B3	C. caretta	I	54.0	49.5	61.0	58.0	QQH518	45486.9	60497.4

Date	Light Phase	Strata	Species	Sex	S. L. Length	S. L. Width	O. C. Length	O. C. Width	Tag Number	Release (Loran	Location Coords.)
7/10/91	N	A2	C. caretta	I	87.0	67.5	93.5	84.5	QQH520	45486.9	60497.4
7/10/91	N	A2	C. caretta	I	63.9	52.0	69.5	65.5	QQH519	45486.9	60497.4
8/13/91	N	D3	C. caretta	I	62.5	53.0	67.5	64.5	QQH557	45471.5	60487.1
8/13/91	N	D3	C. caretta	I	65.0	62.0	68.5	66.5	QQH558	45471.5	60487.1
8/13/91	N	D3	C. caretta	I	76.5	60.0	81.0	74.0	QQH559	45471.5	60487.1
8/13/91	N	E2	C. caretta	I	79.0	63.0	87.0	78.0	QQH575	45471.5	60487.1
8/13/91	N	E3	C. caretta*	I	57.5	47.0	81.0	59.0	QQH512	45475.7	60471.5
9/9/91	D	B2	C. caretta*	I	67.0	56.0	71.5	67.0	PPV897	45487.9	60483.0
9/10/91	N	B2	C. caretta	I	61.5	50.0	65.5	61.0	QQH522	45487.5	60503.0
9/10/91	N	B1	C. caretta	I	59.0	49.5	64.0	60.0	QQH574	45487.5	60503.0
9/11/91	N	D1	C. caretta	I	88.0	67.0	96.0	84.0	QQH571	45471.1	60486.6
9/11/91	N	D1	C. caretta	I	71.0	58.0	76.5	75.0	QQH573	45471.1	60486.6
9/11/91	N	E3	C. caretta	I	85.0	66.0	93.0	82.0	QQH565	45471.1	60486.6
9/23/91	D	D2	C. caretta*	I	58.0	48.5	62.0	59.0	QQH574	32 39.53	79 43.81
9/23/91	D	D3	C. caretta	I	73.5	60.5	77.0	74.0	QQH512	32 39.53	79 43.81
9/23/91	D	B2	C. caretta	I	62.0	56.5	66.0	65.0	QQH578	32 39.53	79 43.81
9/24/91	N	B2	C. caretta	I	69.0	56.0	72.0	70.0	QQH570	45483.3	60499.4
9/25/91	N	D2	C. caretta	I	55.0	47.0	61.5	57.0	QQH567	45474.6	60491.9
9/25/91	N	D3	C. caretta*	I	88.5	69.0	89.0	82.0	QQR143	45474.6	60491.9
10/21/91	N	D2	C. caretta	I	69.0	55.0	74.5	69.5	QQH581	45484.2	60500.6
10/22/91	N	D3	C. caretta	I	71.0	57.0	77.5	69.5	QQH583	45479.6	60495.1
11/7/91	D	B3	C. caretta	I	57.5	52.0	61.5	61.0	QQH586	45477.7	60489.6
11/7/91	D	D3	L. kempi	I	36.0	35.0	37.0	37.5	QQH587	45477.7	60489.6