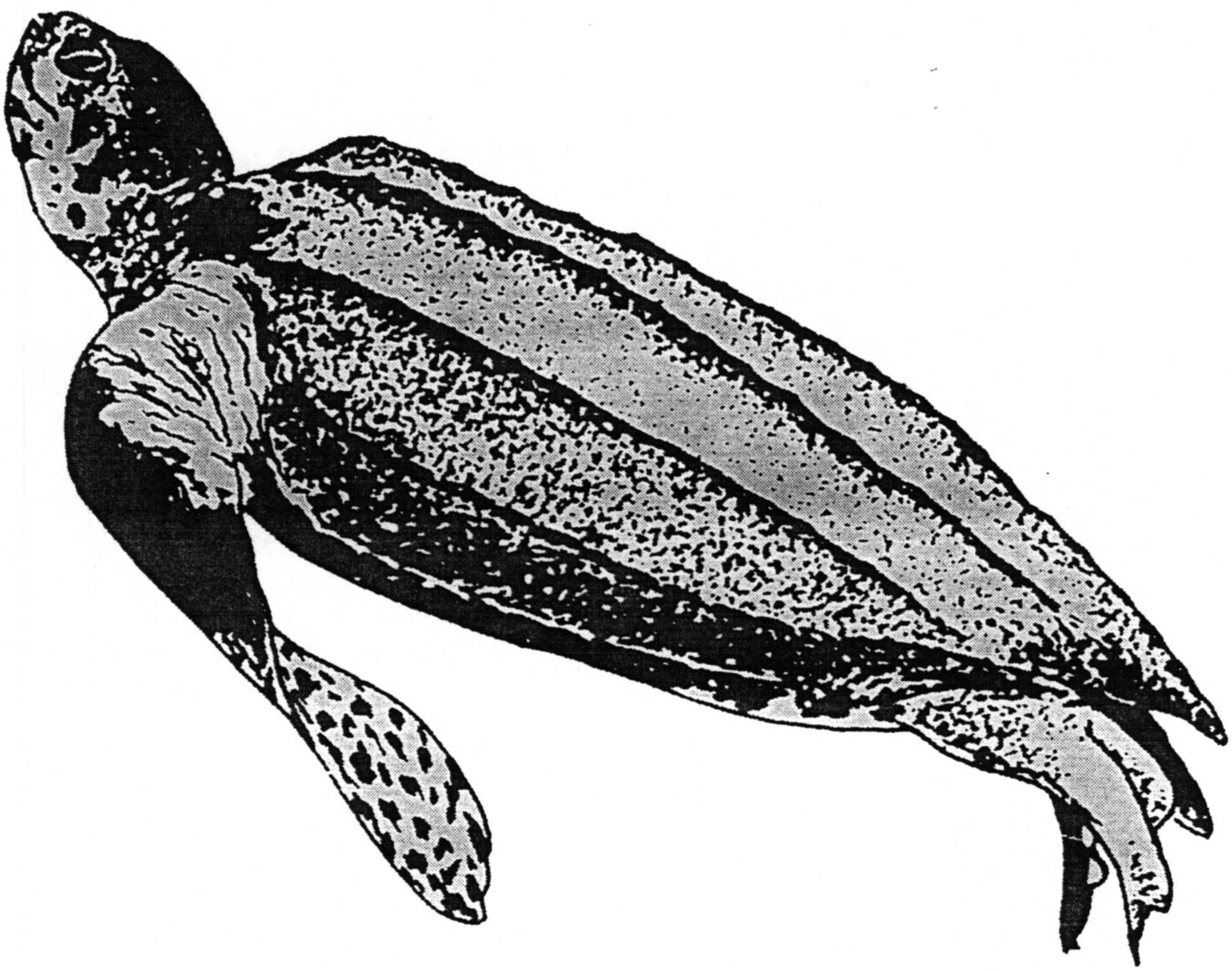
OCS Study
MMS 95-0024

Abundance and Distribution of Sea Turtles off North Carolina



U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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Abundance and Distribution of Sea Turtles off North Carolina

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EXECUTIVE SUMMARY

The coastal area immediately adjacent to Cape Hatteras, NC is a major migratory pathway for loggerhead (Caretta caretta), leatherback (Dermochelys coriacea), and Kemp's ridley (Lepidochelys kempii) sea turtles (CeTAP, 1982a, 1982b; Keinath et al., 1989; Sauls et al., 1990; Lee and Palmer, 1981; Musick et al., 1985b; Epperly and Veishlow, 1989; Shoop and Kenney, 1992). During spring, turtles migrate from the south past Cape Hatteras to summer in northern waters. Juvenile loggerheads and ridleys enter estuaries such as Chesapeake Bay, Long Island Sound, and Cape Cod Bay, while the leatherbacks travel as far north as Newfoundland and possibly farther (Bleakney, 1965; CeTAP 1982a, 1982b; Danton and Prescott, 1988; Goff and Lien, 1988; Lazell, 1980; Lutcavage, 1981; Morreale and Standora, 1989; Shoop and Kenney, 1992; Shoop et al., 1981; STSSN, 1991). When water temperatures fall in the autumn, turtles return to south of Cape Hatteras, as far as the Atlantic coast of Florida, to overwinter (Keinath et al., 1989). During these migrations in the spring and fall months, turtles are concentrated as they pass through the Cape Hatteras region, probably because of the narrowness of the continental shelf in the area (Anon., 1992). During the summer months, some turtles may take up residency off the North Carolina coast, but the density is lower than during migration (CeTAP, 1982a, 1982b; Epperly and Veishlow, 1989; Lee and Palmer, 1981). Mobil Oil submitted a plan to drill a single exploratory well 45 miles east-northeast of Cape Hatteras, NC. Therefore, the Minerals Management Service (MMS) is funding a closer look at the distribution, abundance, and migration patterns of sea turtles in the area to help evaluate the potential for impact on endangered and threatened sea turtle species.

OBJECTIVES

The objectives of this study were to:

1. Analyze and/or summarize existing aerial survey, satellite telemetry, and stranding data;

2. Conduct additional aerial surveys near Cape Hatteras; and

3. Track Kemp's ridley turtles utilizing satellite telemetry.

These data were used to define the migration and temporal and spacial distribution and abundance of sea turtles in the area to determine habitat usage and number of turtles which utilize the area.

METHODS

The Virginia Institute of Marine Science (VIMS) Sea Turtle Research Project has conducted aerial surveys covering the area between Cape Henry, VA, to Cape Hatteras (Diamond Shoals Light), NC, from 1985 to 1989 to estimate abundance of loggerhead turtles in the area (Keinath et al., 1987). For this study, we initiated surveys in 1991 from approximately Oregon Inlet to Hatteras Inlet. Three areas were surveyed; from 75.0 km to 18.5 km north of Cape Hatteras (northern zone), from 18.5 km north to 18.5 km south of Cape Hatteras (middle zone), and from 18.5 to 75.0 km south of Cape Hatteras (southern zone) to follow the migratory movements of turtles north and south of the study area. All surveys were flown to 27.8 km offshore. Following our established protocol, surveys were flown at an altitude of 152 meters, and at a speed of 130 km/hr (Musick et al., 1987; Byles, 1988). Two observers, one on each side of the airplane, scanned the sea surface and recorded the occurrence of turtles and other sea creatures.

Loggerhead and leatherback sea turtles are easily recognized from the air, thus we directly calculated the density of these two species from the survey data. But small size and cryptic coloration make ridleys difficult to detect from an airplane. For the purpose of this study, we assumed ridley and loggerhead turtles strand in proportion to the population size of each species in the area, and we applied the ratio of stranded ridleys to stranded loggerheads to our aerial survey density estimates of loggerheads to calculate the density of ridleys in the area. This method of estimating Kemp's ridley abundance has weaknesses, but it is the best and only method to estimate Kemp's ridley abundance. Because Kemp's ridleys inhabit shallow estuarine foraging grounds during mid-summer months (Musick, 1988; Morreale and Standora, 1989; Ogren, 1989), they are largely absent from stranding data during those months. Thus, stranding data for spring and fall (when ridleys and loggerheads are actively migrating along the coast) were used to estimate Kemp's ridley densities at those times.

Since only turtles at the surface of the water are observed on aerial surveys, a correction factor can be used to account for submerged turtles (Bellmund et al., 1987; Byles, 1988; Keinath, 1986; Keinath et al., 1987; Musick et al., 1985b; Musick et al., 1992; Standora et al., 1984). If the amount of time a turtle spends at the surface is known, an adjustment factor can be calculated as the inverse of the proportion of time spent at the surface. The diving data required to calculate the adjustment factor for loggerhead and leatherback turtles was obtained by satellite telemetry. Satellite tags were attached with fiberglass to 9 loggerheads (two adults, 7 juveniles) and seven ridleys (one mature, six juveniles). From this data, an adjustment factor was calculated to determine the number of turtles represented by each turtle observed at the surface, and by multiplying this factor by the relative density, an estimate of population density was obtained.

In addition to diving data, satellite telemetry was used to track movements of the sea turtles. This method has been successfully utilized to gather location data of sea turtles since 1985 (Byles, 1982; Byles and Keinath, 1991; Keinath, et al., 1989). All this data was utilized to describe movement, migratory patterns, and habitat use.

RESULTS

Density estimates of surfaced loggerheads in the 1985-1989 study ranged from 0 (in December) to 0.372 turtles km^{-2} (in early May 1986). In the 1991-1992 study density estimates of loggerheads at the surface north of Cape Hatteras ranged from 0 (in August 1991 and January, early April, June and September 1992) to 0.314 turtles km^{-2} (in early July 1992). Density ranged from 0 (in January and early April 1992) to 0.314 turtles km^{-2} (in early July 1992) for the northern zone, from 0 (in June 1992) to 0.187 turtles km^{-2} (in early April 1992) in the middle zone, and from 0 (in August 1991, June and September 1992) to 0.179 turtles km^{-2} (early April 1992) in the southern zone. Diving data from three satellite telemetered loggerheads showed that the turtles migrating south along the North Carolina coast stayed at the surface 10.6% of the time, providing an adjustment factor of 9.4 to compensate for submerged turtles not observed, yielding population density estimates up to 2.952 turtles km^{-2} (2.952 turtles km^{-2} in the northern zone, 1.758 turtles km^{-2} in the middle zone, and 1.683 turtles km^{-2} in the southern zone). In general, highest densities were observed in the spring (May and June), and lowest in late summer and autumn, while during the summer months, densities fluctuated. Up to 4,500 loggerheads were estimated to travel through the area annually.

The ratio of stranded ridleys to loggerheads ranged up to 0.2500, providing population estimates up to 0.738 ridleys km^{-2}. However, during some years the flounder trawl fishery interacts with turtles migrating south in the autumn, and incurs high mortality on sea turtles. Because Kemp's ridley is a summer estuary inhabitant, we feel that the ratio for this period (0.1095) is most representative for calculating standing stock of ridleys from stranding ratios. This provides population estimates for ridleys up to 493.72 turtles in the northern zone, up to 171.69 turtles in the middle zone, and up to 224.10 turtles in the southern zone.

Few leatherback turtles were observed, and surface density estimates ranged up to 0.072 turtles km^{-2} when observed. No dive data is available for leatherbacks off North Carolina's coast. A leatherback turtle tracked in the Caribbean was at the surface 13.1% of the time, yielding an adjustment factor of 7.6, providing estimated population densities up to 0.532 turtles km^{-2} (Keinath and Musick, 1994).

Data from aerial surveys and satellite telemetry show that turtles migrate from waters north of Cape Hatteras in the autumn, rounding Cape Hatteras during October and November. Once south of Hatteras, telemetered turtles either became pelagic in deep offshore waters (two loggerheads), travelled nearshore to Florida (two loggerheads and two ridleys), overwintered off North Carolina in the west side of the Gulf Stream (three loggerheads), or transmissions ceased shortly after rounding the Cape. One loggerhead which overwintered off Florida and three which overwintered off North Carolina returned to the Chesapeake Bay the following year, rounding Cape Hatteras during May. These movements were supported by aerial survey data.

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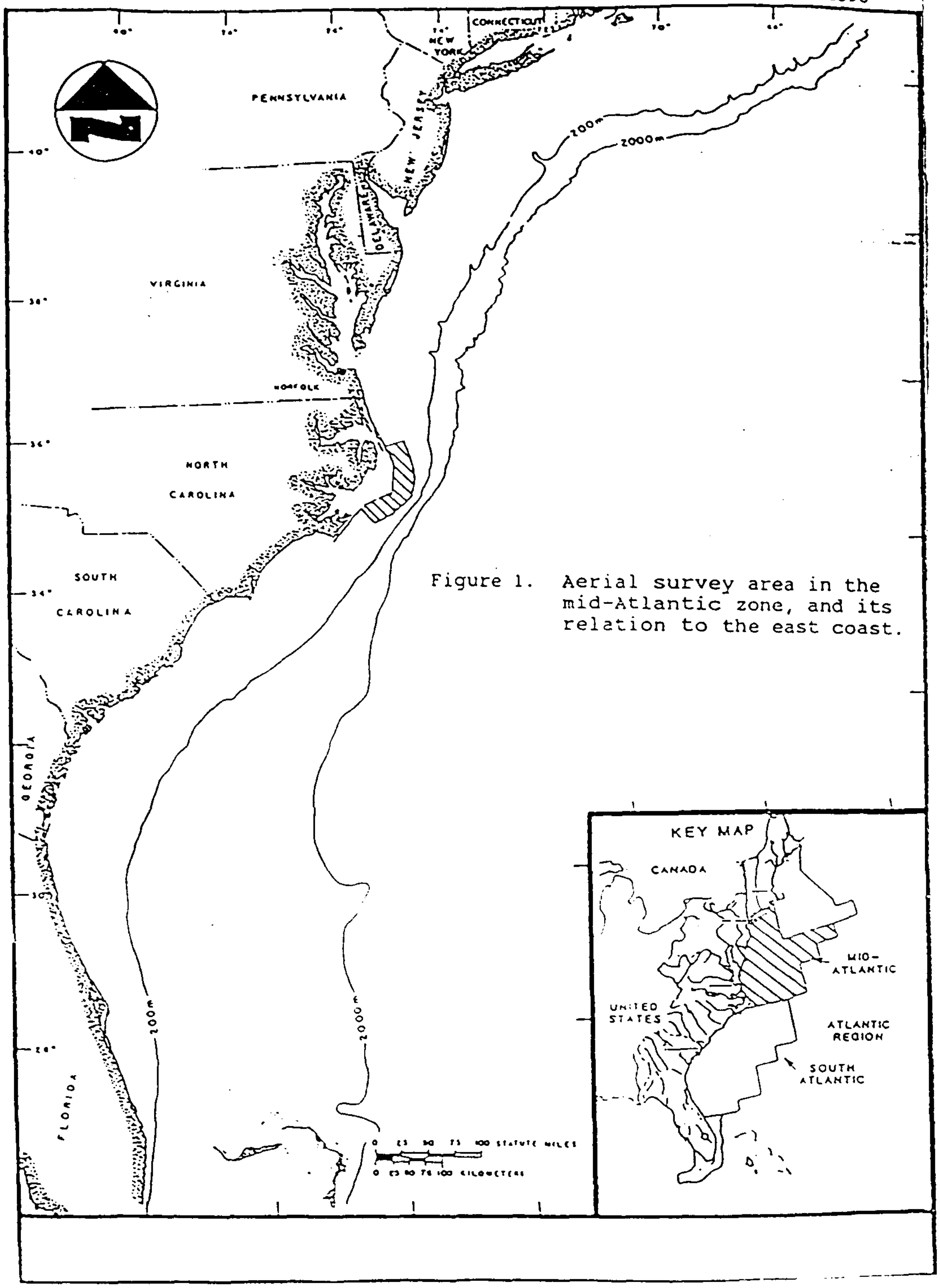

Figure 1. Aerial survey area in the mid-Atlantic zone, and its relation to the east coast.

1. INTRODUCTION

In 1982 the Minerals Managements Service (MMS) assumed responsibilities for leasing submerged Federal lands. One of the priority goals assigned to the MMS is the protection of the marine and coastal environments. This includes conducting studies in areas or regions of lease sales to ascertain the "environmental impacts on the marine and coastal environments of the Outer Continental Shelf and coastal areas which may be affected by oil and gas development" (Weetman, 1991). Mobil Oil has leased an area 64 km off Cape Hatteras, North Carolina (Manteo Block 467; Figure 1) and has cited the Manteo unit as an area for drilling a single exploratory well (Weetman, 1991). This area is most likely to produce gas rather than oil, up to 5 trillion cubic feet - a 34 year supply for the State of North Carolina at the present rate of consumption (Weetman, 1991). However, petroleum drilling activities may possibly affect sea turtles (Balazs, 1985; Carr, 1987; Chan and Liew, 1988; Coston-Clements and Hoss, 1983; Lee and Socci, 1989; Lutcavage, 1994; Plotkin and Amos, 1988; Ross et al., 1989; Stanley et al., 1988; Vargo et al., 1986), which may inhabit the area, and are considered threatened or endangered by the federal government (CFR , 1987).

The coastal area immediately adjacent to Cape Hatteras, NC is a major migratory pathway for loggerhead (Caretta caretta), leatherback (Dermochelys coriacea), and Kemp's ridley (Lepidochelys kempii) sea turtles (CeTAP, 1982a, 1982b; Epperly and Veishlow, 1989; Keinath, 1993; Keinath and Musick, 1990, 1991a, 1991b, 1991c; Keinath et al., 1992; Lazell, 1980; Lee and Palmer, 1981; Musick et al., 1987, 1994; Shoop and Kenney, 1992; Shoop et al., 1981), this close association to shore is probably due to the narrowness of the Continental Shelf and position of the Gulf Stream, which limits the offshore occurrence of turtles (Epperly and Veishlow, 1989; Fritts et al., 1983a, 1983b; Hoffman and Fritts, 1982; Musick et al., 1987, 1994; Schroeder and Thompson, 1987; Thompson, 1984). During spring, turtles migrate from as far south as Florida past Cape Hatteras to summer in northern waters (Barnard et al., 1989; Burke, 1990; Burke and Standora, 1993; Burke et al., 1991; CeTAP, 1982a, 1982b; Keinath, 1993; Killingley and Lutcavage, 1983; Meylan and Sadove, 1986; Morreale and Standora, 1989; Morreale et al., 1992; Sauls et al., 1990; Shoop, 1987; Shoop and Kenney, 1992; Shoop et al., 1981; Thompson, 1988). Juvenile loggerheads and Kemp's ridleys enter estuaries such as Chesapeake Bay, Long Island Sound, and Cape Cod Bay, while the leatherbacks travel as far north as Newfoundland and possibly farther (Bellmund et al., 1987; Bleakney, 1965; Danton and Prescott, 1988; Goff and Lien, 1988; Keinath et al., 1987a, 1987b, 1989; Lazell, 1980; Lutcavage, 1981; Lutcavage and Musick, 1985; Meylan and Sadove, 1986; Morreale and Standora, 1989; Morreale et al., 1992; Musick, 1988; Musick et al., 1985a, 1985b, 1987; Shoop, 1980, 1987; Shoop and Kenney, 1992; Shoop et al., 1981). When water temperatures fall in the autumn, turtles return to south of Cape Hatteras to overwinter (Bellmund et al., 1987; CeTAP, 1982a, 1982b; Keinath, 1993; Keinath and Musick, 1990; Keinath, et al., 1989; Lazell, 1980; Shoop, 1987; Shoop and Kenney, 1992; Shoop et al., 1981). During migration in the spring and fall months, turtles passing through the Cape Hatteras region are concentrated along the shallow nearshore waters, probably because of the narrowness of the continental shelf in the area (Anon., 1992; Epperly et al., 1989).

During summer months, some turtles also may take up residency off the North Carolina coast, but the density of turtles at this time may be lower than during migration (Epperly and Veishlow, 1989; Epperly et al., 1989; Keinath, 1993; Keinath et al., 1989; Musick et al., 1989). Satellite telemetry, stranding data, and aerial surveys were used to describe the temporal and spatial occurrence, movements, migratory patterns, habitat use, and population characteristics of sea turtles in the coastal area near Cape Hatteras. These were used to determine habitat utilization and sea turtle abundance in the Manteo Block area.

Objectives

The objectives of this study were to:

1. Analyze and/or summarize existing aerial survey, satellite telemetry, and stranding data;

2. Conduct additional aerial surveys near Cape Hatteras; and

3. Track Kemp's ridley turtles utilizing satellite telemetry.

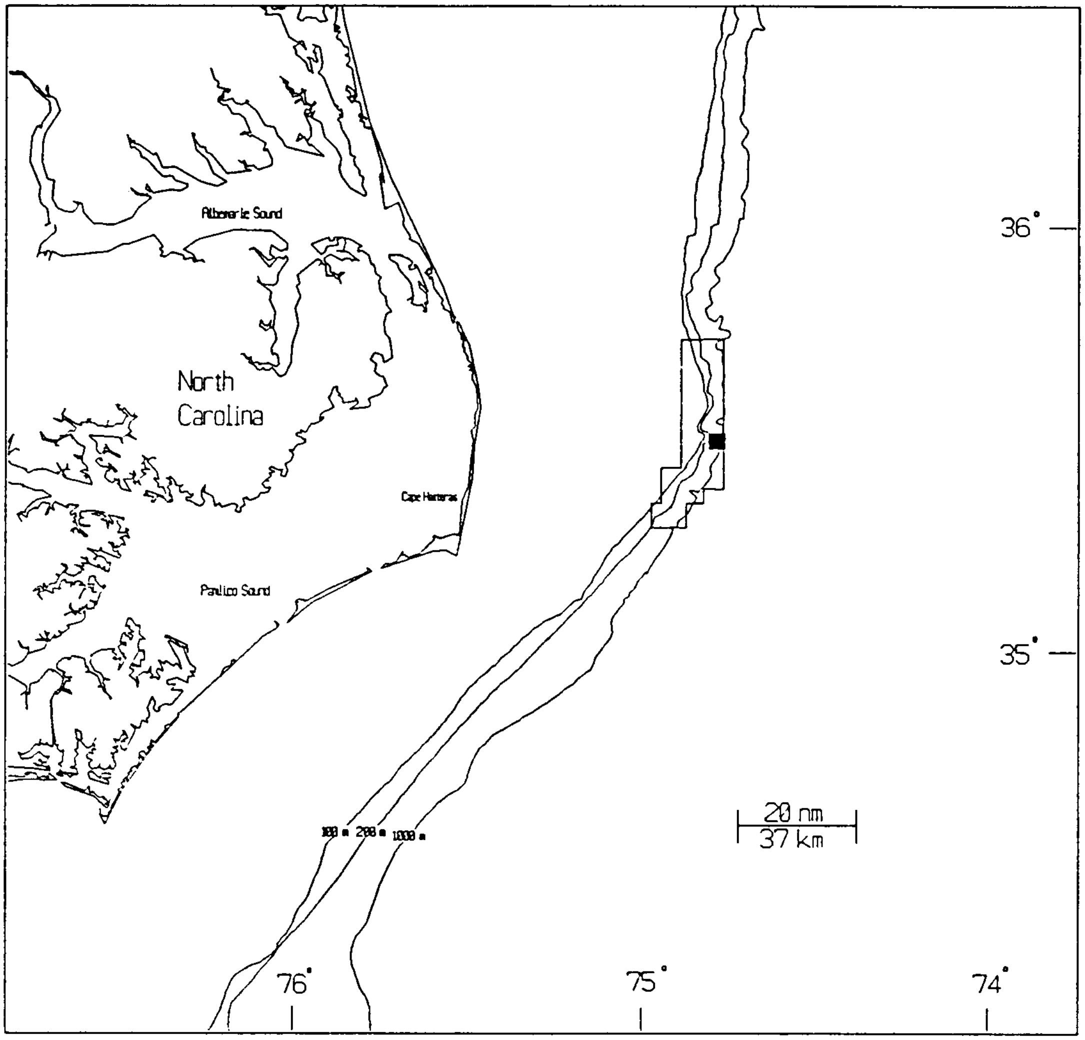

Figure 1. Manteo Block (enclosed area), and the proposed exploratory Mobil drill site (black area).

2. METHODS

Satellite telemetry

Satellite transmitters were affixed to the top of turtle's carapaces at the highest dome and secured with fiberglass. We used the Argos system to track seven Kemp's ridley and nine loggerhead sea turtles for up to 271 days. Prior to release, either inside Chesapeake Bay or on the adjacent Atlantic coast, turtles were held in an enclosed facility in tanks containing filtered water of the same temperature, salinity, and light condition as their natural environment.

Satellite telemetry uses UHF transmitters which transmit signals to a satellite which in turn relays them to an earth station. The Argos satellite telemetry system utilizes NOAA Tiros satellites to calculate transmitter location by doppler shift of the transmitter's radio frequency (Kenward 1987), and also allows transmission of digital data collected by transmitter sensors. Data collected by on board sensors has included water temperature and precise diving/surfacing data (Byles, 1989; Byles and Dodd, 1989; Keinath, 1991; Keinath et al. 1989), and a depth sensing prototype (Byles and Keinath, 1990) has been developed. A salt water switch was used to determine dive parameters, and the switch also served to turn the transmitter off while underwater (UHF radiowaves do not travel through seawater) in order to extend the battery life. Data is transmitted from satellites to ground stations, and processed and disseminated by Argos (Byles and Keinath, 1990; Keinath, 1991). Data can be accessed via computer and modem, and back up diskettes or print-outs of monthly data are available from Argos. Location, parameters sent by the transmitter, day and time of reception, and probability of location accuracy are among data received. In contrast to radio and sonic telemetry, which can provide continuous data, the Argos system provides only a limited number of daily fixes, depending on latitude (Kenward, 1987). Since Tiros satellites are polar orbiting, more fixes are possible at higher latitudes (up to 15 per day) than at the equator (up to seven per day). The probability of receiving a location is further decreased because the transmitter is below the surface most of the time. Up to two fixes per day have been received from wild loggerhead turtles tracked off the east coast of the US (Keinath, 1993), although there are occasions when no positions are recorded for days. Temperatures recorded from the transmitters were plotted against date if significant north or south movements were made, or if the track was long term (> 3 months). Data was analyzed to describe movement, migratory patterns, and habitat use of sea turtles around Cape Hatteras.

Aerial surveys

Aerial surveys provide a quantitative assessment of seasonal standing stocks of the sea turtles off Cape Hatteras based on randomly stratified flight lines over the area. This design yields estimates of seasonal abundance with related confidence intervals. The VIMS Sea Turtle Research Project has conducted 40 aerial surveys covering the area between Cape Henry to Cape Hatteras (Diamond Shoals Light) since 1985 to estimate density of loggerhead turtles in the area (Figure 2, Appendix 17). Twenty surveys were flown during 1986, 15 in the northern zone and five in the southern zone (Figure 2). From 1987 to 1989 ten surveys were flown, eight in the northern zone and two in the southern zone. We performed ten surveys from approximately Oregon Inlet to Hatteras Inlet during 1991 and 1992 specifically for this project. Three areas were surveyed during each flight (with one exception), one from 75.0 km to 18.5 km north of Cape Hatteras (northern zone), one from 18.5 north to 18.5 km south of Cape Hatteras (middle zone), and one from 18.5 to 75.0 km south of Cape Hatteras (southern zone) from shore to 27.8 km offshore to determine relative abundance of migratory turtles north and south of the area of interest (Figures 3, 4). Following our established protocol (Bellmund et al., 1987; Blaylock, 1992; Byles, 1988; Epperly and Veishlow, 1989; Epperly et al., 1990; Keinath, 1993; Keinath et al., 1987a, 1987b, 1991, 1992; Musick, 1986. 1988; Musick et al., 1985a, 1985b, 1987, 1989, 1994)., surveys were flown in a De Havilland U-6A Beaver at an altitude of 152 m, and at a speed of 130 km/hr. Two observers, one on each side of the plane, scanned the sea surface for turtles and other sea creatures. When an animal was sighted, the following data were taken:

1) Sighting angle from the transect line

2) Time of observation

3) Species

The sighting angle was measured with a clinometer (Suunto PM-5) and is used to determine the distance each animal is from the transect line. Since turtles are rarely sighted under the airplane (0-50 m) and sighting efficiency drops off dramatically beyond 300 meters (see results), the effective visual swath surveyed is 250 meters on each side of the plane. Thus density of turtles can be calculated as:

$$D = N / A$$

where D = density of turtles observed

N = number of turtles observed

A = area surveyed

and: $A = (O * W) * L$

where O = number of observers (2 in the present study)

W = survey strip width (250 m in this study)

L = length of survey line

Thus, for this study

$$D = N / (0.5 \text{ km} * L)$$

This model assumes all turtles at the surface in the 250 m strip on each side of the plane are observed. Epperly and Veishlow (1989) and Epperly et al. (1993) deployed different sized turtle models and found size (30 - 90 cm length) was not a significant factor in the observer's ability to sight turtles, and that an average of 97.2% of turtles at the surface within the strip were sighted. This supports the assumption that virtually all turtles at the surface are observed on a survey.

Byles (1988) compared this 'strip transect analysis' to a more complicated Hermite polynomial function ('line transect analysis'; Burnham et al., 1980) which accounts for turtles at the surface but not seen by observers, and found that both methods produced similar results (eg. means of 423 vs 372 turtles in his study area). Epperly et al. (1990, 1993) discussed limitations, assumptions, and differences in strip versus line transect analysis, and concluded that strip transect methods "assuredly" underestimate density of turtles at the surface, while line transect methods may either over or underestimate densities. Thus we, like Byles (1988) and Epperly et al. (1993), chose to use the truncated strip transect analysis to calculate turtle densities because it is more direct and intuitively understandable to a broader audience. Geometric means and confidence intervals (95%) of loggerhead turtle densities were calculated utilizing each flight line as a replicate using a log(x+1) transformation (Sokal and Rohlf, 1981) on PC-SAS. Mean densities of leatherback turtles were calculated in the same manner, but because of the very small number of leatherbacks sighted, confidence intervals were not calculated.

Since only turtles at the surface of the water are observed on aerial surveys, a correction factor must be used to account for submerged turtles (Bellmund et al., 1987; Byles, 1988; Dodd and Byles, 1991; Keinath, 1986; Keinath et al., 1987a, 1987b; Musick et al., 1985b; Musick et al., 1992; Standora et al., 1984). If the amount of time a turtle spends at the surface is known, an adjustment factor can be calculated as the inverse of the proportion of time spent at the surface (Keinath, 1986; Musick et al., 1985a). By multiplying this factor (9.4 for loggerheads, 7.6 for leatherbacks) by the relative density values for the surfaced turtles, an estimate of population density may be obtained. The diving data required to calculate the adjustment factor for this study and previous studies was obtained by satellite telemetry of loggerheads migrating in the Cape Hatteras vicinity and from a leatherback tracked in the Caribbean (Keinath, 1993; Keinath and Musick, 1993; Musick et al., 1992). Estimated standing stocks were calculated for each of the three zones surveyed in 1991 and 1992 by multiplying the estimated population densities by the areas of each zone (north = 1527.4 km^2, middle = 891.9 km^2, south = 1216.0 km^2).

Loggerhead and leatherback sea turtles are easily recognized from the air thus we directly calculated the density of these two species from the survey data. Small size and cryptic coloration make Kemp's ridleys difficult to detect from an airplane. The National Marine Fisheries Service (NMFS) maintains a database of all sea turtles found stranded along the coast of the United States. We utilized data from the Sea Turtle Stranding and Salvage Network centralized database (STSSN, 1991) to document strandings in STSSN zone 35 (35° to 36° north latitude).

Assuming Kemp's ridley and loggerhead turtles strand in proportion to the population size of each species in the area, we applied the ratio of stranded Kemp's ridleys to stranded loggerheads to our aerial survey population estimates of loggerheads to calculate the density of Kemp's ridleys in the area (Keinath et al., 1991, 1994):

$$Nl * (Sr / Sl) = Nr$$

where Nl = estimated density of loggerheads

Sr = number of stranded Kemp's ridleys

Sl = number of stranded loggerheads

Nr = the estimated density of Kemp's ridleys

Though the proportional stranding method of estimating Kemp's ridley abundances has its weaknesses, it is the best and only available method of estimation. Because Kemp's ridleys occupy shallow estuarine foraging grounds during mid-summer months (Byles, 1988; Keinath et al., 1987b), they are largely absent from the survey area during those months (supported by stranding data). Thus we used ratios of stranded Kemp's ridleys to loggerheads for the spring and fall, which are more representative of Kemp's ridley abundance, and better population estimates are achieved.

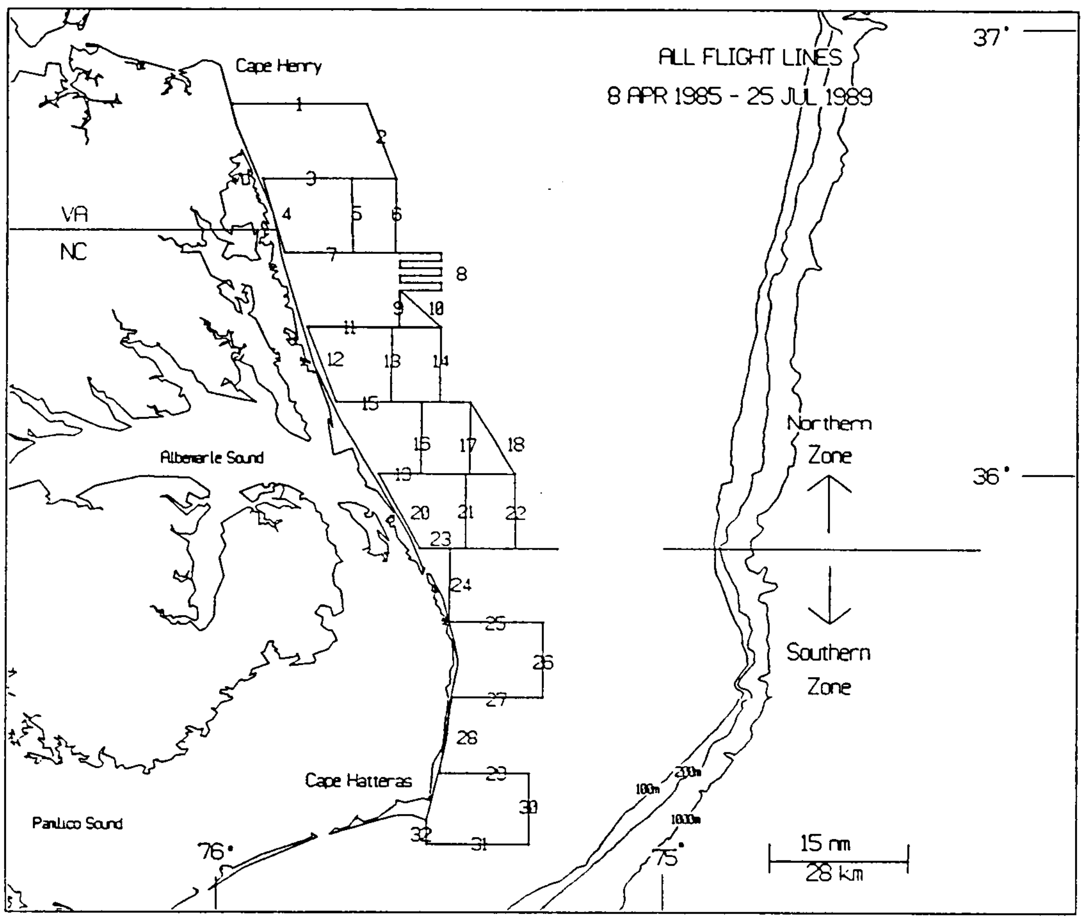

Figure 2. Aerial survey transects flown during 1985 - 1989. Various lines were surveyed on each flight (Appendix 17). The transects were divided into northern and southern zones (adapted from Keinath, 1993; Musick, 1986, 1988; Musick et al., 1987, 1989).

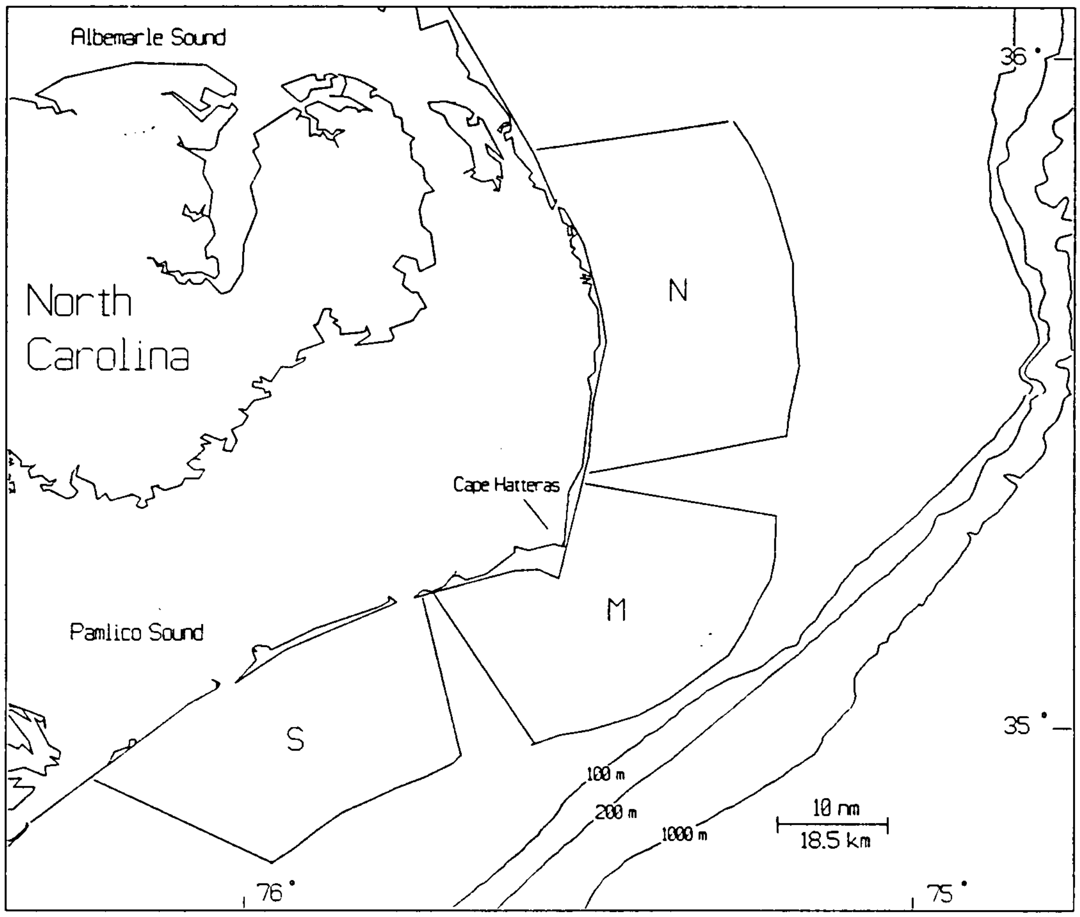

Figure 3. Aerial survey zones flown for this study during 1991 - 1992. Attempts were made to survey all three zones on each flight. N = northern zone, M = middle zone, S = southern zone.

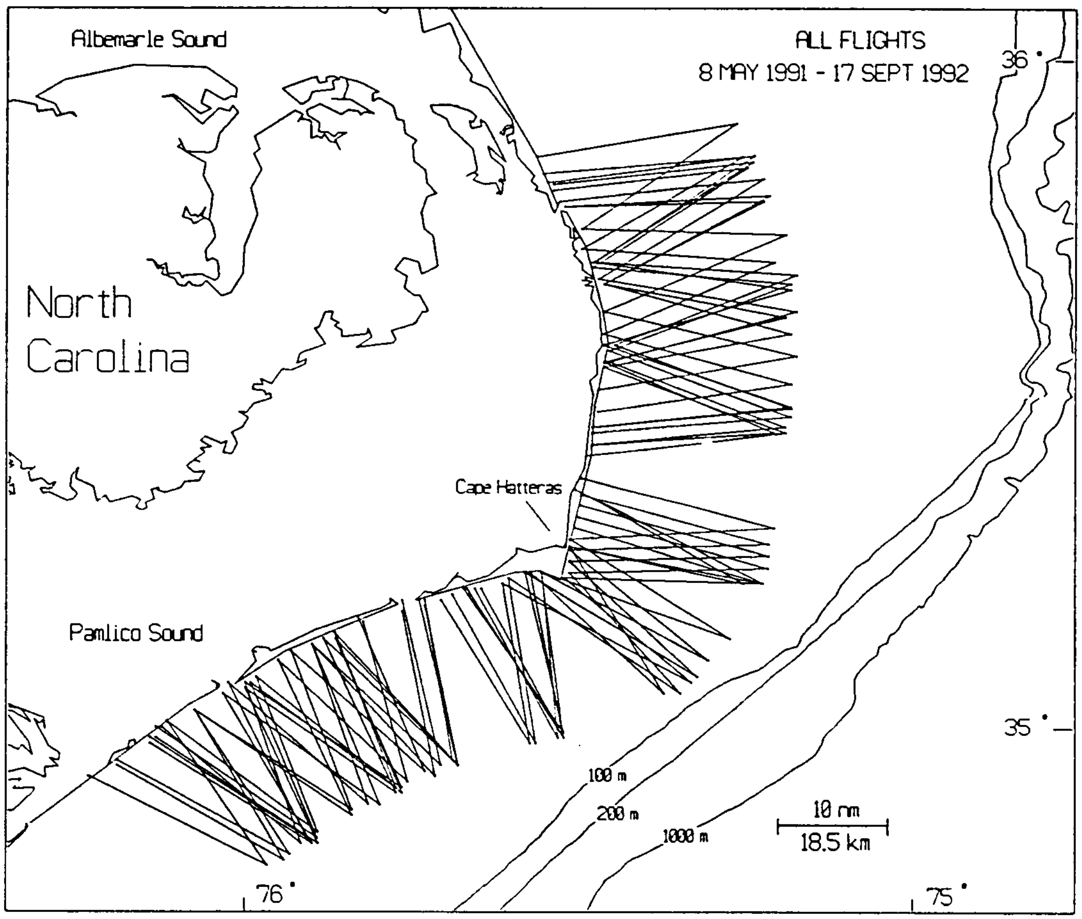

Figure 4. Transects surveyed for this study during 1991 - 1992.

SURVEY METHOD

Distance a turtle is from flight path - 152m × tan(θ), where θ - angle turtle is sighted at.

Only turtles between 50 and 300 meters from flight path (ie. 18° to 63°) used for data analysis.

Survey area for two observers - 2(250 m) × flight path distance, or 0.5 km × flight path distance.

Observed turtle density - turtles seen / area surveyed.

Estimated turtle density - observed density × adjustment factor.

Estimated population - estimated density × area of water body.

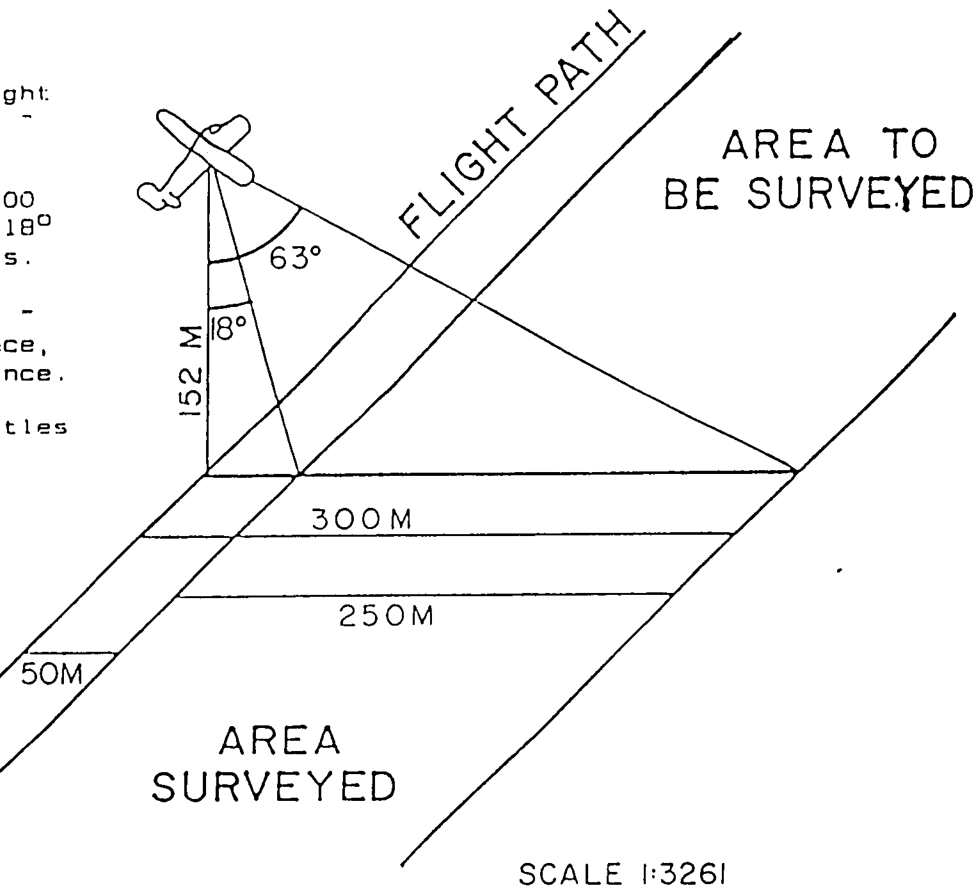

Figure 5. Methods used to estimate turtle density by aerial surveys.

3. RESULTS

Satellite telemetry

In addition to the nine loggerheads we tracked previously (Keinath, 1993), we tracked the movements of seven Kemp's ridley turtles specifically for this project (Tables 1 & 2). Instrumented turtles were released in the autumn either in the Chesapeake Bay or along the coast between Cape Henry, Virginia and Cape Hatteras, North Carolina. Duration of tracks were from 21 d to over 8 mo, when either the transmitter became detached from the turtle or ceased transmitting because of failure or the turtle's death.

Loggerhead 05780 was released off Cape Henry on 24 October 1985 (Table 1). The turtle entered Pamlico Sound between 28 October and 3 November (Figures 6 & 7; Appendix 1). On 29 November the transmitter began transmitting continually, indicating that the transmitter was adrift and not attached to the turtle (Table 2). An aerial survey a few days later indicated heavy shrimp trawling activities in Pamlico Sound, and no regulations for the use of TEDs (turtle excluder devices) were in effect. Turtles are commonly captured in trawl nets (Musick et al., 1992) and we surmised that the turtle was captured in a trawl and that a fisherman had detached the transmitter from the turtle and set it adrift.

Loggerhead 05781 was released off Oregon Inlet on 21 November 1985 (Table 1). The turtle traveled south and rounded Cape Hatteras on 27 November, continuing south past Cape Lookout (Figures 8 & 9; Appendix 2). During the third week of December the turtle entered the Gulf Stream and travelled north in deep water, until 2 January when the turtle started moving southerly in the west wall of the Gulf Stream. Signals ceased on 15 January when the turtle was in deep water off North Carolina (Table 2; Figures 8 & 9; Appendix 2).

Loggerhead 05783 was released in the York River on 5 October 1986 (Table 1). The turtle travelled south nearshore and rounded Cape Hatteras between 18 and 31 October and continued south (Figures 10 & 11; Appendix 3). On 31 October the transmitter began transmitting continually (Table 2), indicating that the transmitter was adrift and not attached to the turtle. Heavy trawling activities were occurring in the area at the time the transmitter was detached, and still no regulations for the use of TEDs (turtle excluder devices) were in effect, and we again surmised that the turtle was captured in a trawl and the fisherman detached the transmitter from the turtle and set it adrift.

Loggerhead 05784 was released off Oregon Inlet on 3 December 1987 (Table 1). The turtle entered the Gulf Stream and travelled to the north of Bermuda in the Atlantic Ocean (Figures 12 & 13; Appendix 4). The first week of January 1988 the turtle began swimming southwest and again entered the Gulf Stream and travelled north during late April. In early May the turtle began swimming southeast in deep water, and transmissions ceased on 31 May 1988 (Table 2; Figures 12 & 13; Appendix 4).

Loggerheads 04932 and 04933 were released at BBNWR on 9 November 1989 (Table 1). Both turtles traveled south nearshore and rounded Cape Hatteras the last week of November (Figures 14 - 17; Appendix 5 & 6). The turtles continued south nearshore and were off Savannah Georgia by mid-December, and off Cape Canaveral by Mid-January 1990. Loggerhead 04932 continued south to the eastern Florida Keys, where it remained until the transmitter ceased transmitting on 28 May (Table 2; Figures 14 & 15; Appendix 5). Loggerhead 04933 remained off Cape Canaveral until the middle of March when it began travelling north. The turtle passed Cape Fear and Cape Hatteras in early May, and entered the Chesapeake Bay in the second week of May (Table 2; Figures 16 & 17; Appendix 6).

Loggerheads 04934 and 04937 were released at VIMS on 22 October 1991 (Table 1), and both exhibited tail and carapace lengths indicating that the turtles were either mature or nearly mature males. The turtles travelled south and rounded Cape Hatteras the last week of October (Figures 18 - 21; Appendix 7 & 8). The turtles overwintered over the continental shelf between Cape Fear and Cape Lookout. The turtles began migrating north in mid-April to early May 1992, rounded Cape Hatteras in late May, and entered the Chesapeake Bay in early June (Table 2; Figures 18 - 21; Appendix 7 & 8).

Loggerhead 04935 was released at BBNWR on 28 October 1991 (Table 1) after nesting. The turtle travelled south and rounded Cape Hatteras the last week of October (Figures 22 & 23; Appendix 9). The turtle overwintered over the continental shelf just to the south of Cape Hatteras, and entered Pamlico Sound during March 1992. The turtle began migrating north in early May and transmissions ceased on 24 May when the turtle was off Kittyhawk North Carolina (Table 2; Figures 22 & 23; Appendix 9).

Seven Kemp's ridley turtles were tracked specifically for this project. The turtles had been in captivity for various amounts of time (Table 1). Six of the turtles were juveniles , and one (number 1234) was well above the minimum size of nesting females, indicating it was an adult (Table 1). All turtles were over 40 cm straight line carapace length at release. We deemed this to be the minimum length that a sea turtle can carry a satellite transmitter and exhibit behavior uninhibited by the attached transmitter (Byles and Keinath, 1990).

Kemp's ridley 01229 was released at Back Bay National Wildlife Refuge (BBNWR), Virginia Beach on 23 October 1991 (Table 1). The turtle traveled south nearshore, and rounded Cape Hatteras the last week of October (Figures 24 & 25; Appendix 10). The turtle continued south, farther offshore, but in water less than 100 m deep, and arrived off Cape Lookout early in the first week of November, then started to travel south later that week (Figures 24 & 25; Appendix 10). The last position was obtained on 13 November, when the turtle was nearshore between Cape Lookout and Cape Fear (Table 2).

Kemp's ridley 04938 was released at BBNWR on 28 October 1991 (Table 1). The turtle traveled south nearshore, and rounded Cape Hatteras the first week of November (Figures 26 & 27; Appendix 11). The turtle continued south and rounded Cape Fear 10 - 12 November, arriving at the South Carolina - Georgia border during the end of December, and transmission ceased on 18 January 1992 when the turtle was off the Georgia - Florida border (Table 2; Figures 26 & 27; Appendix 11).

Kemp's ridley 04939 was released at BBNWR on 28 October 1991 (Table 1). The turtle traveled south farther offshore than the previous two Kemp's ridleys, and rounded Cape Hatteras the first week of November (Figures 28 & 29; Appendix 12).

The turtle continued south and rounded Cape Fear 17 - 19 November, arriving at the South Carolina - Georgia border during the second week of December, and continued to travel south to Cape Canaveral when transmission ceased on 4 January 1992 (Table 2; Figures 28 & 29; Appendix 12).

Kemp's ridleys 01230, 01231, 01233, and 01234 were released at BBNWR on 14 September 1993 (Table 1). Turtle 1230 travelled north and entered Chesapeake Bay three days after release, and remained in the Bay until signals ceased on 7 October (Table 2; Figures 30 & 31; Appendix 13). Kemp's ridleys 1231, 1233, and 1234 all travelled south and were off Oregon Inlet by the end of September, and continued south to Cape Hatteras when transmissions ceased (Table 2; Figures 32 - 37; Appendices 14 - 17).

Duration of reception of data was vastly greater for the larger ST-3 model satellite transmitters (up to over 250 days), while the ST-6 transmitters lasted under 100 days, with 30 - 50 days being the norm (Table 2). It appears there is a problem with the ST-6 transmitters, probably with the seawater switch. However, small turtles, such as the Kemp's ridleys we were tracking, could not support the weight of an ST-3 transmitter.

Table 1

Data on sea turtles satellite tagged by VIMS. TRX NO = satellite transmitter identification code, SP = species, SLCL = straight line carapace length at capture, LAST DATA = date of last data reception. York = York River, CCB = Cape Cod Bay, Potomac = Potomac River, BBNWR = Back Bay National Wildlife Refuge, CB mouth = mouth of Chesapeake Bay, OI = Oregon Inlet, CH = off Cape Hatteras, VIMS = VIMS beach (York River).

TRX NO	SP	CAPTURE DATE	CAPTURE LOCATION	SLCL	RELEASE DATE	RELEASE LOCATION
5780	Cc	19 Jun 85	Potomac	83.7	24 Oct 85	CB mouth
5781	Cc	8 Aug 85	York	78.5	21 Nov 85	OI
5783	Cc	3 Jul 86	Potomac	80.9	5 Oct 86	York
5784	Cc	25 Aug 87	Potomac	92.5	3 Dec 87	CH
4932	Cc	28 Sep 89	Potomac	59.9	9 Nov 89	BBNWR
4933	Cc	6 Oct 89	Potomac	69.6	9 Nov 89	BBNWR
4934	Cc	12 Sep 91	Potomac	86.1	22 Oct 91	VIMS
4937	Cc	16 Sep 91	York	90.4	22 Oct 91	VIMS
4935	Cc	30 Sep 91	York	60.2	28 Oct 91	BBNWR
1229	Lk	26 Nov 88	Dare NC	22.1	23 Oct 91	BBNWR
4938	Lk	19 Jun 91	York	38.1	28 Oct 91	BBNWR
4939	Lk	15 Nov 87	CCB	30.0	28 Oct 91	BBNWR
1230	Lk	29 May 93	Potomac	48.2	14 Sep 93	BBNWR
1231	Lk	24 May 93	York	51.8	14 Sep 93	BBNWR
1233	Lk	10 Jun 93	Potomac	43.9	14 Sep 93	BBNWR
1234	Lk	1 Sep 93	Potomac	64.8	14 Sep 93	BBNWR

Table 2

Tracking information on satellite tracked sea turtles. TRX NO = transmitter identification code. Cc = loggerhead sea turtle, Lk = Kemp's ridley sea turtle. TYPE = transmitter configuration; F-3 = trailing float model ST-6; B-3 = epoxy backpack model ST-3; B-6 = epoxy backpack model ST-6.

TRX NO	SPECIES	DURATION OF POSITIONS	FINAL DISPOSITION	TYPE
5780	Cc	24 Oct 85 - 29 Nov 85	detached	F-3
5781	Cc	21 Nov 85 - 15 Jan 86	signal ceased	F-3
5783	Cc	5 Oct 86 - 31 Oct 86	detached	F-3
5784	Cc	3 Dec 87 - 31 May 88	signal ceased	F-3
4932	Cc	9 Nov 89- 28 May 90	signal ceased	B-3
4933	Cc	9 Nov 89 - 22 Jun 90	signal ceased	B-3
4934	Cc	22 Oct 91- 15 Jun 92	signal ceased	B-3
4937	Cc	22 Oct 91- 17 Jul 92	signal ceased	B-3
4935	Cc	28 Oct 91- 24 May 92	signal ceased	B-3
1229	Lk	23 Oct 91- 13 Nov 91	signal ceased	B-6
4938	Lk	28 Oct 91- 18 Jan 92	signal ceased	B-6

Table 2

Tracking information on satellite tracked sea turtles. TRX NO = transmitter identification code. Cc = loggerhead sea turtle, Lk = Kemp's ridley sea turtle. TYPE = transmitter configuration; F-3 = trailing float model ST-6; B-3 = epoxy backpack model ST-3; B-6 = epoxy backpack model ST-6. (continued).

TRX NO	SPECIES	DURATION OF POSITIONS	FINAL DISPOSITION	TYPE
4939	Lk	28 Oct 91 - 4 Jan 92	signal ceased	B-6
1230	Lk	14 Sep 93 - 7 Oct 93	signal ceased	B-6
1231	Lk	14 Sep 93 - 11 Nov 93	signal ceased	B-6
1233	Lk	14 Sep 93 - 9 Oct 93	signal ceased	B-6
1234	Lk	14 Sep 93- 19 Oct 93	signal ceased	B-6

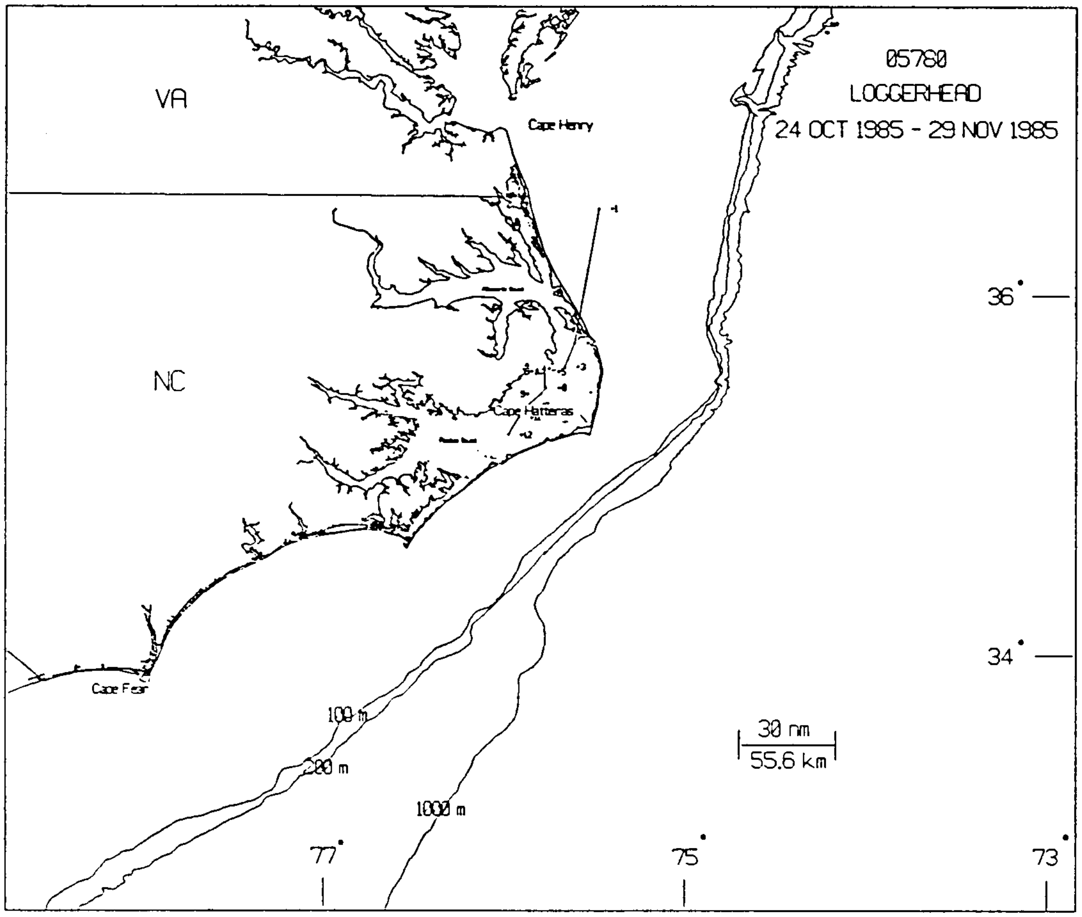

Figure 6. Positions of loggerhead sea turtle 05780 as elucidated by satellite telemetry. The turtle was released off Cape Henry, Virginia Beach, Virginia on 24 October 1985 and the transmitter detached from the turtle on 29 November 1985. Numbered points correspond to "POINT NO" in Appendix 1 (from Byles, 1988).

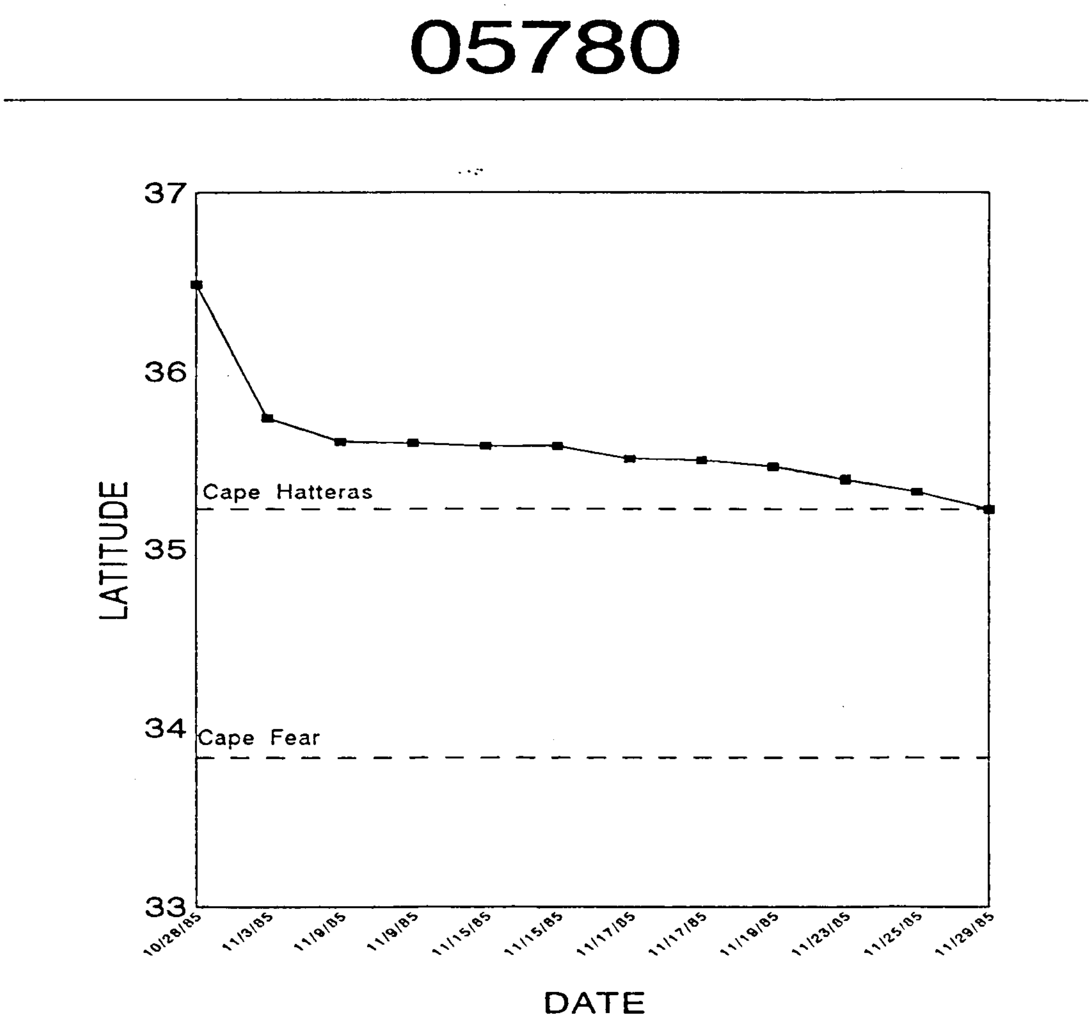

Figure 7. Latitude as a function of date of loggerhead sea turtle 05780 as elucidated by satellite telemetry (adapted from Byles, 1988).

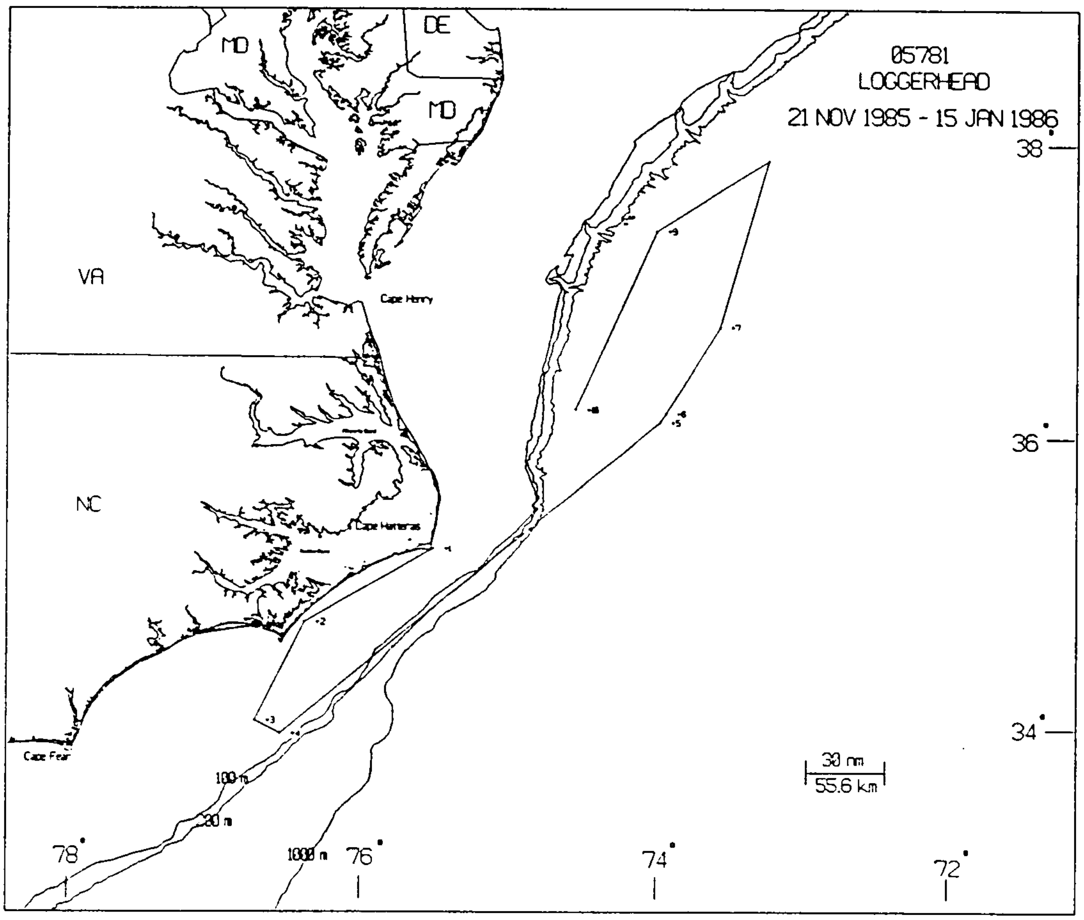

Figure 8. Positions of loggerhead sea turtle 05781 as elucidated by satellite telemetry. The turtle was released off Oregon Inlet, North Carolina on 12 November 1985 and the last location was received on 15 January 1986. Numbered points correspond to "POINT NO" in Appendix 2 (from Byles, 1988).

05781

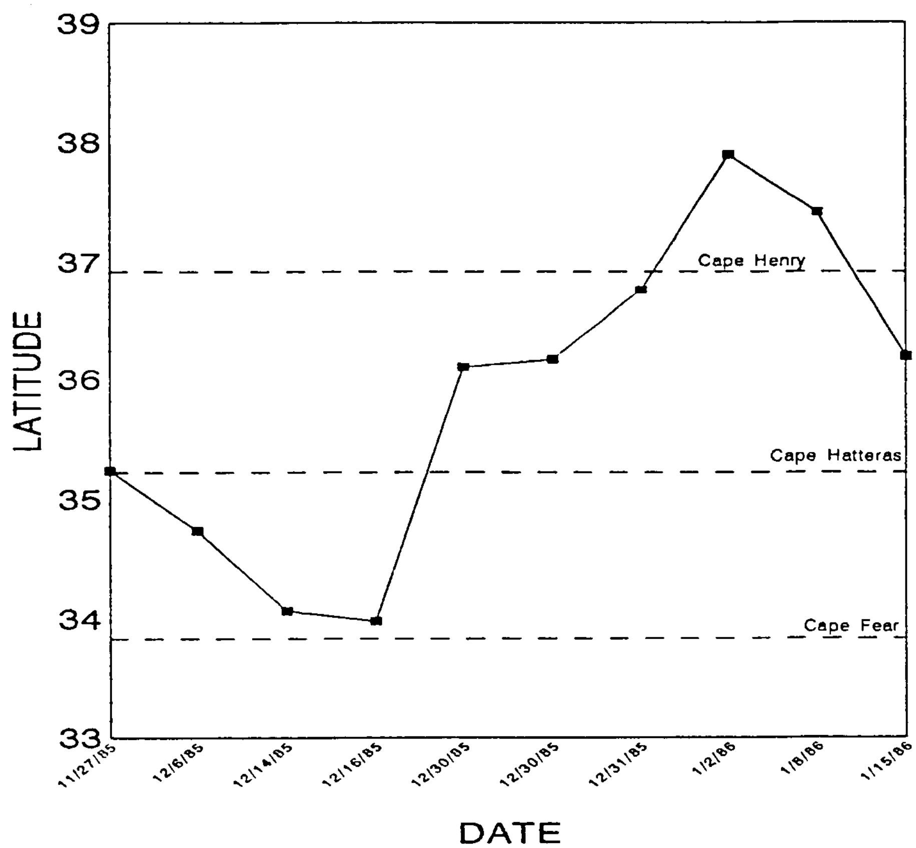

Figure 9. Latitude as a function of date of loggerhead sea turtle 05781 as elucidated by satellite telemetry. Winter positions north of Cape Hatteras were in the Gulf Stream (See Figure 10) (adapted from Byles, 1988).

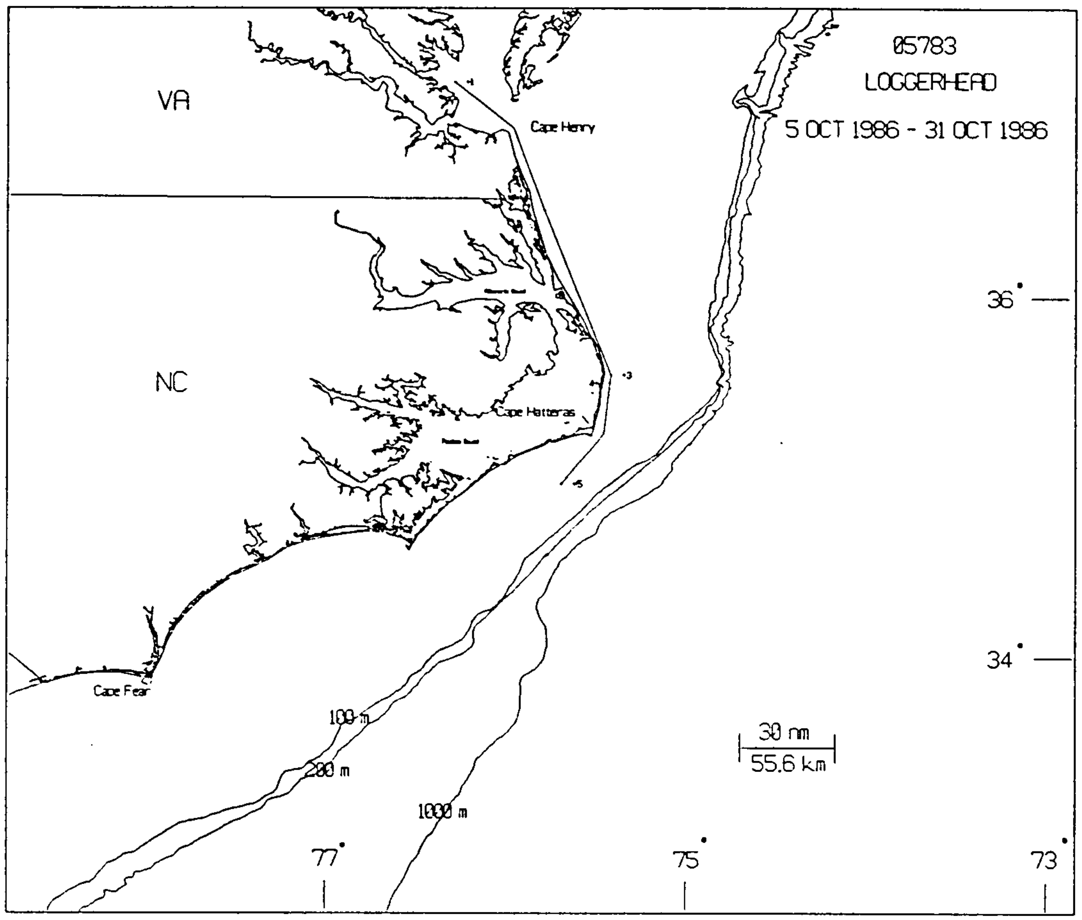

Figure 10. Positions of loggerhead sea turtle 05783 as elucidated by satellite telemetry. The turtle was released at the mouth of the York River, Virginia on 5 October 1986 and the transmitter detached from the turtle on 31 October 1986. Numbered points correspond to "POINT NO" in Appendix 3 (from Keinath, 1993).

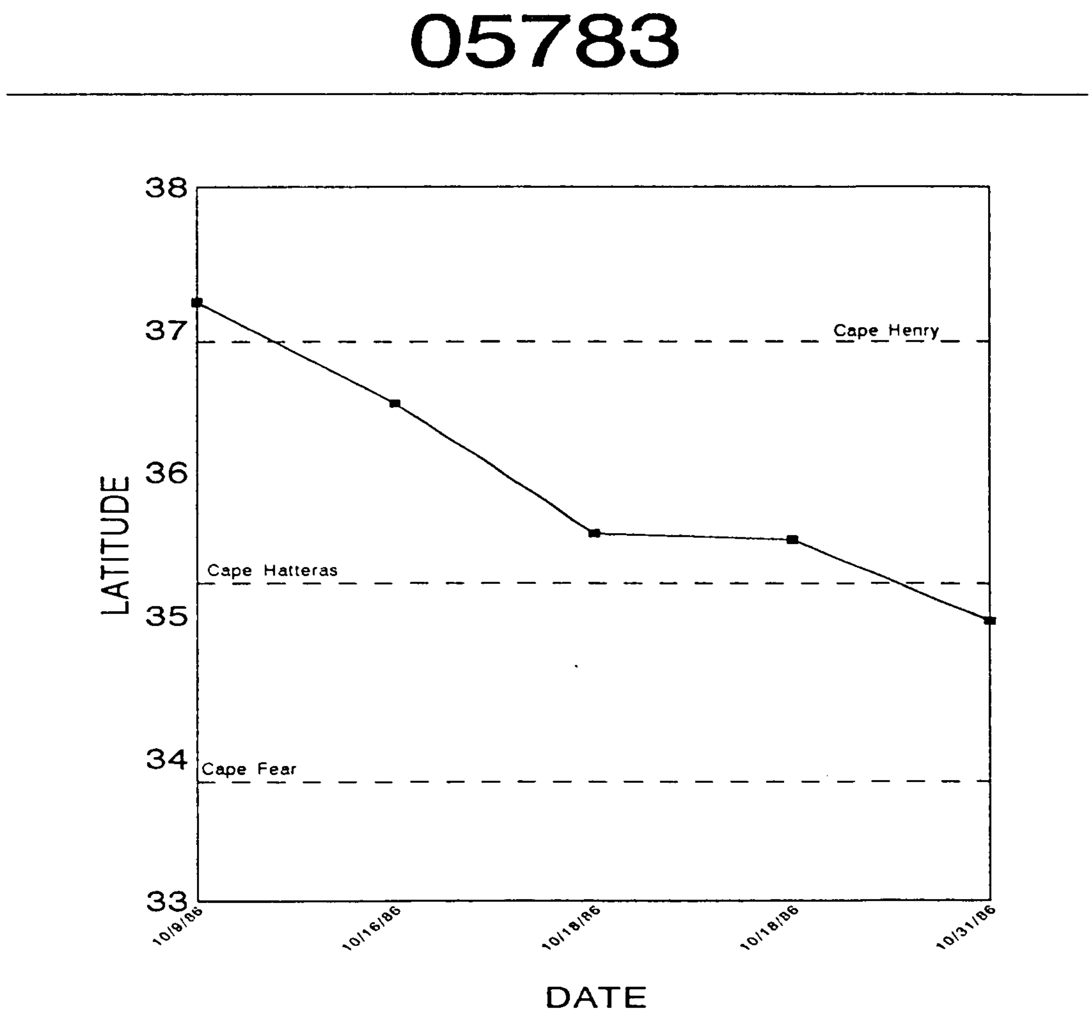

Figure 11. Latitude as a function of date of loggerhead sea turtle 05783 as elucidated by satellite telemetry (from Keinath, 1993).

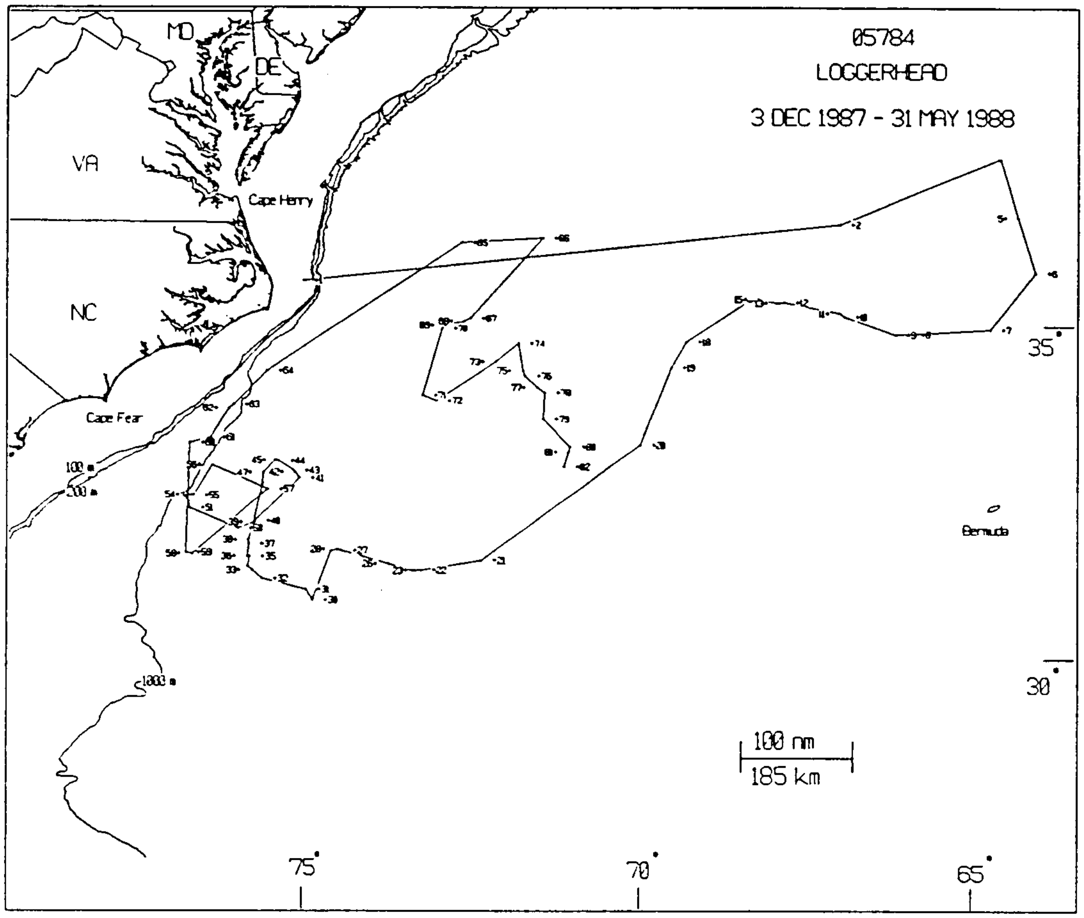

Figure 12. Positions of loggerhead sea turtle 05784 as elucidated by satellite telemetry. The turtle was released off Oregon Inlet, North Carolina on 3 December 1987 and the last location was received on 31 May 1988. Numbered points correspond to "POINT NO" in Appendix 4 (from Keinath, 1993).

05784

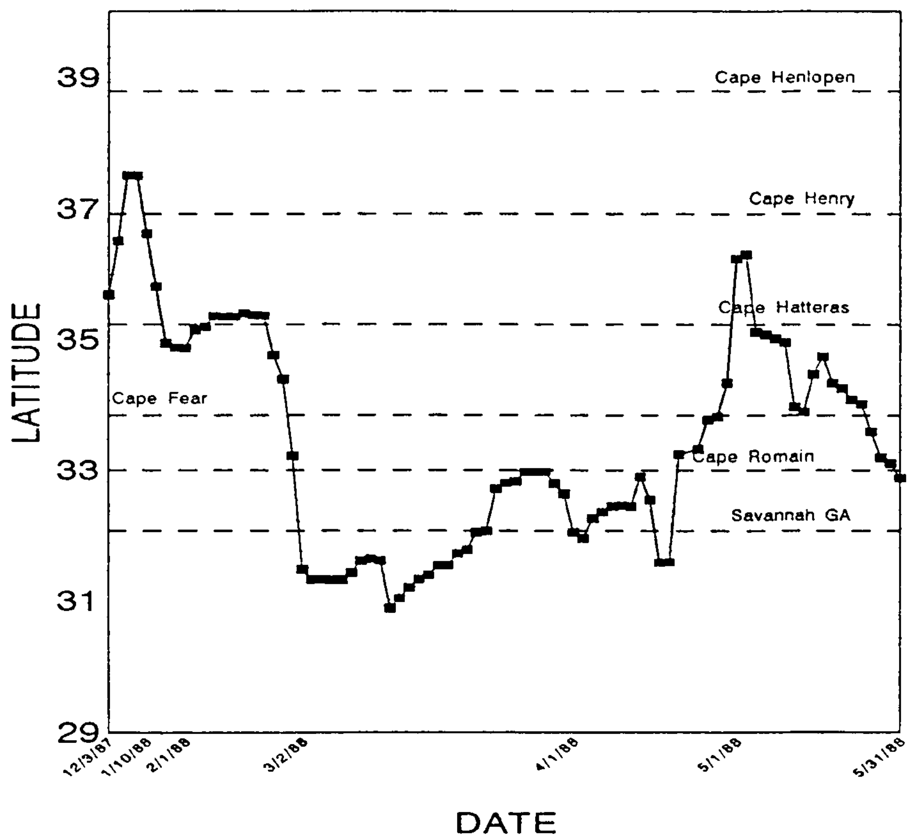

Figure 13. Latitude as a function of date of loggerhead sea turtle 05784 as elucidated by satellite telemetry (from Keinath, 1993).

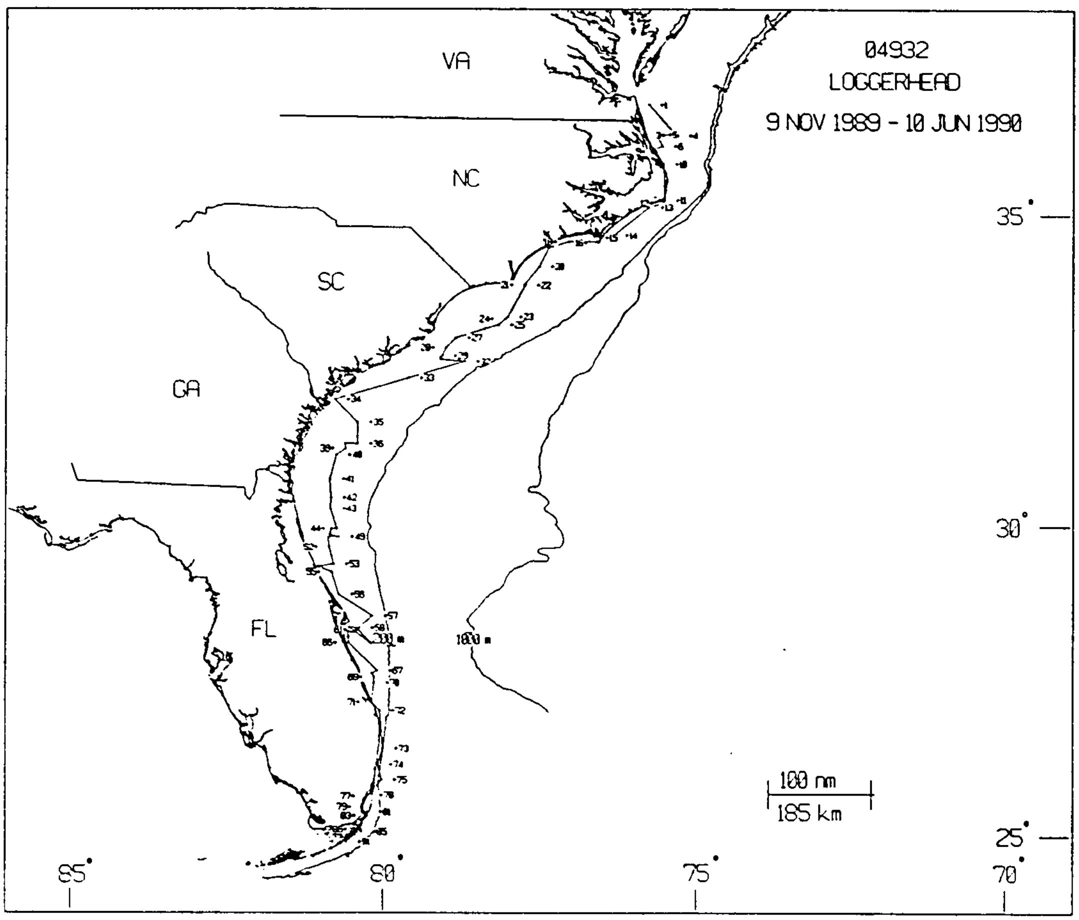

Figure 14. Positions of loggerhead sea turtle 04932 as elucidated by satellite telemetry. The turtle was released at Back Bay National Wildlife Refuge, Virginia Beach, Virginia on 9 November 1989 and the last location was received on 28 May 1990. Numbered points correspond to "POINT NO" in Appendix 5 (from Keinath, 1993).

04932

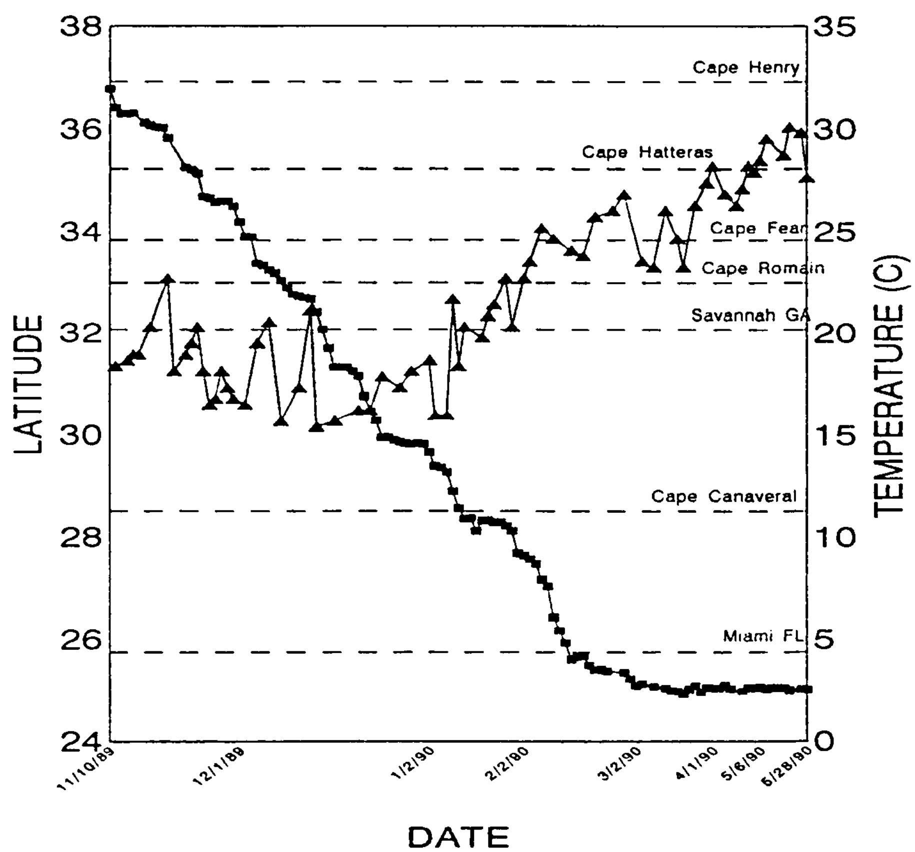

Figure 15. Latitude (squares) and temperature (triangles) as a function of date of loggerhead sea turtle 04932 as elucidated by satellite telemetry (from Keinath, 1993).

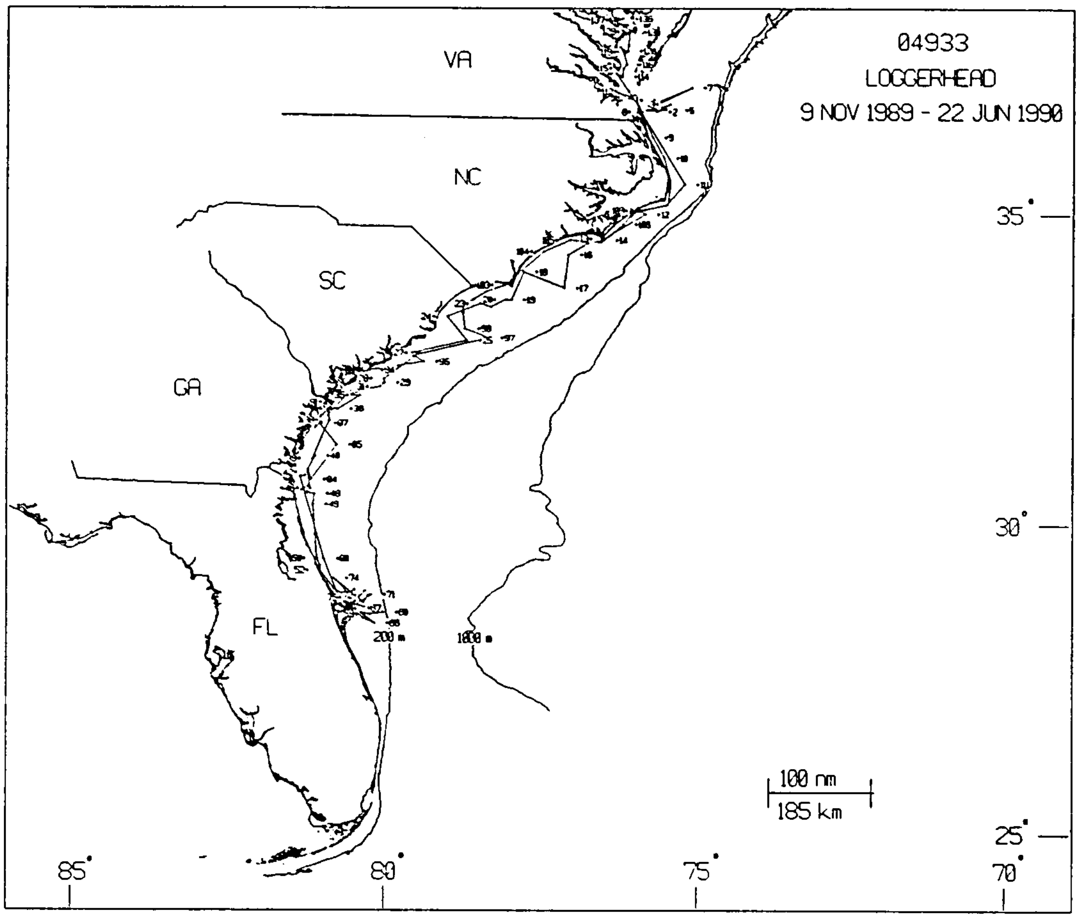

Figure 16. Positions of loggerhead sea turtle 04933 as elucidated by satellite telemetry. The turtle was released at Back Bay National Wildlife Refuge, Virginia Beach, Virginia on 9 November 1989 and the last location was received on 22 June 1990. Numbered points correspond to "POINT NO" in Appendix 6 (from Keinath, 1993).

04933

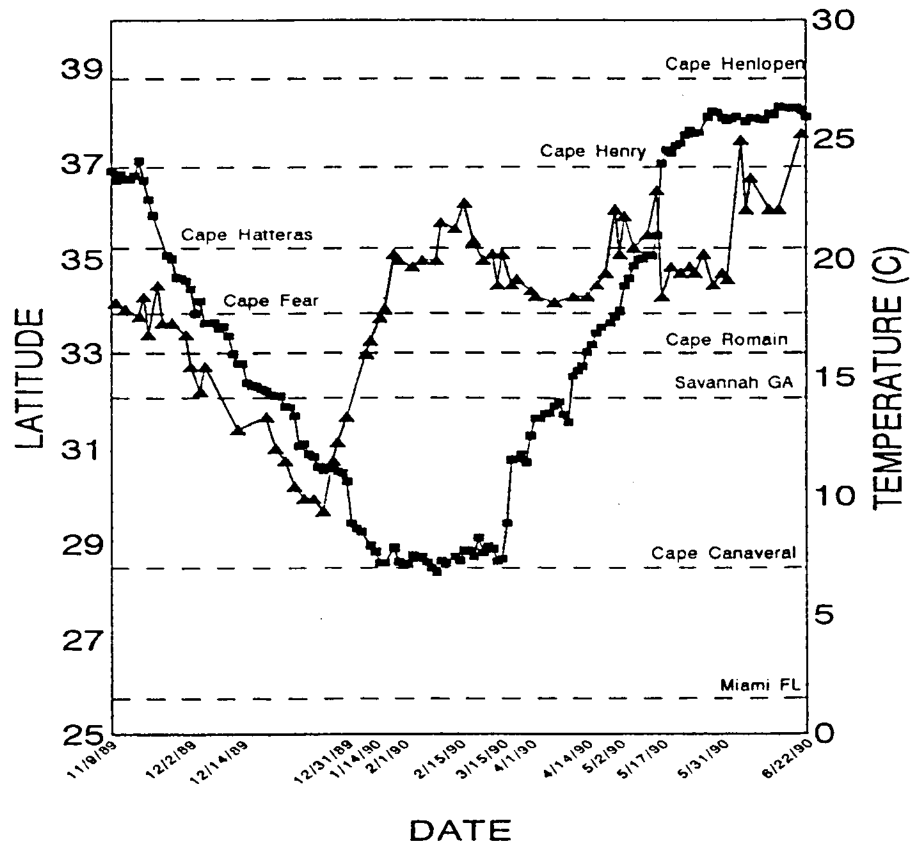

Figure 17. Latitude (squares) and temperature (triangles) as a function of date of loggerhead sea turtle 04933 as elucidated by satellite telemetry (from Keinath, 1993).

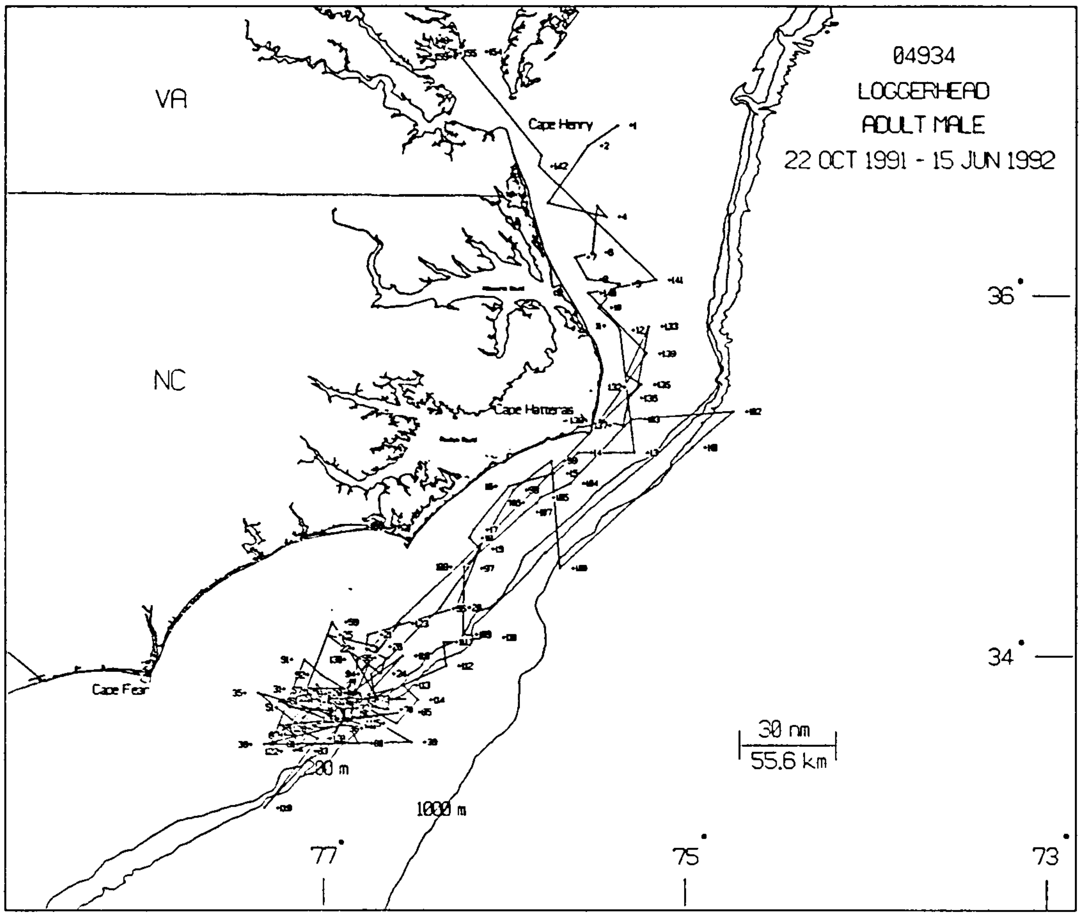

Figure 18. Positions of loggerhead sea turtle 04934 as elucidated by satellite telemetry. The turtle was released at Gloucester Point, Virginia on 22 October 1991 and the last location was received on 15 June 1992. Numbered points correspond to "POINT NO" in Appendix 7 (from Keinath, 1993).

04934

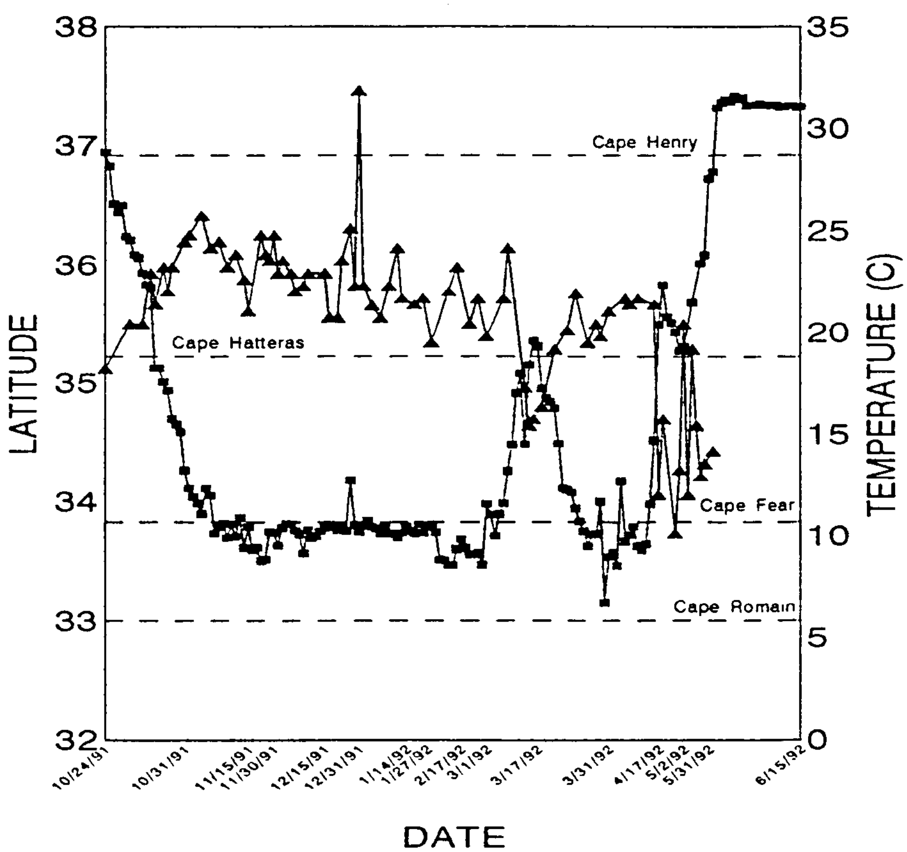

Figure 19. Latitude (squares) and temperature (triangles) as a function of date of loggerhead sea turtle 04934 as elucidated by satellite telemetry (from Keinath, 1993).

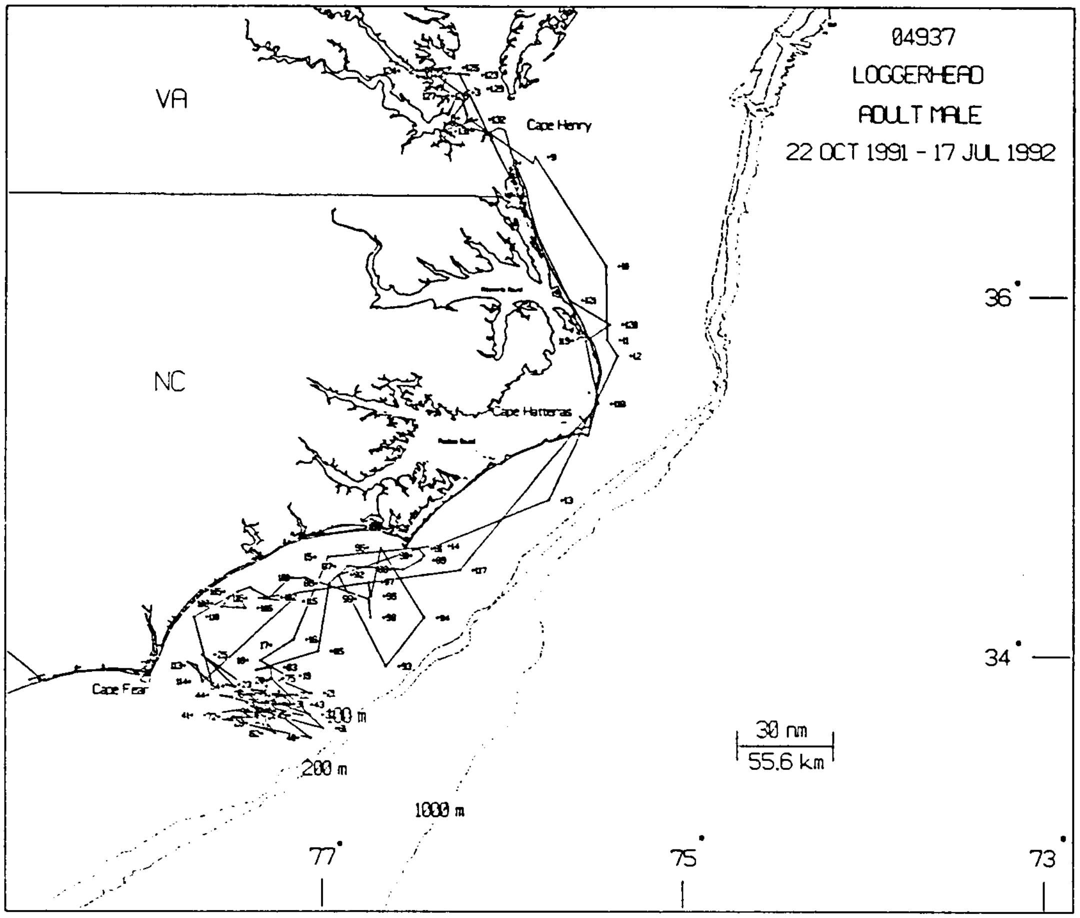

Figure 20. Positions of loggerhead sea turtle 04937 as elucidated by satellite telemetry. The turtle was released at Gloucester Point, Virginia on 22 October 1991 and the last location was received on 17 July 1992. Numbered points correspond to "POINT NO" in Appendix 8 (from Keinath, 1993).

04937

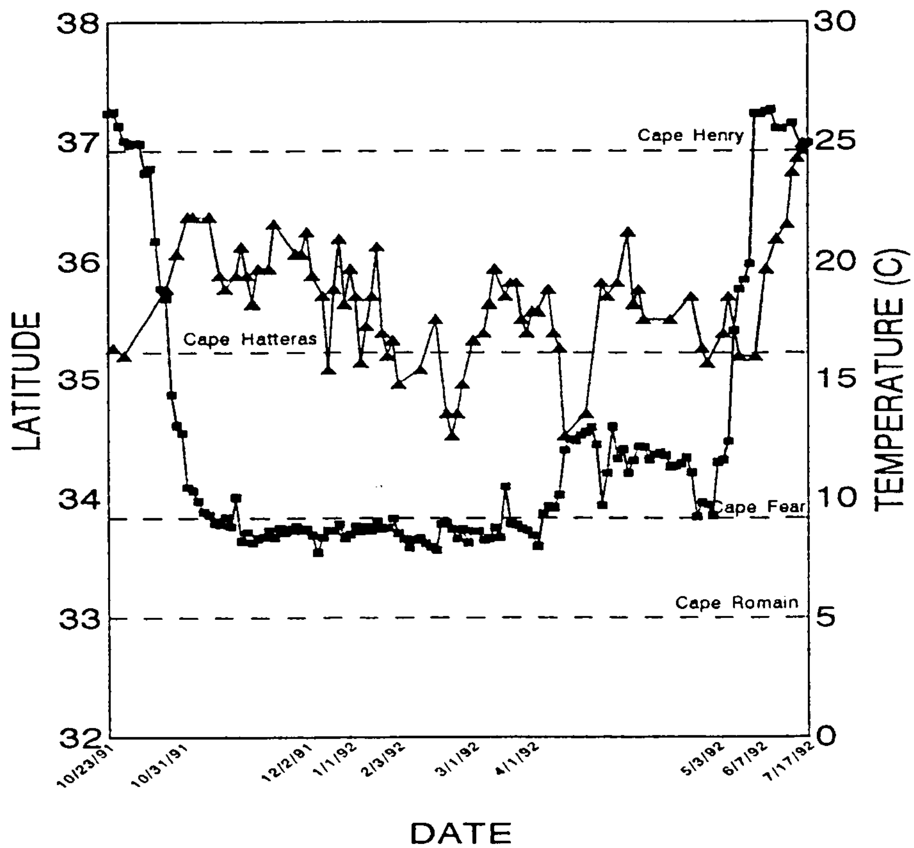

Figure 21. Latitude (squares) and temperature (triangles) as a function of date of loggerhead sea turtle 04937 as elucidated by satellite telemetry (from Keinath, 1993).

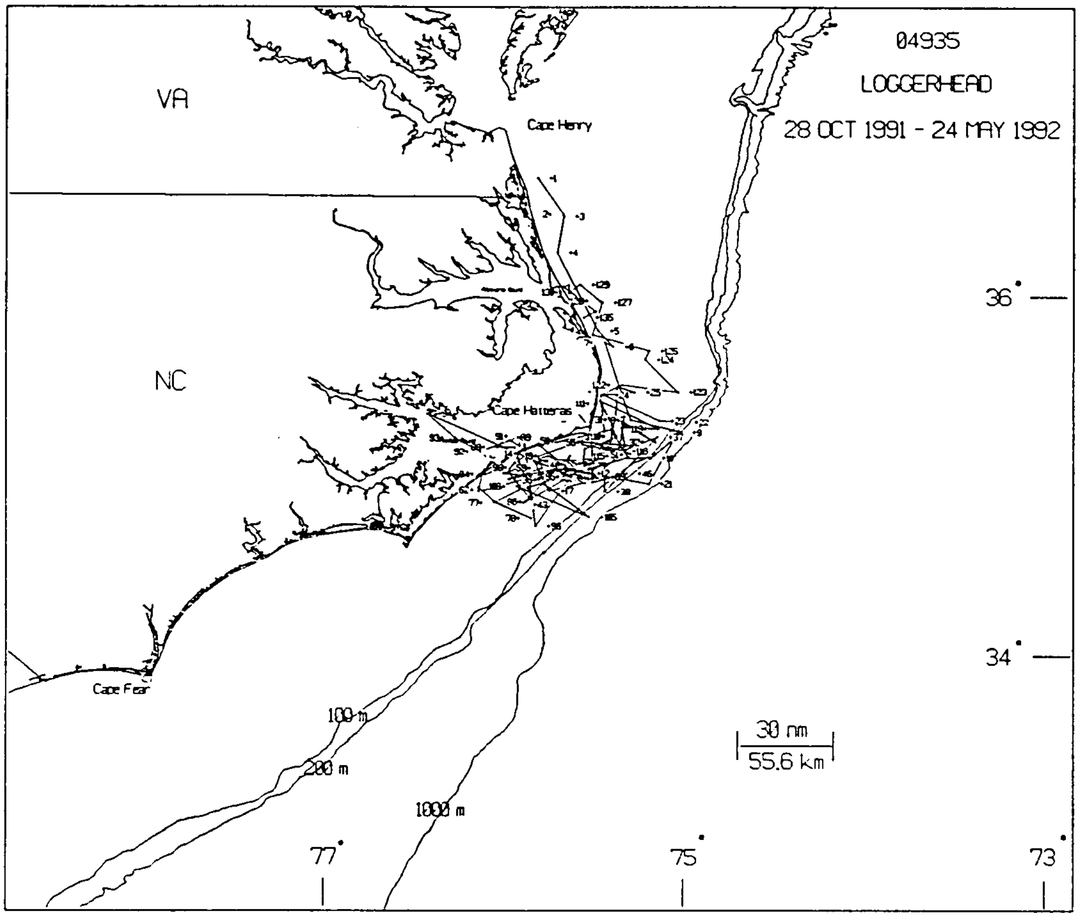

Figure 22. Positions of loggerhead sea turtle 04935 as elucidated by satellite telemetry. The turtle was released at Back Bay National Wildlife Refuge, Virginia Beach, Virginia on 28 October 1991 and the last location was received on 24 May 1992. Numbered points correspond to "POINT NO" in Appendix 9 (from Keinath, 1993).

04935

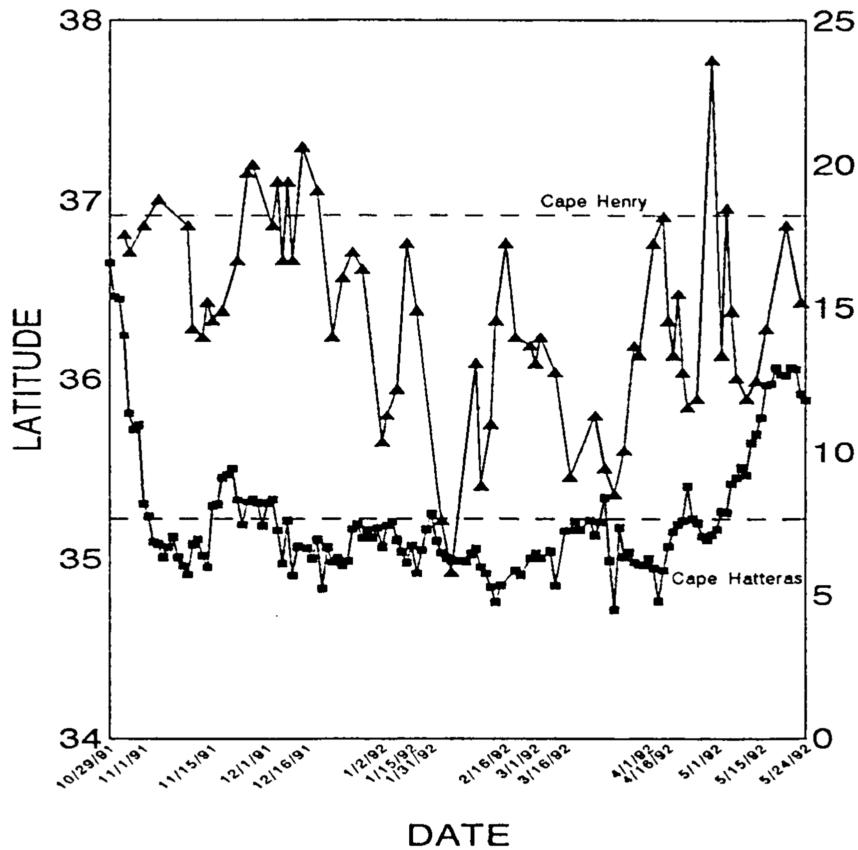

Figure 23. Latitude (squares) and temperature (triangles) as a function of date of loggerhead sea turtle 04935 as elucidated by satellite telemetry (from Keinath, 1993).

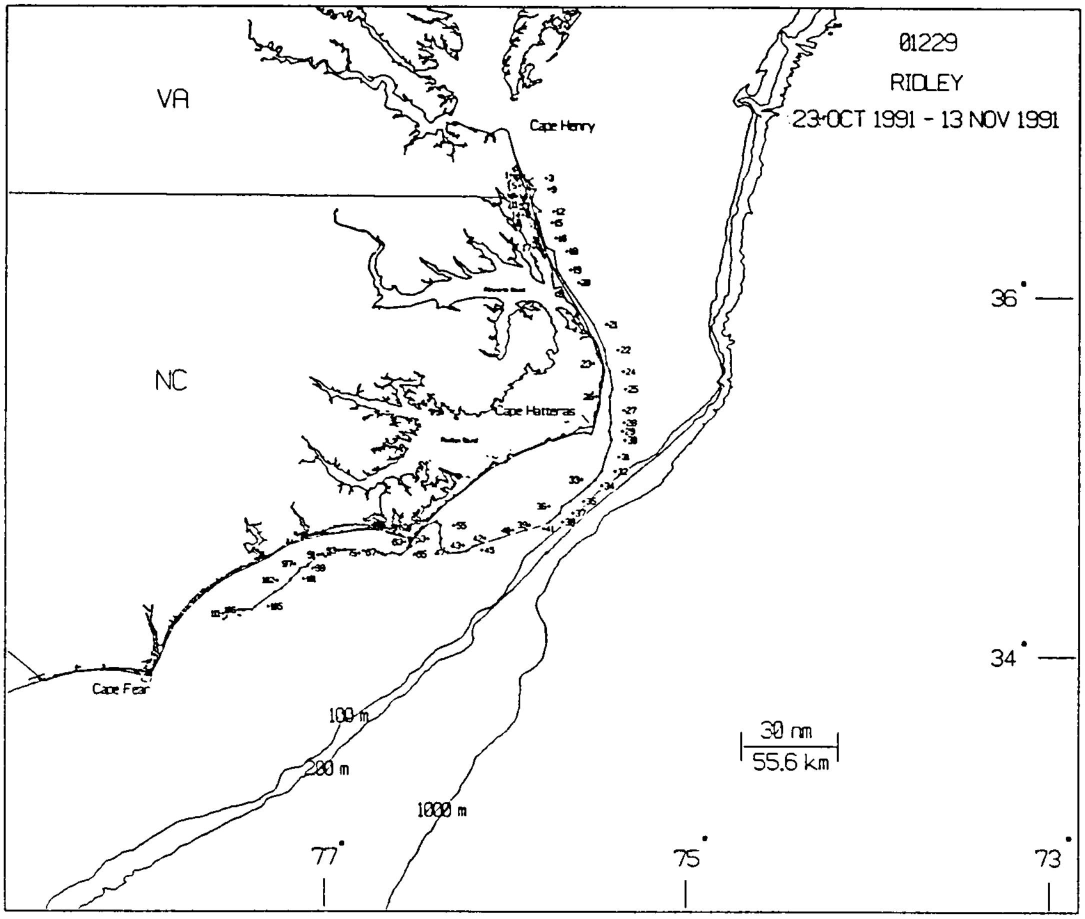

Figure 24. Positions of Kemp's ridley sea turtle 01229 as elucidated by satellite telemetry. The turtle was released at Back Bay National Wildlife Refuge, Virginia Beach, Virginia on 23 October 1991 and the last location was received on 13 November 1991. Numbered points correspond to "POINT NO" in Appendix 10.

01229

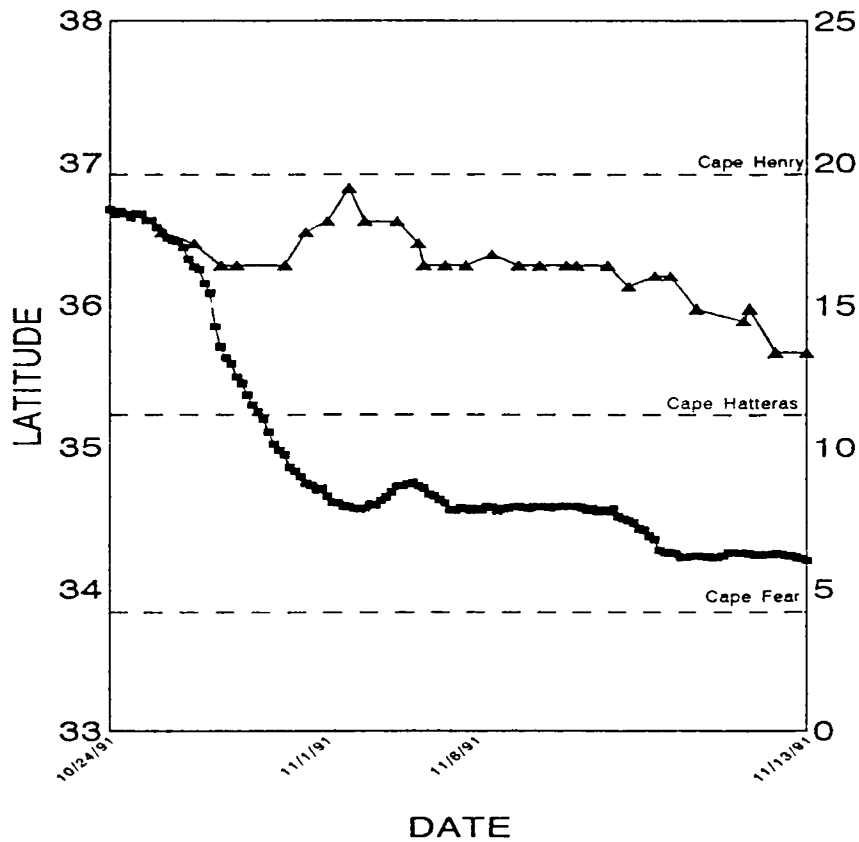

Figure 25. Latitude (squares) and temperature (triangles) as a function of date of Kemp's ridley sea turtle 01229 as elucidated by satellite telemetry.

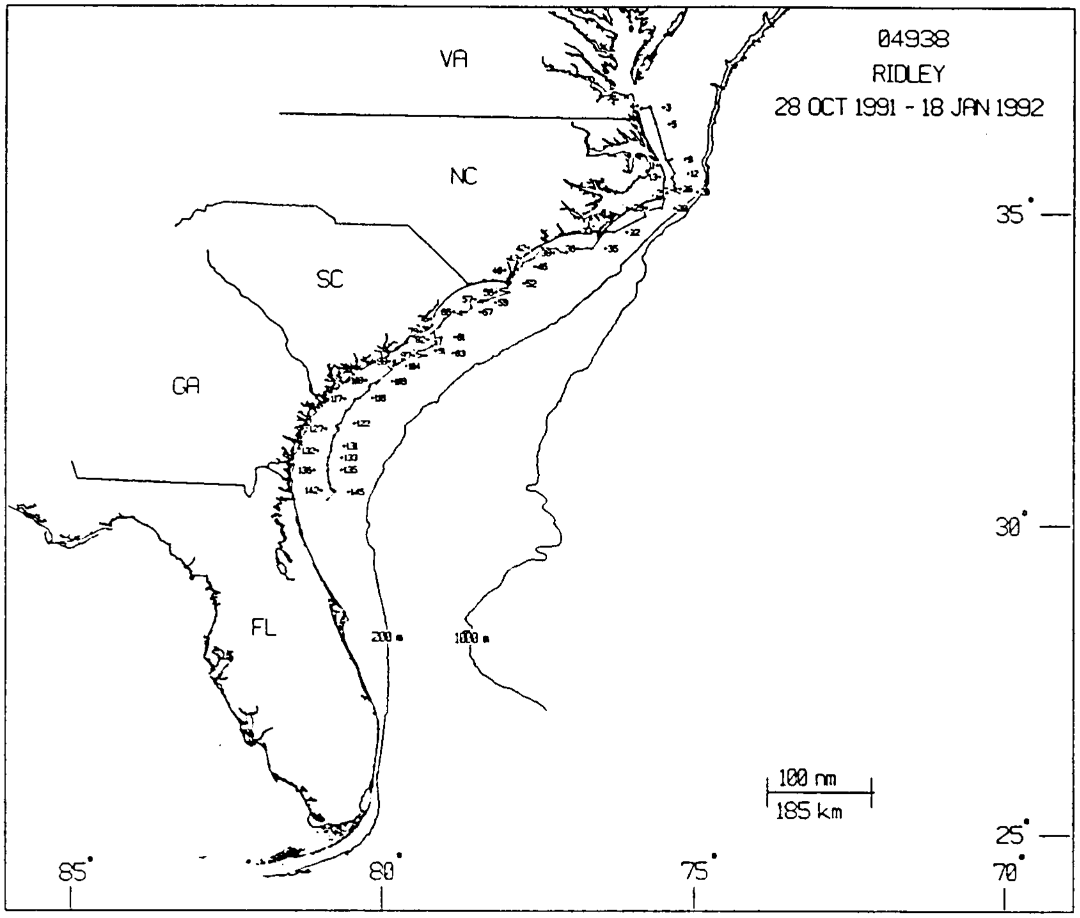

Figure 26. Positions of Kemp's ridley sea turtle 04938 as elucidated by satellite telemetry. The turtle was released at Back Bay National Wildlife Refuge, Virginia Beach, Virginia on 28 October 1991 and the last location was received on 18 January 1992. Numbered points correspond to "POINT NO" in Appendix 11.

04938

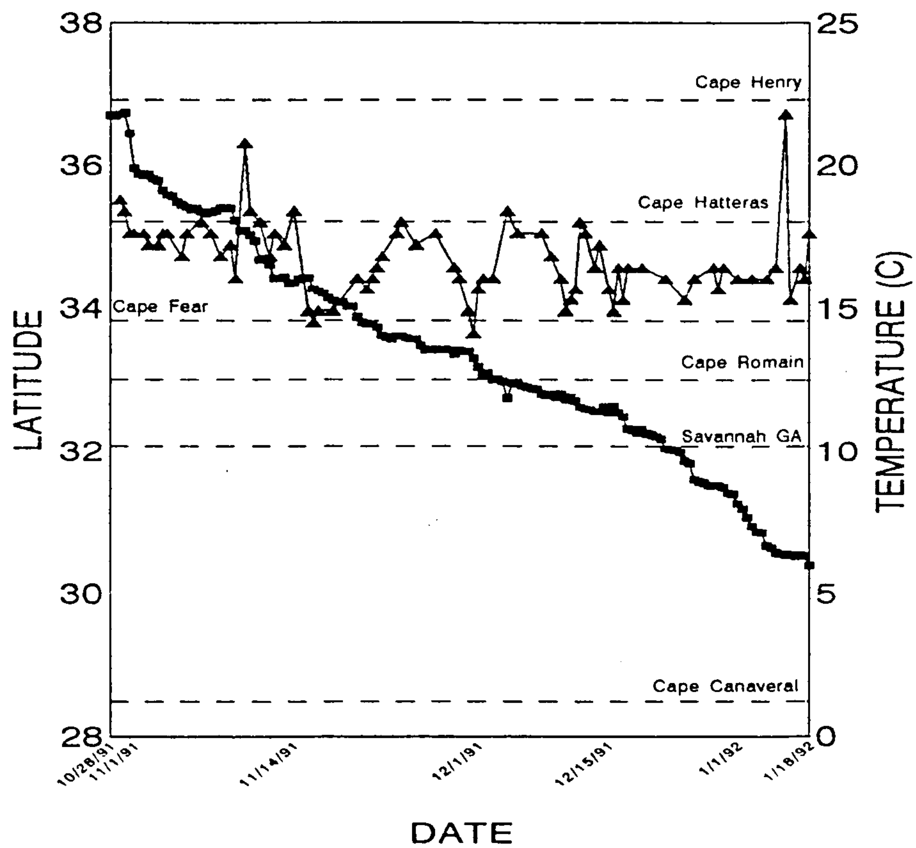

Figure 27. Latitude (squares) and temperature (triangles) as a function of date of Kemp's ridley sea turtle 04938 as elucidated by satellite telemetry.

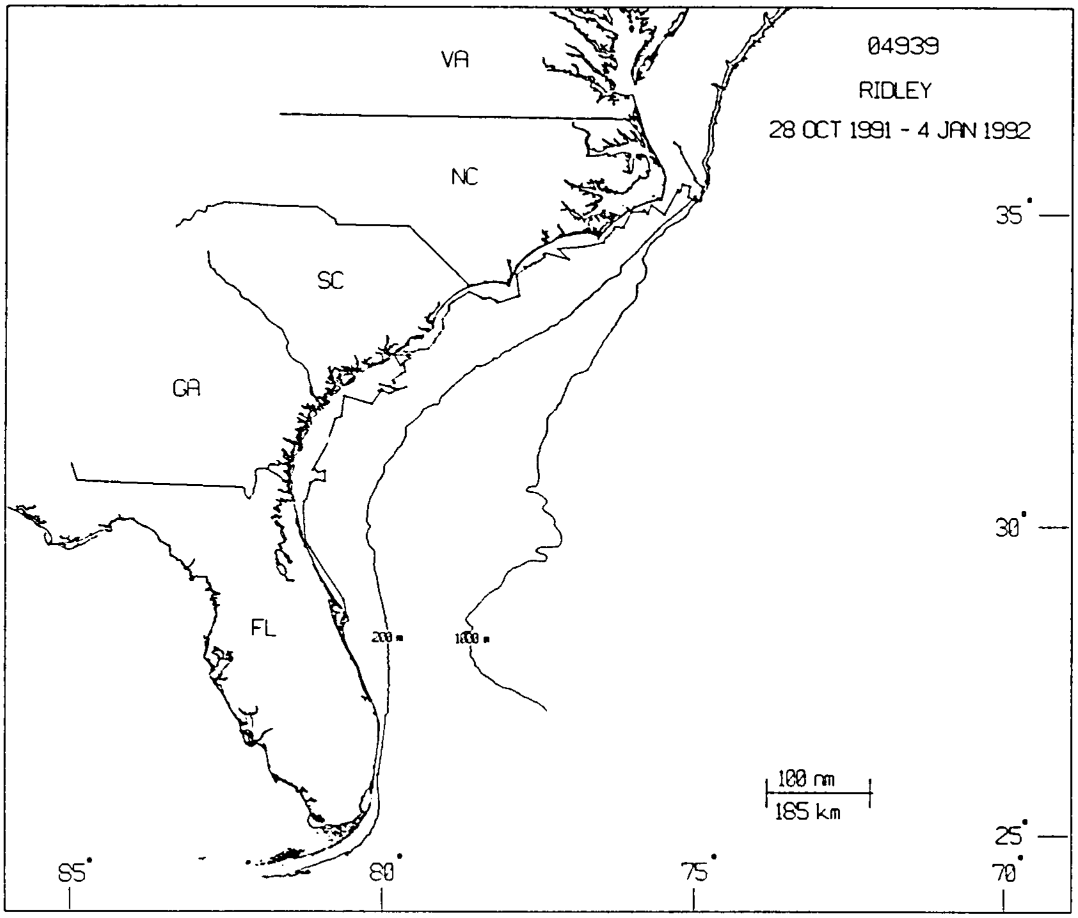

Figure 28. Positions of Kemp's ridley sea turtle 04939 as elucidated by satellite telemetry. The turtle was released at Back Bay National Wildlife Refuge, Virginia Beach, Virginia on 28 October 1991 and the last location was received on 4 January 1992. Numbered points correspond to "POINT NO" in Appendix 12.

04939

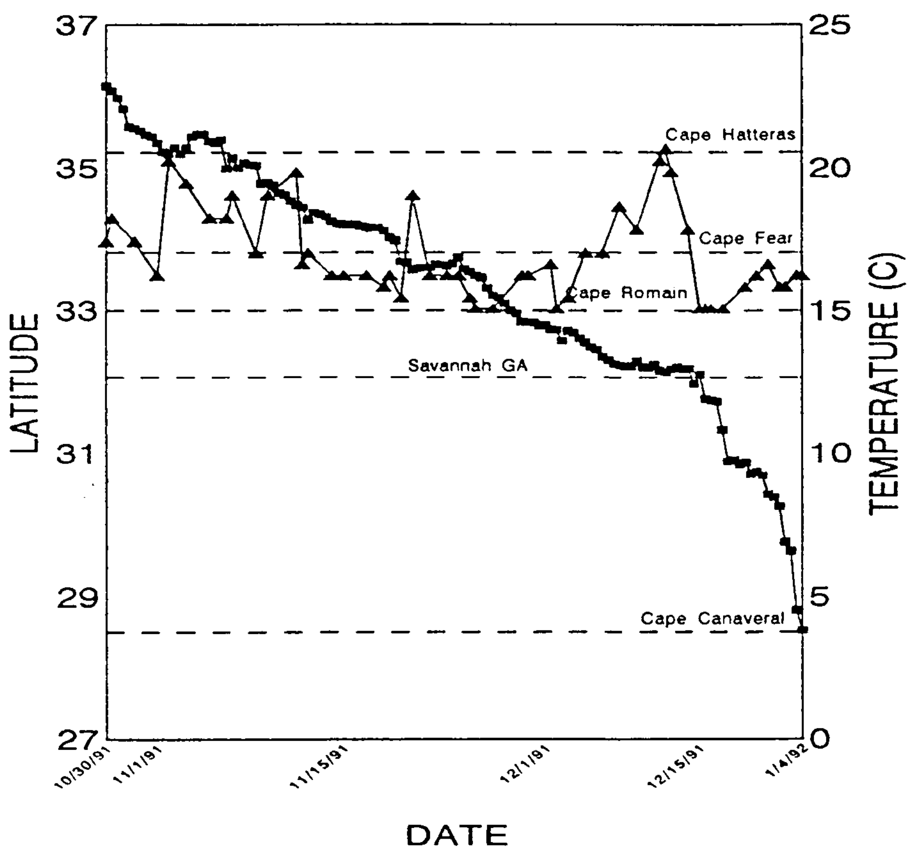

Figure 29. Latitude (squares) and temperature (triangles) as a function of date of Kemp's ridley sea turtle 04939 as elucidated by satellite telemetry.

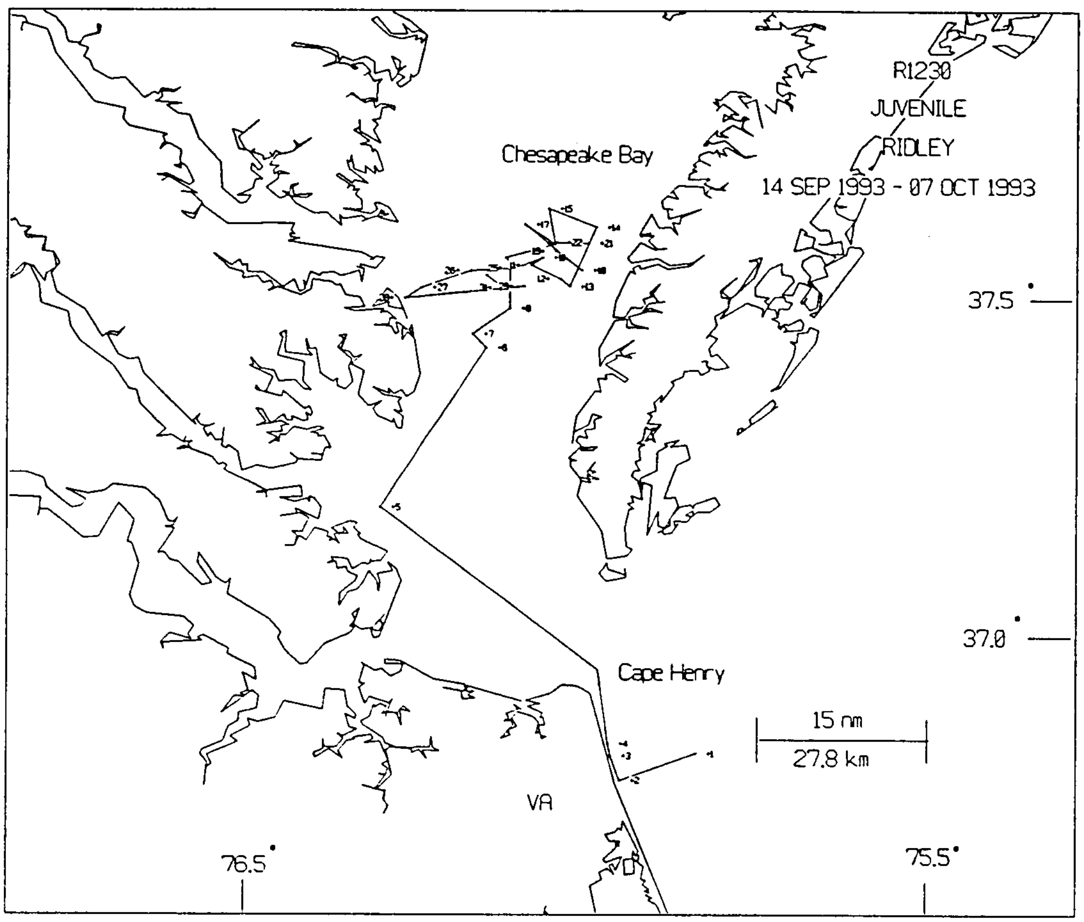

Figure 30. Positions of Kemp's ridley sea turtle 01230 as elucidated by satellite telemetry. The turtle was released at Back Bay National Wildlife Refuge, Virginia Beach, Virginia on 14 September 1993 and the last location was received on 7 October 1993. Numbered points correspond to "POINT NO" in Appendix 13.

R1230

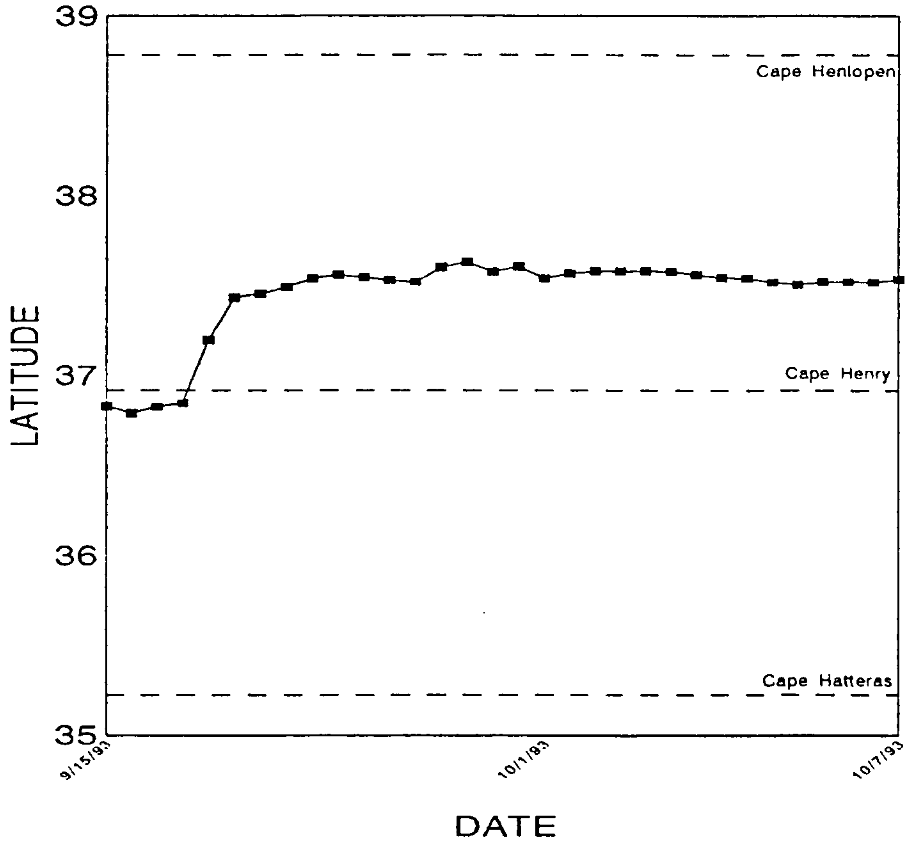

Figure 31. Latitude as a function of date of Kemp's ridley sea turtle 01230 as elucidated by satellite telemetry.

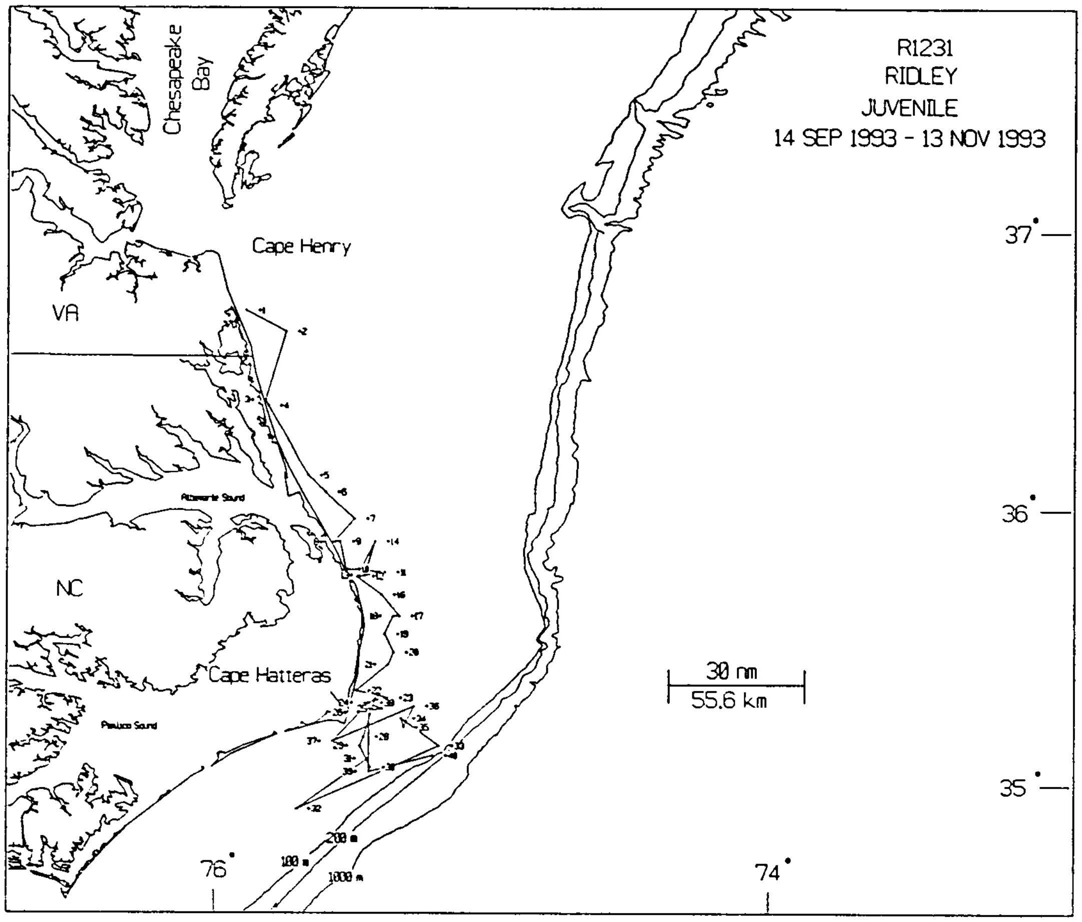

Figure 32. Positions of Kemp's ridley sea turtle 01231 as elucidated by satellite telemetry. The turtle was released at Back Bay National Wildlife Refuge, Virginia Beach, Virginia on 14 September 1993 and the last location was received on 13 November 1993. Numbered points correspond to "POINT NO" in Appendix 14.

R1231

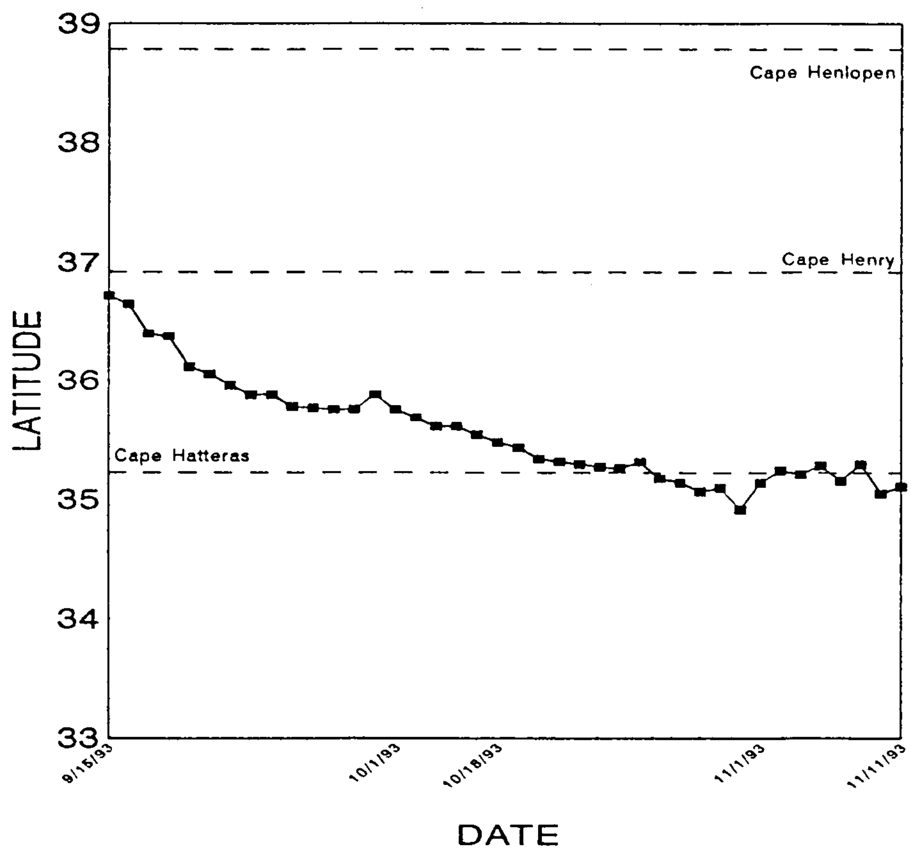

Figure 33. Latitude as a function of date of Kemp's ridley sea turtle 01231 as elucidated by satellite telemetry.

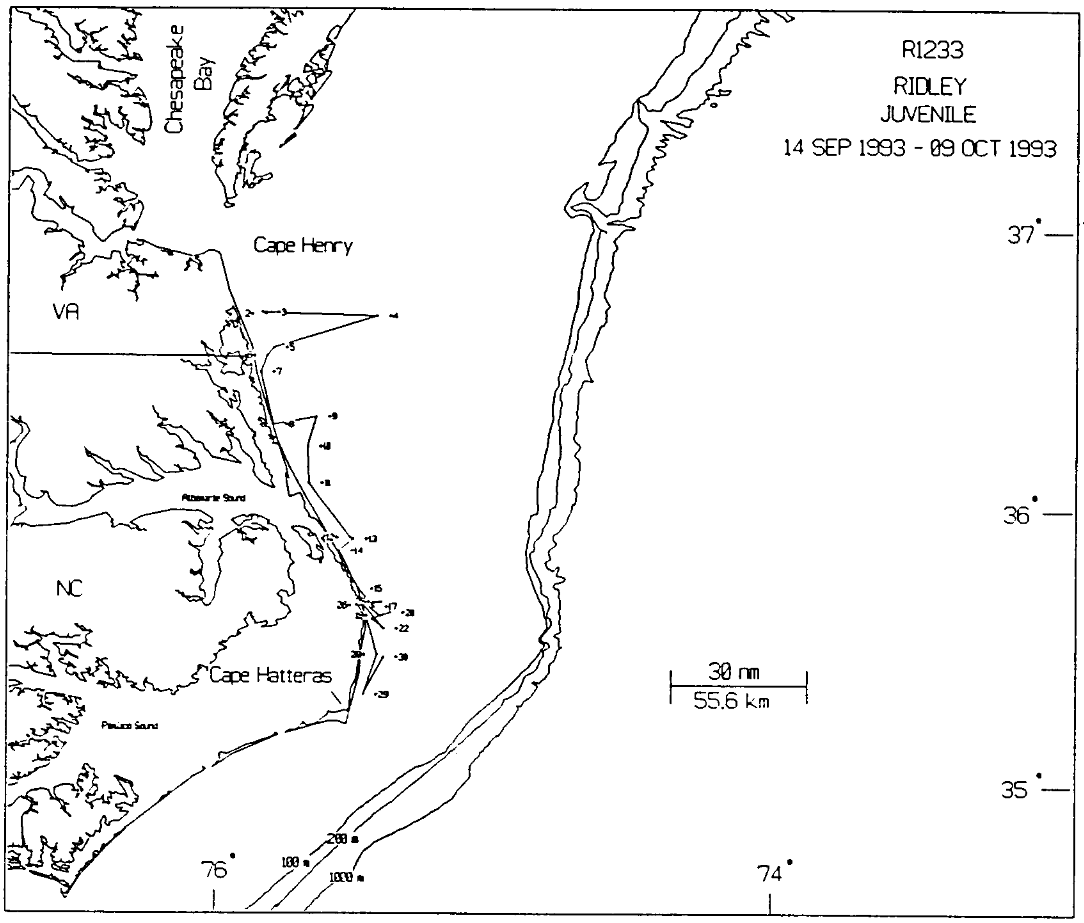

Figure 34. Positions of Kemp's ridley sea turtle 01233 as elucidated by satellite telemetry. The turtle was released at Back Bay National Wildlife Refuge, Virginia Beach, Virginia on 14 September 1993 and the last location was received on 9 October 1993. Numbered points correspond to "POINT NO" in Appendix 15.

R1233

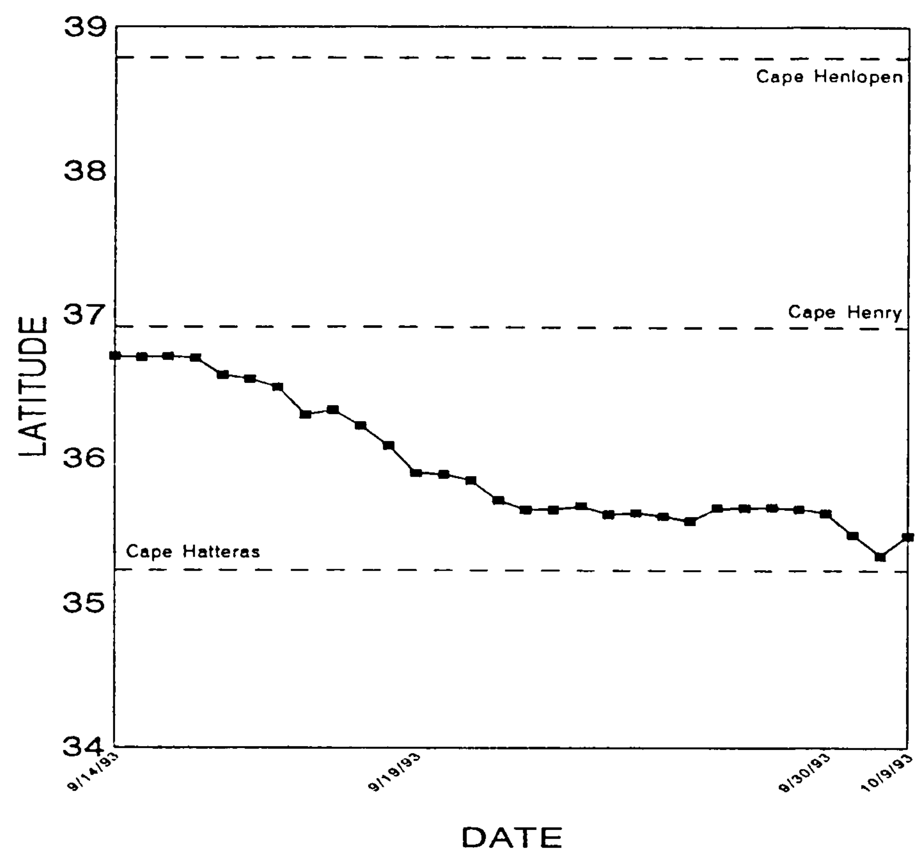

Figure 35. Latitude as a function of date of Kemp's ridley sea turtle 01233 as elucidated by satellite telemetry.

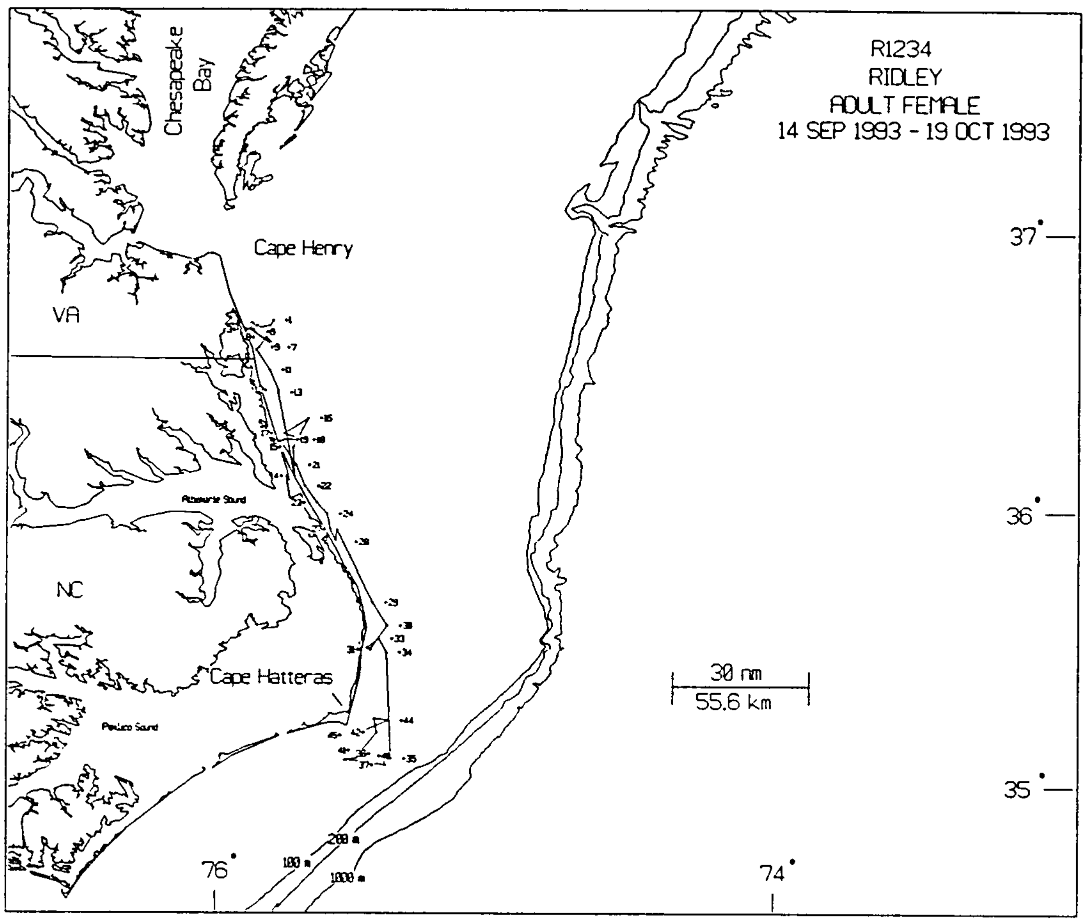

Figure 36. Positions of Kemp's ridley sea turtle 01234 as elucidated by satellite telemetry. The turtle was released at Back Bay National Wildlife Refuge, Virginia Beach, Virginia on 14 September 1993 and the last location was received on 19 October 1993. Numbered points correspond to "POINT NO" in Appendix 16.

R1234

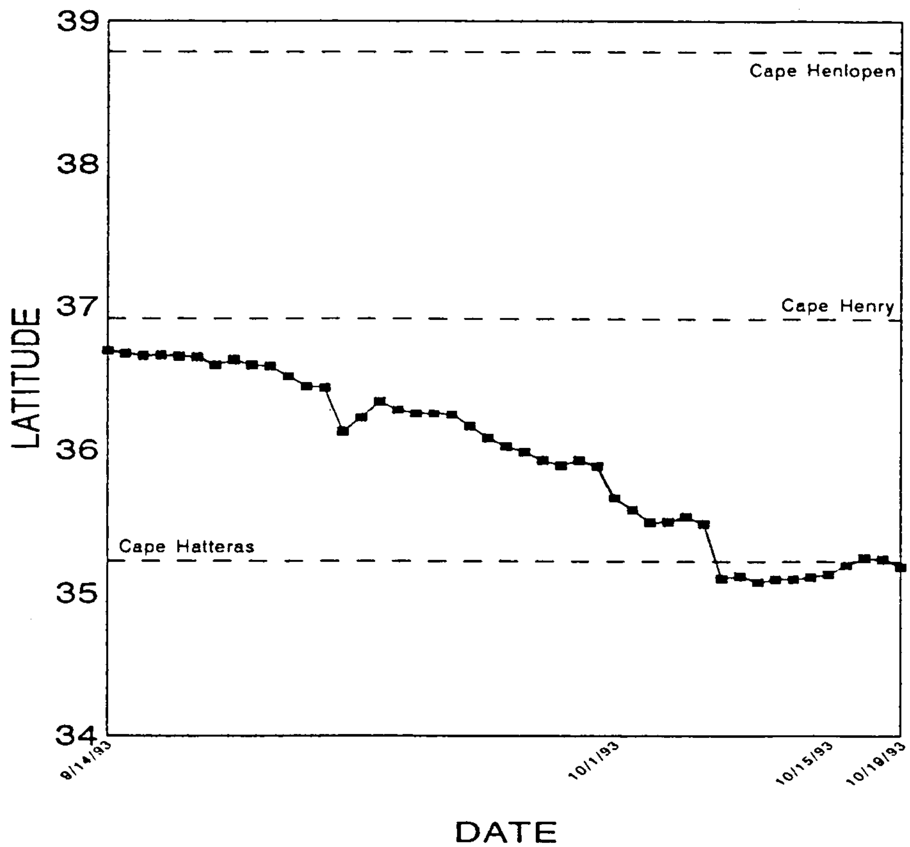

Figure 37. Latitude as a function of date of Kemp's ridley sea turtle 01234 as elucidated by satellite telemetry.

Aerial surveys

Eleven surveys were flown during 1985; nine in the northern zone and two in the southern zone (Figures 2 & 38; Table 3; Appendix 17). During April, more loggerheads were observed in the southern zone. The majority of turtles observed during the year was during early May in the northern zone. Abundances decreased throughout the remainder of the year. Abundance increased during the 6 August survey, decreased in the 5 September and stabilized for the remainder of the year (Table 3; Figure 38).

Nineteen surveys were flown during 1986; 15 in the northern zone and four in the southern zone (Figures 2 & 39; Table 3; Appendix 17). On 7 May both zones were surveyed and turtles were more abundant in the northern zone. Turtles became very abundant in the northern zone during late May, and few were observed in mid-June. Abundances fluctuated throughout the rest of the year (Table 3; Figure 39; Appendix 17).

From 1987 through 1989 ten surveys were flown; nine in the northern zone and one in the southern zone (Figures 2 & 40; Table 3; Appendix 17). Turtles were observed in the northern zone on 16 September 1987, however no turtles were seen in that zone on 3 December. During 1988 turtle abundance was high in early June. Flights on two consecutive days in July showed a variation in abundance between days, but abundance increased until late July. Abundance dropped dramatically in August and October. Two surveys were flown on 25 July 1989; one each in the northern and southern zone. Few but equal numbers of turtles were observed in each zone (Table 3; Figure 40; Appendix 17).

In 1991 and 1992 we attempted to survey each of the three zones (Figures 3, 41, 42) on each day. A plot of distance of turtles observed as a function of distance from the flight line for these surveys (Figure 43) substantiate our previous data suggesting most turtles are observed in a 50 - 300 m swath on each side of the plane. On the first survey, the sea state deteriorated, which limits the ability of observers to see turtles (Thompson, 1984), and the southern zone was not surveyed. In May 1991 most turtles were observed in the northern zone, then turtles became less abundant but approximately equally distributed throughout the summer. During November 1991 most turtles were observed in the southern zone. No turtles were observed in the northern zone in January 1992, and one turtle was seen in each of the other zones. In April 1992 no turtles were observed in the northern zone, and equal numbers were seen in the middle and southern zone. In June turtles were only observed in the northern zone. In July and September most turtles were seen in the northern zone, followed by the middle and southern zones.

Density estimates of surfaced loggerheads for the 1985 - 1989 surveys in the northern zone ranged from 0 (in December) to 0.372 turtles km^{-2} (in May 1986; Table 3). In the southern zone, surface density estimates of loggerheads ranged from 0.017 (in May 1986) to 0.187 turtles km^{-2} (in April 1985). Diving data from three satellite telemetered loggerheads showed that turtles migrating south along the North Carolina coast stayed at the surface 10.6% of the time, providing an adjustment factor of 9.4. Applying the adjustment factor yields population density estimates for loggerheads up to 3.500 turtles km^{-2} in the northern zone and 1.757 turtles km^{-2} in the southern zone (Table 3).

Density estimates of surfaced loggerheads in the 1991-1992 study ranged from 0 (in August 1991, and June and September 1992) to 0.179 turtles km^{-2} in the southern zone, from 0 (in June 1992) to 0.187 turtles km^{-2} (in April 1992) in the middle zone, and from 0 (in January and April 1992) to 0.314 turtles km^{-2} (in July 1992) in the northern zone (Table 4). Applying the adjustment factor of 9.4 yields population density estimates up to 2.952 turtles km^{-2} 1992 and total population estimates up to 4508.88 turtles km^{-2} in the northern zone in July (Table 4).

Leatherbacks were observed in May, July, August, October, and November (Tables 5 & 6). Few leatherbacks were observed on any of the surveys and surfaced turtle density ranged up to 0.070 turtles km^{-2} (Tables 5 & 6). No dive data is available for leatherbacks off North Carolina's coast, however a leatherback turtle tracked off St. Croix Island in the Caribbean was at the surface 13.1% of the time (Keinath and Musick, 1993), yielding an adjustment factor of 7.6 providing population density estimates for leatherbacks in the 1985 - 1989 study up to 0.231 turtles km^{-2} (Table 5) and up to 0.532 turtles km^{-2} in the 1991 - 1992 study when six leatherbacks were observed in the northern zone in July 1992 (Table 6).

During some years the flounder trawl fishery interacts with turtles migrating south in the autumn, and incurs high mortality on sea turtles, which subsequently wash up dead along the coast (Figures 44 & 45). The ratio of stranded Kemp's ridleys to loggerheads range up to 0.2500 (Tables 7 & 8), with geometric means for the ratios of 0.0706 for all years combined, and 0.0953 for only the years which had Kemp's ridley strandings (Table 7). Geometric means for strandings by month was 0.0478 overall (Table 8). However, since Kemp's ridley is a summer estuary inhabitant, and probably only ventures into the area around Cape Hatteras during migration (November through March), and the flounder trawl fishery incurs high mortality on sea turtles during this time (Table 8) (Musick et al., 1992), we feel the ratio for this time period (0.1095) is most representative for calculating standing stock of Kemp's ridleys from stranding ratios (this ratio is also relatively close to the ratio over the years when Kemp's ridleys stranded (Table 7); and the autumn migration period is supported by our satellite tracking). This provides population estimates for Kemp's ridleys up to 493.72 turtles in the northern zone, up to 171.69 turtles in the middle zone, and 224.10 turtles in the southern zone.

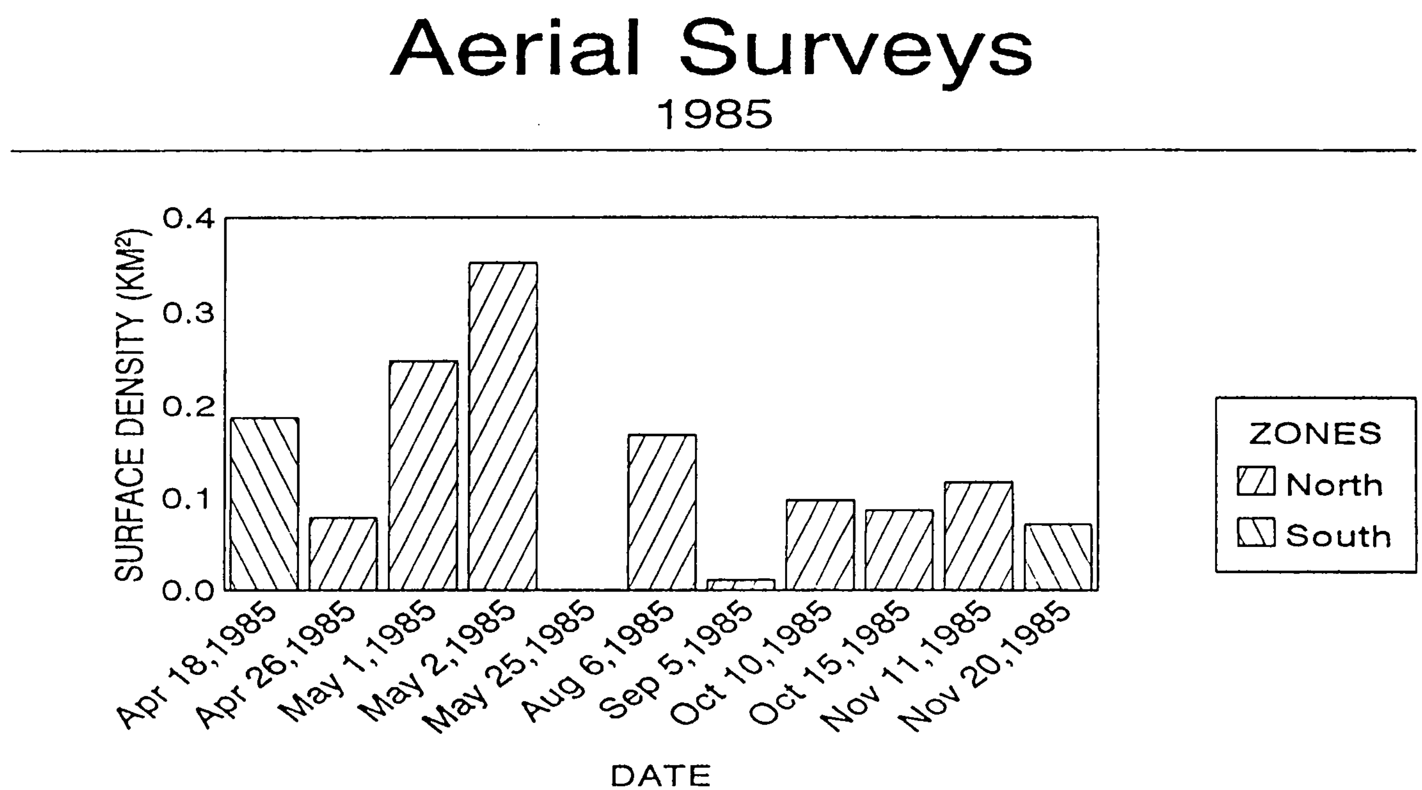

Figure 38. Density of surfaced loggerhead turtles observed on aerial surveys off Cape Hatteras in each of the two zones (Figure 2) during 1985. Either the northern or southern zone was surveyed on a given date. N = northern zone, S = southern zone (adapted from Musick, 1986. 1988; Musick et al., 1987, 1989).

Aerial Surveys

1986

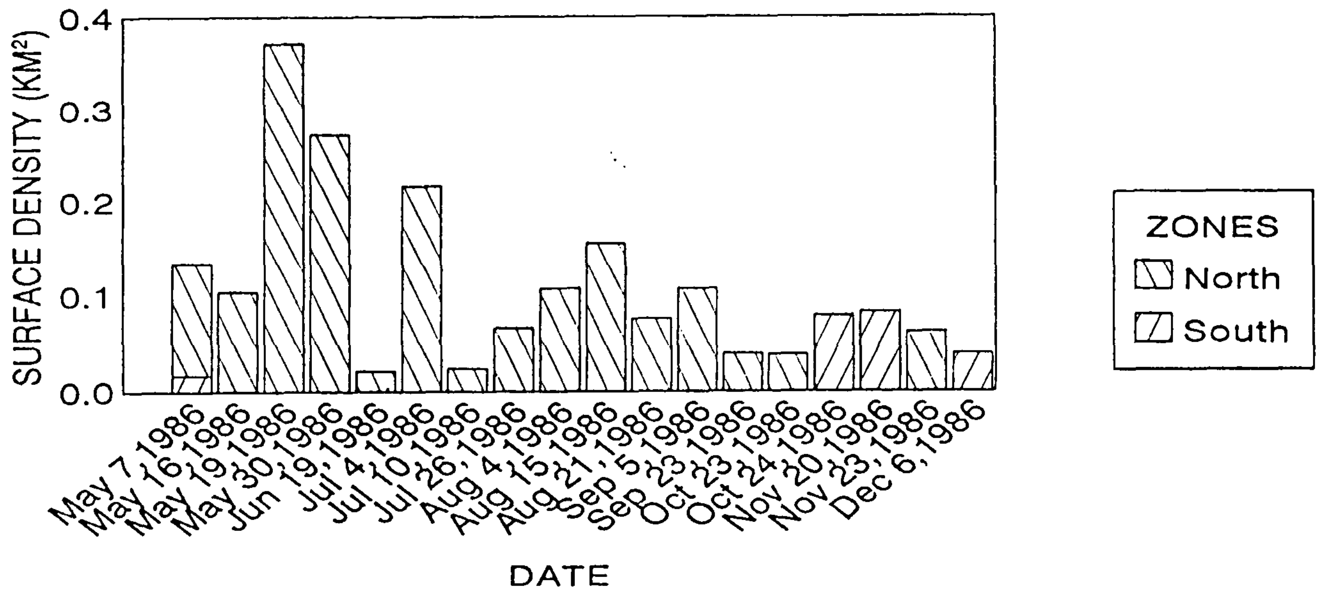

Figure 39. Density of surfaced loggerhead turtles observed on aerial surveys off Cape Hatteras in each of the two zones (Figure 2) during 1986. Both the northern and southern zones were surveyed on 30 April 1986 and 7 May 1986, only one zone was surveyed on the other dates. N = northern zone, S = southern zone (adapted from Musick, 1986. 1988; Musick et al., 1987, 1989).

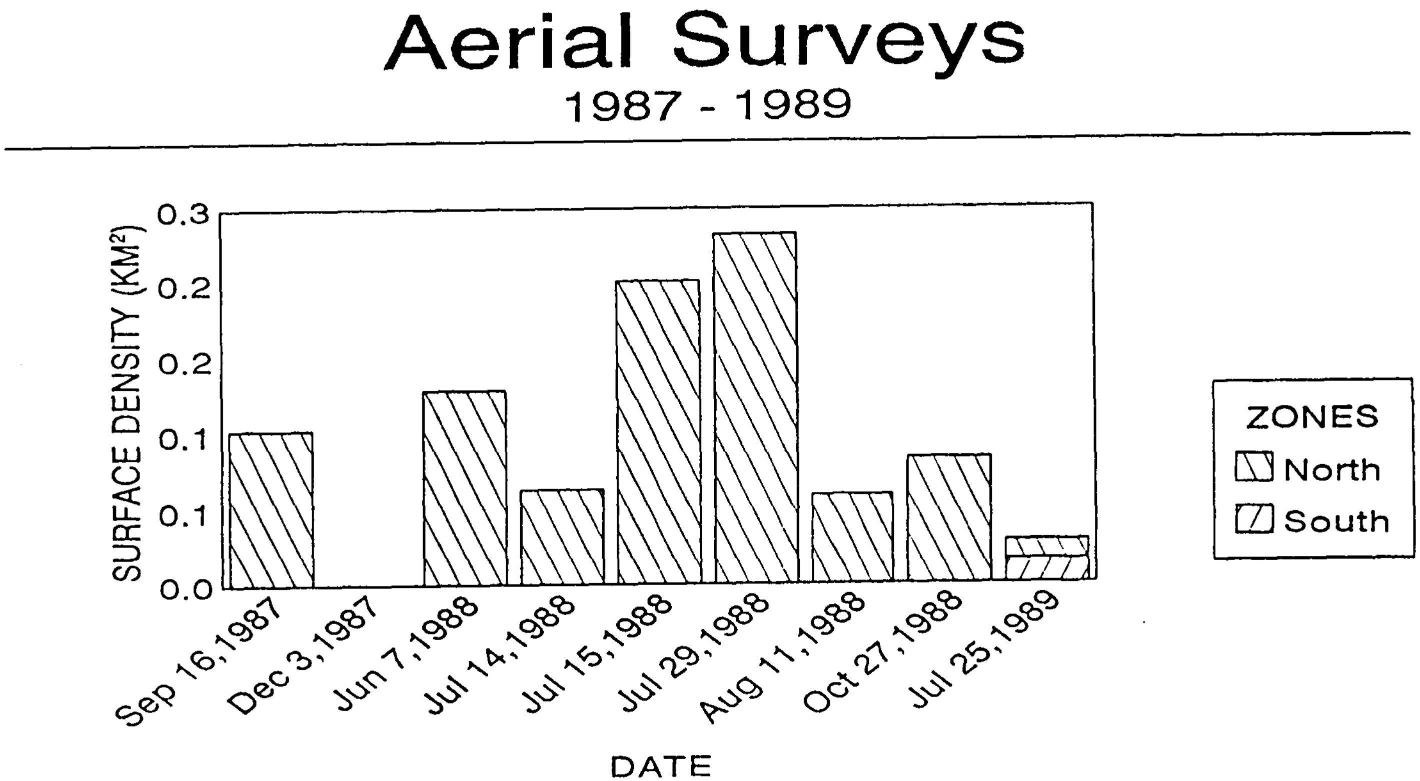

Figure 40. Density of surfaced loggerhead turtles observed on aerial surveys off Cape Hatteras in each of the two zones (Figure 2) during 1987 - 1989. Both the northern and southern zones were surveyed on 25 July 1989, only one zone was surveyed on the other dates. N = northern zone, S = southern zone (adapted from Musick, 1986. 1988; Musick et al., 1987, 1989).

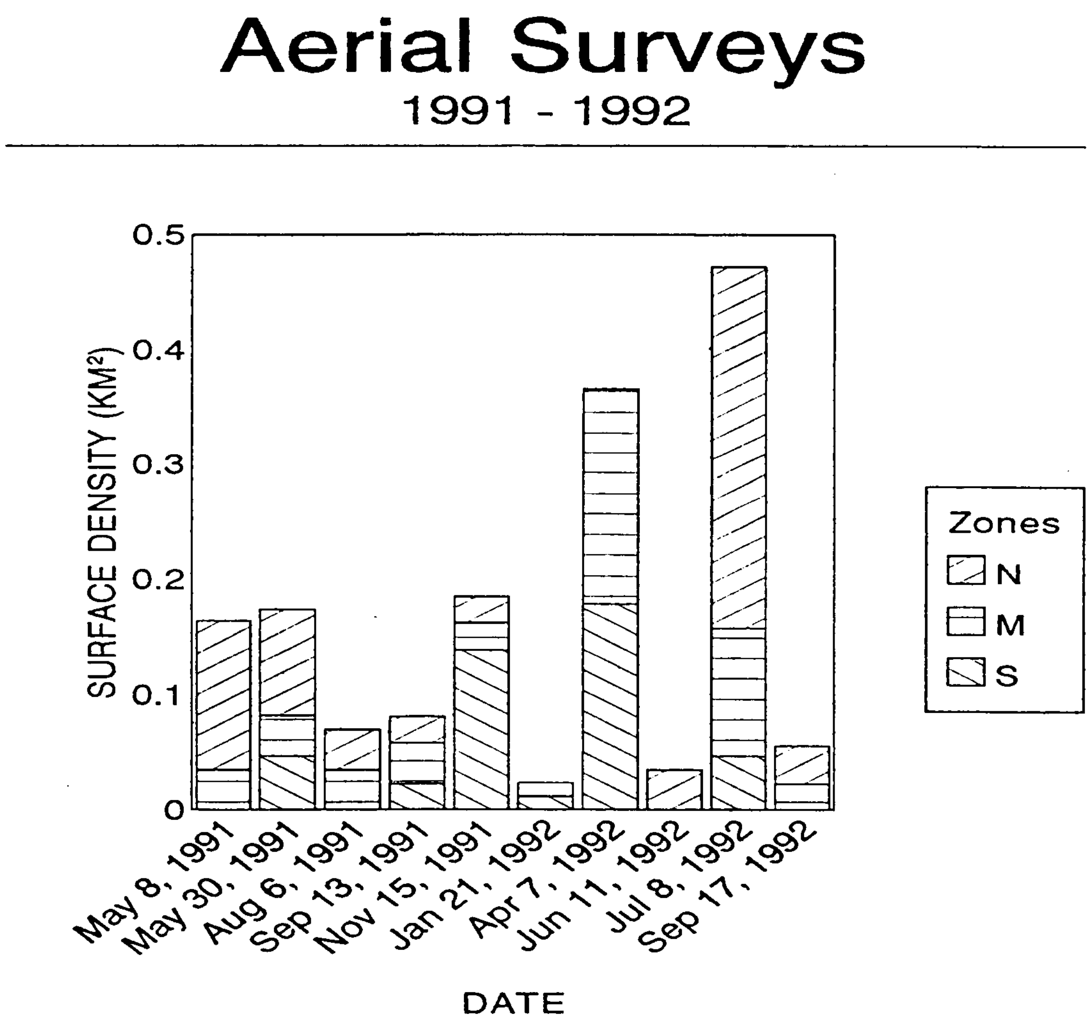

Figure 41. Density of surfaced loggerhead turtles observed on aerial surveys off Cape Hatteras in each of the three zones (Figure 3). Only the northern and middle zones were surveyed on 8 May 1991. All three zones were surveyed on other dates. N = northern zone; M = middle zone; S = southern zone.

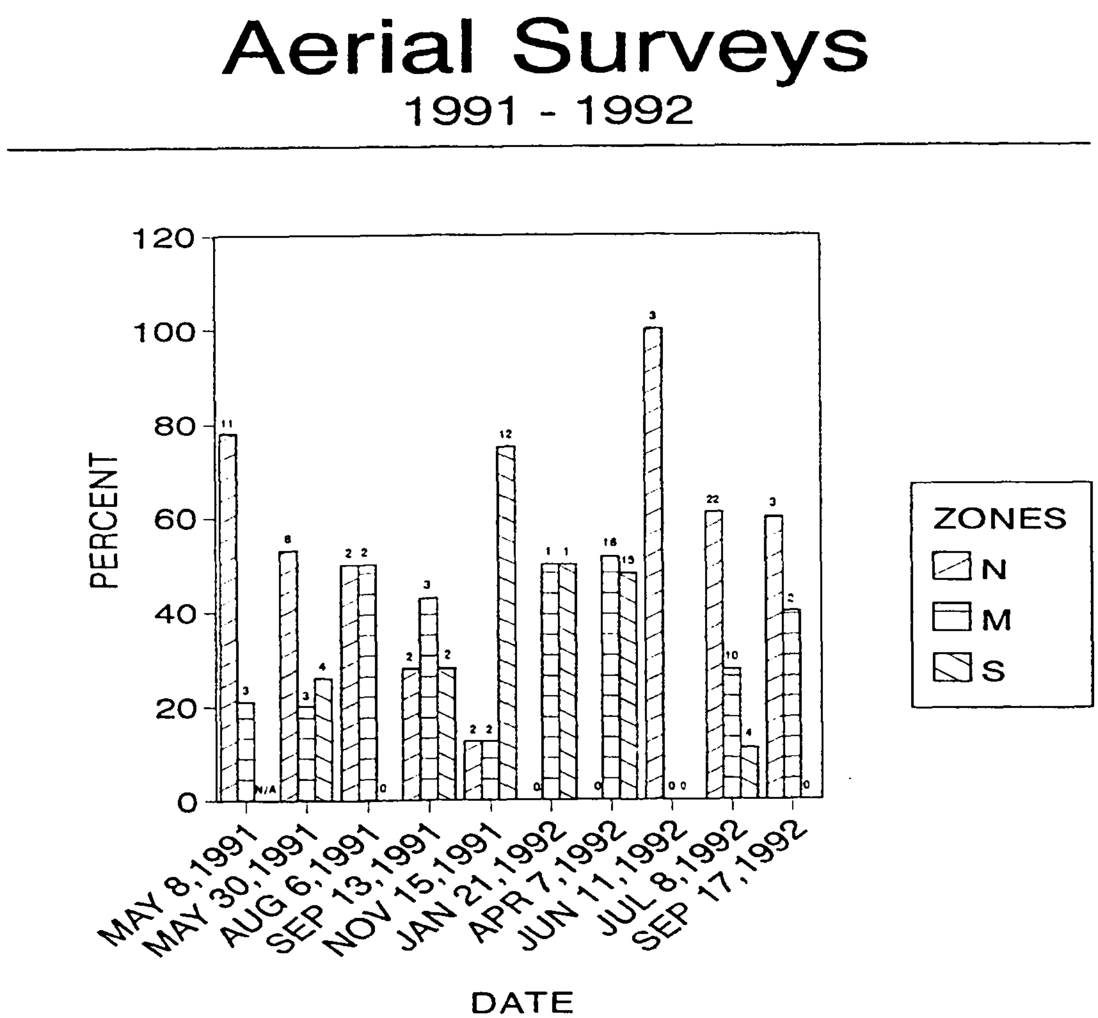

Figure 42. Percentage of loggerhead turtles observed on aerial surveys off Cape Hatteras in each of the three zones (Figure 3). Number of turtles observed over bars. N = northern zone; M = middle zone; S = southern zone; N/A = not surveyed.

Turtles Observed By Distance From Flight Line

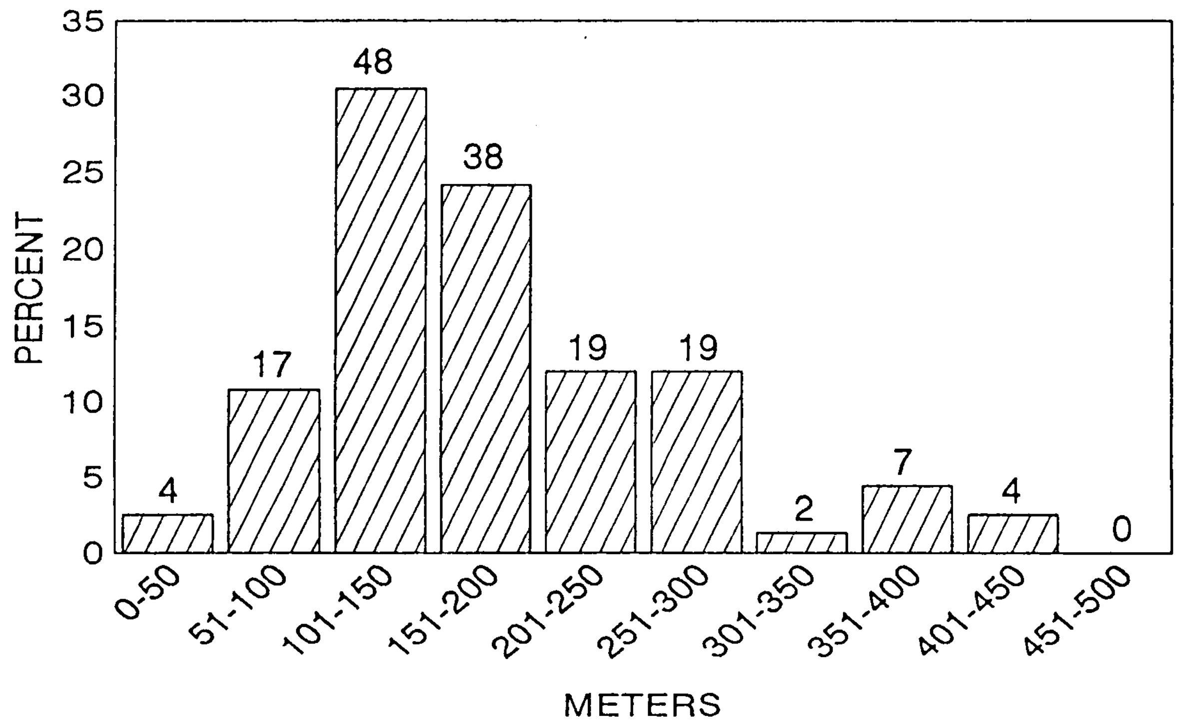

Figure 43. Number of turtles observed by distance from the flight line on aerial surveys performed in 1991 - 1992.

Table 3

Estimated density of loggerhead turtles in the two zones surveyed during 1985 through 1989, in turtles km-2. SD = geometric mean (log(X+1) transformed) surface density (upper number), sample size = number of lines surveyed (in parenthesis), and geometric 95% confidence intervals (lower numbers); EPD = estimated population density, in same format as SD. N/A = not applicable (sample size of 1).

DATE	Northern zone		Southern zone	
	SD	EPD	SD	EPD
18 Apr 1985			0.187 (10) 0.082-0.302	1.757 (10) 0.770-2.840
26 Apr 1985	0.079 (10) 0.040-0.120	0.746 (10) 0.377-1.130		
1 May 1985	0.248 (2) 0.131-0.790	2.327 (2) 1.227-7.426		
2 May 1995	0.352 (2) 0.235-0.481	3.310 (2) 2.207-4.518		
25 May 1985	N/A (1)	N/A (1)		
6 Aug 1995	0.168 (2) 0.164-0.173	1.581 (2) 1.539-1.623		
5 Sep 1985	0.011 (2) 0.011-0.034	0.105 (2) 0.104-0.319		
10 Oct 1985	0.098 (2) 0.012-0.220	0.920 (2) 0.113-2.068		
15 Oct 1985	0.087 (7) 0.005-0.177	0.822 (7) 0.044-1.663		
11 Nov 1985	0.117 (10) 0.021-0.221	1.096 (10) 0.199-2.077		
20 Nov 1985			0.072 (3) 0.037-0.108	0.675 (3) 0.344-1.016
7 May 1986	0.117 (7) 0.040-0.199	1.096 (7) 0.378-1.867	0.017 (9) 0.007-0.042	0.164 (9) 0.066-0.399
16 May 1986	0.104 (2) 0.018-0.241	0.978 (2) 0.165-2.264		
19 May 1986	0.372 (9) 0.259-0.495	3.500 (9) 2.439-4.656		

Table 3

Estimated density of loggerhead turtles in the two zones surveyed during 1985 through 1989, in turtles km-2. SD = geometric mean (log(X+1) transformed) surface density (upper number), sample size = number of lines surveyed (in parenthesis), and geometric 95% confidence intervals (lower numbers); EPD = estimated population density, in same format as SD. N/A = not applicable (sample size of 1). (continued).

DATE	Northern zone		Southern zone	
	SD	EPD	SD	EPD
30 May 1986	0.273 (12) 0.160-0.398	2.570 (12) 1.504-3.742		
19 Jun 1986	0.0212 (8) 0.003-0.040	0.200 (8) 0.028-0.375		
4 Jul 1986	0.217 (8) 0.103-0.342	2.035 (8) 0.969-3.212		
10 Jul 1986	0.024 (8) 0.001-0.050	0.228 (8) 0.007-0.469		
26 Jul 1986	0.066 (4) 0.053-0.080	0.624 (4) 0.498-0.752		
4 Aug 1986	0.107 (8) 0.061-0.156	1.009 (8) 0.572-1.465		
15 Aug 1986	0.155 (8) 0.073-0.244	1.457 (8) 0.682-2.292		
21 Aug 1986	0.076 (8) 0.043-0.109	0.713 (8) 0.407-1.028		
5 Sep 1986	0.107 (8) 0.069-0.148	1.009 (8) 0.645-1.387		
23 Sep 1986	0.040 (12) 0.020-0.060	0.373 (12) 0.186-0.563		
23 Oct 1986	0.039 (10) 0.010-0.070	0.371 (10) 0.090-0.660		
24 Oct 1986			0.079 (9) 0.020-0.142	0.743 (9) 0.185-1.332
20 Nov 1986			0.083 (9) 0.020-0.160	0.779 (9) 0.100-1.507
23 Nov 1986	0.062 (12) 0.015-0.111	0.580 (12) 0.140-1.041		

Table 3

Estimated density of loggerhead turtles in the two zones surveyed during 1985 through 1989, in turtles km-2. SD = geometric mean (log(X+1) transformed) surface density (upper number), sample size = number of lines surveyed (in parenthesis), and geometric 95% confidence intervals (lower numbers); EPD = estimated population density, in same format as SD. N/A = not applicable (sample size of 1). (continued).

DATE	Northern zone		Southern zone	
	SD	EPD	SD	EPD
6 Dec 1986			0.040 (9) 0.004-0.086	0.374 (9) 0.040-0.806
16 Sep 1987	0.103 (9) 0.044-0.164	0.965 (9) 0.416-1.544		
3 Dec 1987	0.000 (11)	0.000 (11)		
7 Jun 1988	0.129 (10) 0.055-0.208	1.213 (10) 0.519-1.955		
14 Jul 1988	0.064 (10) 0.020-0.110	0.603 (10) 0.187-1.037		
15 Jul 1988	0.201 (14) 0.118-0.290	1.886 (14) 1.105-2.725		
29 Jul 1988	0.232 (14) 0.160-0.309	2.184 (14) 1.504-2.908		
11 Aug 1988	0.060 (10) 0.027-0.094	0.566 (10) 0.254-0.888		
27 Oct 1988	0.084 (14) 0.042-0.129	0.792 (14) 0.391-1.210		
25 Jul 1989	0.013 (10) 0.002-0.024	0.123 (10) 0.017-0.230	0.016 (9) 0.000-0.033	0.152 (9) 0.002-0.309

Table 4

Estimated density of loggerhead turtles in the three zones surveyed during 1991 and 1992, in turtles km^{-2}. SD = calculated surface density; EPD = estimated population density. ESS = estimated standing stock in each zone in # turtles. Mean is geometric mean (log(x + 1)), CI = 95% confidence intervals. Number of turtles observed indicated in parenthesis under means. Six lines were surveyed in each zone.

DATE	ZONE	SD Mean	SD CI	EPD Mean	EPD CI	ESS Mean	ESS CI
8 May 91	North	0.129 (11)	0.054-0.209	1.213	0.508-1.965	1852.74	775.92-3001.34
	Mid	0.035 (3)	0.004-0.068	0.329	0.038-0.639	293.44	33.89-569.92
30 May 91	North	0.092 (8)	0.010-0.180	0.865	0.094-1.692	1321.20	143.58-2584.36
	Mid	0.035 (3)	0.004-0.068	0.329	0.038-0.639	293.44	33.89-569.92
	South	0.047 (4)	0.000-0.095	0.442	0.000-0.893	537.47	0-1085.89
6 Aug 91	North	0.035 (2)	0.004-0.068	0.329	0.038-0.639	502.51	58.04-976.01
	Mid	0.035 (2)	0.004-0.068	0.329	0.038-0.639	293.44	33.89-569.92
	South	0.000	0.000-0.000	0.000	0.000	000.00	000.00
13 Sept 91	North	0.023 (2)	0.000-0.054	0.216	0.000-0.508	329.92	0-775.92
	Mid	0.035 (3)	0.004-0.068	0.329	0.038-0.639	293.44	33.89-976.01
	South	0.023 (3)	0.000-0.070	0.216	0.000-0.658	262.66	0-800.13

Table 4

Estimated density of loggerhead turtles in the three zones surveyed during 1991 and 1992, in turtles km^{-2}. SD = calculated surface density; EPD = estimated population density. ESS = estimated standing stock in each zone in # turtles. Mean is geometric mean (log(x + 1)), CI = 95% confidence intervals. Number of turtles observed indicated in parenthesis under means. Six lines were surveyed in each zone. (continued).

DATE	ZONE	SD		EPD		ESS	
		Mean	CI	Mean	CI	Mean	CI
15 Nov 91	North	0.023 (2)	0.000-0.054	0.216	0.000-0.508	329.92	0-775.92
	Mid	0.023 (2)	0.000-0.054	0.216	0.000-0.508	192.65	0-453.09
	South	0.139 (12)	0.046-0.240	1.307	0.432-2.256	1589.31	525.31-2743.30
21 Jan 92	North	0.000	0.000-0.000	0.000	0.000	000.00	000.00
	Mid	0.012 (1)	0.000-0.035	0.113	0.000-0.329	100.78	0-293.44
	South	0.012 (1)	0.000-0.035	0.113	0.000-0.329	137.41	0-400.06
7 Apr 92	North	0.000	0.000-0.000	0.000	0.000	000.00	000.00
	Mid	0.187 (16)	0.096-0.286	1.758	0.902-2.688	1567.96	804.49-2397.43
	South	0.179 (15)	0.132-0.228	1.683	1.241-2.143	2046.53	1509.06-2605.89
11 Jun 92	North	0.035 (3)	0.000-0.083	0.329	0.000-0.780	502.51	0-1191.37
	Mid	0.000	0.000-0.000	0.000	0.000	000.00	000.00
	South	0.000	0.000-0.000	0.000	0.000	000.00	000.00

Table 4

Estimated density of loggerhead turtles in the three zones surveyed during 1991 and 1992, in turtles km^{-2}. SD = calculated surface density; EPD = estimated population density. ESS = estimated standing stock in each zone in # turtles. Mean is geometric mean (log(x + 1)), CI = 95% confidence intervals. Number of turtles observed indicated in parenthesis under means. Six lines were surveyed in each zone. (continued).

DATE	ZONE	SD Mean	SD CI	EPD Mean	EPD CI	ESS Mean	ESS CI
8 Jul 92	North	0.314 (23)	0.123-0.538	2.952	1.156-5.057	4508.88	1765.67-7724.06
	Mid	0.111 (10)	0.000-0.245	1.043	0.000-2.303	930.25	0-2054.05
	South	0.047 (4)	0.017-0.079	0.442	0.160-0.743	537.47	194.56-903.49
17 Sept 92	North	0.033 (3)	0.000-0.103	0.310	0.000-0.968	473.49	0-1478.52
	Mid	0.023 (2)	0.000-0.054	0.216	0.000-0.508	192.65	0-453.09
	South	0.000	0.000-0.000	0.000	0.00	000.00	000.00

Table 5

Estimated density of leatherback turtles in the two zones surveyed during 1985 through 1989, in turtles km-2. SD = calculated surface density; EPD = estimated population density. Numbers of turtles observed are indicated in parenthesis.

DATE	Northern zone SD	EPD	Southern zone SD	EPD
18 Apr 1985			0	0
26 Apr 1985	0	0		
1 May 1985	0	0		
2 May 1985	0	0		
25 May 1985	0	0		
6 Aug 1985	0.041 (1)	0.309		
5 Sep 1985	0	0		
10 Oct 1985	0	0		
15 Oct 1985	0	0		
11 Nov 1985	0	0		
20 Nov 1985			0	0
7 May 1986	0	0		
16 May 1986	0	0		
19 May 1986	0	0		
30 May 1986	0.009 (1)	0.065		
19 Jun 1986	0	0		
4 Jul 1986	0.030 (3)	0.231		
10 Jul 1986	0	0		
26 Jul 1986	0	0		
4 Aug 1986	0.009 (1)	0.066		
15 Aug 1986	0	0		
21 Aug 1986	0	0		
5 Sep 1986	0	0		

Table 5

Estimated density of leatherback turtles in the two zones surveyed during 1985 through 1989, in turtles km-2. SD = calculated surface density; EPD = estimated population density. Numbers of turtles observed are indicated in parenthesis. (continued).

DATE	Northern zone SD	Northern zone EPD	Southern zone SD	Southern zone EPD
23 Sep 1986	0	0		
23 Oct 1986	0	0		
24 Oct 1986			0	0
20 Nov 1986			0	0
23 Nov 1986	0.012 (2)	0.089		
6 Dec 1986			0	0
16 Sep 1987	0	0		
3 Dec 1987	0	0		
7 Jun 1988	0	0		
14 Jul 1988	0	0		
15 Jul 1988	0.029 (5)	0.224		
29 Jul 1988	0.004 (1)	0.030		
11 Aug 1988	0	0		
27 Oct 1988	0.018 (4)	0.135		
25 Jul 1989	0	0	0	0

Table 6

Estimated density of leatherback turtles in the three zones surveyed during 1991 and 1992, in turtles km^{-2}. SD = calculated surface density; EPD = estimated population density; NS = not surveyed. Number of turtles observed in parenthesis.

DATE	Northern zone		Middle zone		Southern zone	
	SD	EPD	SD	EPD	SD	EPD
8 May 1991	0	0	0	0	NS	NS
30 May 1991	0	0	0	0	0	0
6 Aug 1991	0.012 (1)	0.091	0.012 (1)	0.091	0	0
13 Sep 1991	0	0	0	0	0	0
15 Nov 1991	0	0	0	0	0	0
21 Jan 1992	0	0	0	0	0	0
7 Apr 1992	0	0	0	0	0	0
11 Jun 1992	0	0	0	0	0	0
8 Jul 1992	0.070 (6)	0.532	0	0	0	0
17 Sep 1992	0	0	0	0	0	0

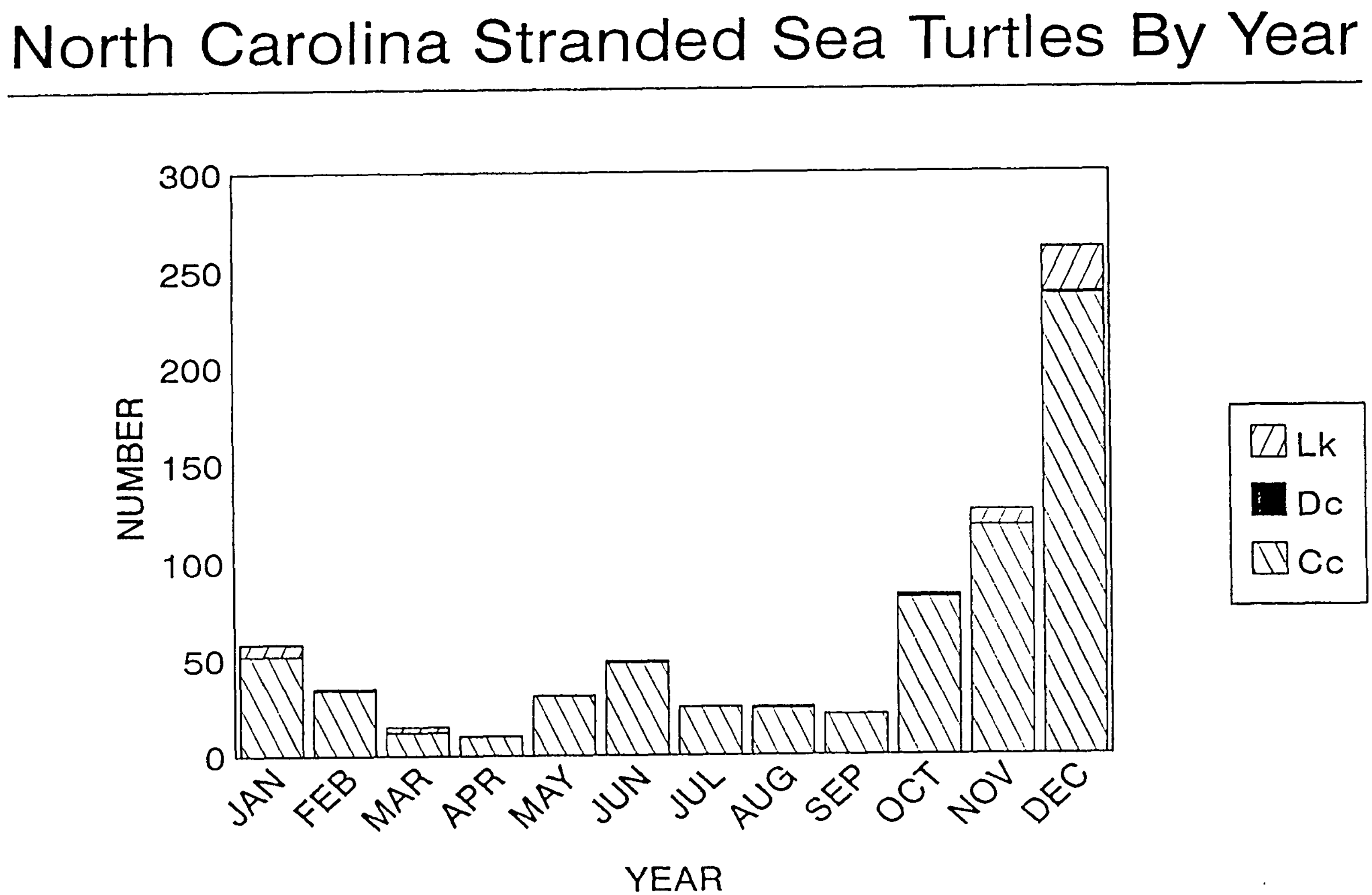

Figure 44. Number of Kemp's ridley (Lk), leatherback (Dc), and loggerhead (Cc) sea turtles stranded in STSSN zone 35 (35° to 36° north latitude) by year, all months combined. From STSSN, 1991.

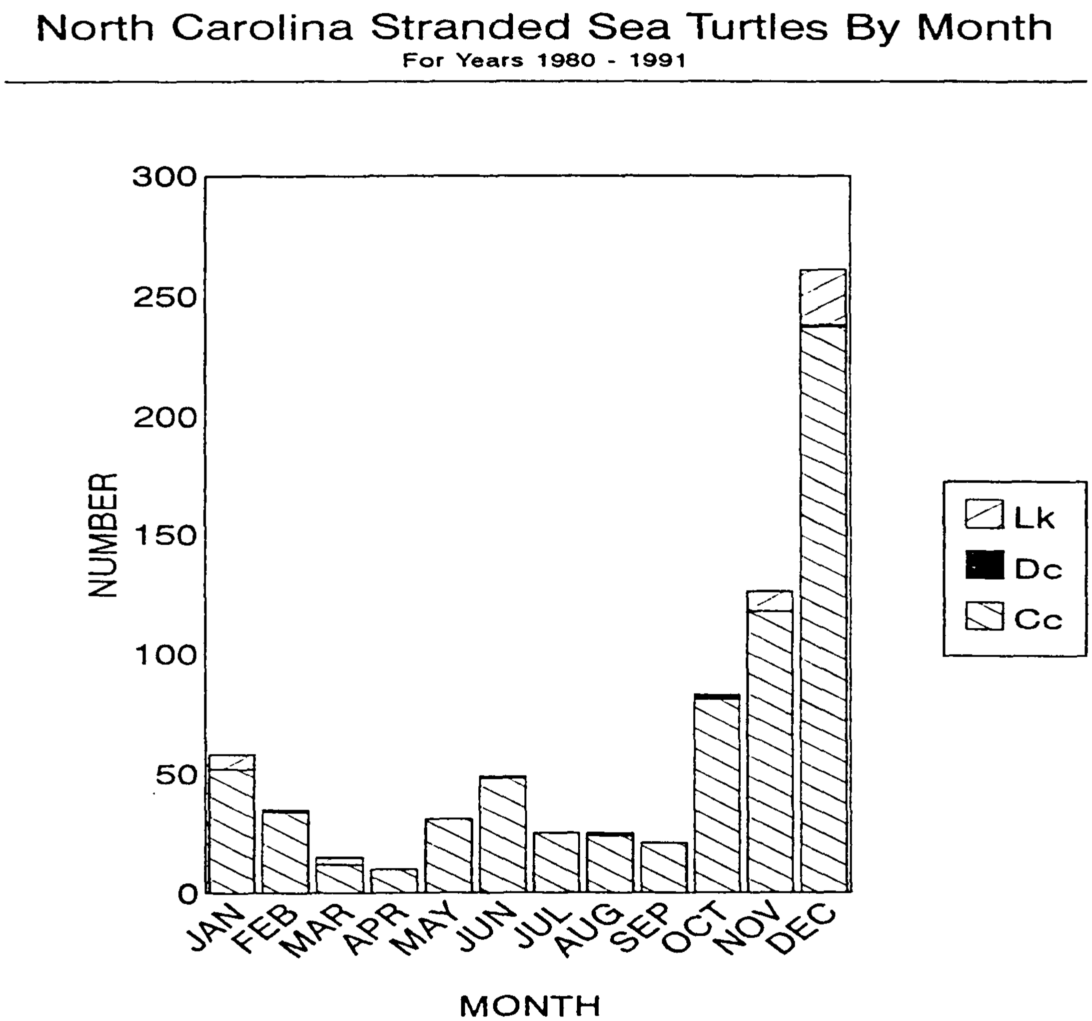

Figure 45. Number of Kemp's ridley (Lk), leatherback (Dc), and loggerhead (Cc) sea turtles stranded in STSSN zone 35 (35° to 36° north latitude) by month for years 1980-1991. From STSSN, 1991.

Table 7

Ratios of stranded Kemp's ridley (Lk) sea turtles to loggerheads (Cc) by year in STSSN zone 35 (35° to 36° north latitude) (STSSN, 1991). OVERALL = geometric (log(X+1) transformed) mean for all months, NOV-MAR = geometric mean for november - march.

YEAR	Lk:Cc
1980	0
1981	0.1786
1982	0.0331
1983	0
1984	0
1985	0.0183
1986	0.0750
1987	0.2353
1988	0.0545
1989	0.0256
1990	0.1325
1991	0.1250
OVERALL	0.0706
DISCOUNTING ZEROS	0.0953

Table 8

Ratios of stranded Kemp's ridley (Lk) sea turtles to loggerheads (Cc) by month (1980-1991) in STSSN zone 35 (35° to 36° north latitude) (STSSN 1991). OVERALL = geometric (log(X+1) transformed) mean for all months, NOV-MAR = geometric mean for november - march. Confidence interval in parenthesis.

MONTH	Lk:Cc
JAN	0.1154
FEB	0.0294
MAR	0.2500
APR	0
MAY	0
JUN	0
JUL	0
AUG	0.0417
SEP	0
OCT	0
NOV	0.0678
DEC	0.0970
OVERALL	0.0478
NOV-MAR	0.1095

4. DISTRIBUTION AND MOVEMENTS

Since 1985 a total of 16 turtles (nine loggerheads and seven Kemp's ridleys) were successfully satellite tracked, the longest for 270 days. Except for one Kemp's ridley which entered the Chesapeake Bay, turtles migrated south from waters north of Cape Hatteras in the autumn, rounding Cape Hatteras during October and November. Once south of Hatteras, telemetered turtles either became pelagic in deep offshore waters (two loggerheads), travelled nearshore to Florida (two loggerheads and two Kemp's ridleys), over-wintered off North Carolina in the west side of the Gulf Stream (three loggerheads and four Kemp's ridleys), or transmissions ceased shortly after rounding the Cape (one loggerhead), with the exception of one transmitter that ceased in Pamlico Sound (one loggerhead) . One loggerhead which overwintered off Florida and three which overwintered off North Carolina returned to the Chesapeake Bay the following year, rounding Cape Hatteras during May. Because of cold temperatures north of Cape Hatteras in the winter, sea turtles must travel to the south of Hatteras or to warmer waters. Keinath (1993) found Kemp's ridleys consistently inhabited waters between 15 and 20°C, while loggerheads inhabited water temperatures both higher and lower than that. Shoop (1987) observed loggerheads and Kemp's ridleys at Georges Banks from May through October, however turtles were not observed there from October through April. Some turtles may overwinter off North Carolina in the west wall of the Gulf Stream, but as in more southerly areas they appear to avoid fully entering the Gulf Stream (Fritts et al., 1983a, 1983b; Hoffman and Fritts, 1982; Schroeder and Thompson, 1987; Thompson, 1984), and if they do they get carried north in the Stream, as did two of our satellite tracked turtles. It appears 15°C is the temperature that mediates migration (Keinath, 1993). Flipper tagging has indicated that loggerhead and Kemp's ridley turtles may migrate as far south as Georgia and Florida (Keinath, 1993; Sauls et al., 1990; Shoop and Ruckdeschel, 1989), and leatherbacks as may travel to and from the Caribbean sea (Keinath and Musick, 1990; Keinath and Fretey, unpublished data). Killingley and Lutcavage (1983) showed that loggerhead turtles from Chesapeake Bay had previously occupied warmer, non-estuarine waters, probably to the south of Virginia in the open ocean. It appears loggerheads are not uncommon south of Cape Hatteras from January through March, but only in offshore waters (Anon., 1985; Epperly et al., 1990, 1993; Fahy, 1954; Fritts et al., 1983b; Lee and Palmer, 1981; Lee and Socci, 1989; Schwartz, 1989; Thompson, 1984, 1988). This phenomenon has also been observed off Florida (Shroeder and Thompson, 1987). Our aerial surveys also detected a southerly migration past Cape Hatteras during October and November and a northerly spring migration past Cape Hatteras in May, consistent with other studies (Epperly et al., 1989).

Our data suggest that Kemp's ridleys and loggerheads tend to follow inshore migration routes around Cape Hatteras. Kemp's ridleys and some loggerheads appear to continue to travel south to Florida for the winter, however some loggerheads occur 50 - 100 km off North Carolina under the influence of the Gulf Stream even in winter. Although a sample size of seven Kemp's ridleys was small and many Kemp's may behave otherwise (as was found in our results for loggerhead turtles), these observations are in agreement with Shoop and Kenney (1992) and other workers to the north of North Carolina (Byles, 1982; Morreale, Pers. Com.) who observed some Kemp's ridleys moving offshore in the fall, possibly in response to cold inshore water. Although turtles may travel to the south to avoid cold temperatures in the winter (Henwood and Ogren, 1987; Keinath, 1993), migration south of North Carolina is not required to find warm water and turtles can overwinter off North Carolina in the west side of the Gulf Stream (Anon., 1992; Lee and Palmer, 1981; Schwartz, 1989; Thompson, 1988), where winter water temperatures are above 17°C (Anon., 1992).

5. POPULATION CHARACTERISTICS

In general, population densities of loggerheads reached a maximum from Cape Hatteras south in April with a secondary peak in November. In accordance with other researchers (Epperly et al., 1989, 1993; Fritts et al., 1983a; Lee and Palmer,1981; Lee and Socci, 1989, Thompson, 1984, 1988) who observed loggerheads in inshore waters near Cape Hatteras from April through November, our estimated population densities were highest in May with a secondary peak in November (Figures 38 - 41, Tables 3 & 4). We feel that high density estimates observed on 6 August 1985, 4 July 1986, 29 July 1988, and 8 July 1992 may have been due to changes in the turtles' surfacing behavior rather than to real increases in standing stocks. The coastal region from Cape Hatteras to Cape Henry is subject to periodic upwelling caused by prolonged southwesterly winds in July and August (Hicks and Miller, 1980; Ingham and Eberwine, 1984; Norcross and Austin, 1988; Wells and Gray, 1960). This phenomenon pulls in cold bottom water from offshore and establishes a strong thermocline. Loggerheads tend to occur in waters of 15 - 18°C or higher (Keinath, 1993; Lutcavage and Musick 1985), and spend more time on the surface when a strong thermocline is present (Keinath and Musick, Unpub. data), and this could explain the July peak of a number of turtles higher than expected (Fig. 41). Data for leatherback turtles shows similar peaks in turtle densities (Tables 5 & 6), although leatherbacks are more tolerant of colder temperatures.

Most of our surface density calculations for loggerheads are comparable to those reported by Shoop et al. (1981) (0.0015 to 0.15 turtles km^{-2}) and Shoop and Kenney (1992) (0.00164 to 0.510 turtles km^{-2}) for the coastal North Atlantic; with the densities reported by Epperly et al., (1990) (up to 0.28 turtles km^{-2}) in Core Sound, North Carolina; and those estimated by Byles (1988) (up to 0.377 turtles km^{-2}) in the lower Chesapeake Bay. We calculated standing stock densities of loggerheads up to 2.952 turtles km^{-2}, comparable to those reported by Keinath et al. (1987b) for the lower Chesapeake Bay (up to 6.1 turtles km^{-2}, with a mode of approximately 3 turtles km^{-2}) and offshore northern North Carolina and southern Virginia (0.4 to 6.6). Byles (1988) calculated the total standing stock of lower Chesapeake Bay of 7905 (S.E. of the mean = 1496) turtles, much larger than our estimates for the three zones around Cape Hatteras. However, Shoop and Kenney (1992) estimated a total population of 2,200 to 11,000 loggerheads in their study area (the coast of the U.S. from Cape Hatteras to Nova Scotia) which encompasses our estimates. Shoop and Kenney stated that their density estimates were greater than any previously reported for the Gulf of Mexico and eastern Florida.

Shoop and Kenney (1992) estimated surface densities of leatherbacks in their study area of 0.00209 - 0.0216 turtles km^{-2}, and a total population of 100 - 900. These density estimate are much lower than our findings, and reflects the small number of turtles observed most of the time, and a large number of turtles observed on single surveys. It is likely this is due to the generally accepted theory that leatherbacks travel north and south in groups, thus providing data such as we observed.

Although Kemp's ridleys are hard to detect by aerial survey, relative temporal and geographic trends in Kemp's ridley population abundance closely reflects those of loggerheads in the spring and fall (but absolute abundance is much lower). Both stranding patterns and tracking studies suggest that Kemp's ridleys migrate through the Hatteras migration corridor at the same time as loggerheads. In summer, however, there probably is a difference between the species because Kemp's ridleys prefer to forage in shallow areas within estuaries such as Chesapeake Bay (Byles, 1988; Lutcavage and Musick, 1985) and Core Sound (Epperly et al., 1990), whereas loggerheads use deeper channel areas in estuaries (Byles, 1988; Lutcavage and Musick, 1985) and occur along the coast (see above). Our maximum estimate of Kemp's ridley standing stock agrees well with the numbers calculated for the Chesapeake Bay standing stock (Keinath et al., 1991) of 300 - 500 turtles.

6. CONCLUSIONS

We estimate up to 4500 loggerheads and approximately 500 Kemp's ridley sea turtles migrate from the south around Cape Hatteras during May to northern summer feeding areas. They return in fall to the south of Cape Hatteras, rounding the Cape during October and November. This movement is probably mediated by water temperature of about 15°C. Kemp's ridleys, as well as some loggerheads, appear to overwinter nearshore as far south as Florida, while other loggerheads either become pelagic in the North Atlantic or stay along the outer shelf over live bottom at the west edge of the Gulf Stream off North Carolina over the winter. Our findings suggest that loggerheads occur near the Manteo Block mostly in the spring and fall, but some loggerheads winter in the Gulf Stream south of the Manteo Block. Kemp's ridleys appear to utilize areas well inshore of the Manteo Block site. Aerial surveys appear to give population estimates comparable to other studies and is perhaps among the best methods for calculating standing stocks. Data for calculating standing stocks, and for tracking movements can be gathered successfully by satellite telemetry, however the ST-3 transmitters appear to transmit data over significantly longer time periods than the ST-6 transmitters. Unfortunately, the ST-3 transmitters are too large to attach to small Kemp's ridley sea turtles.

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8. APPENDICES

Appendix 1. Data from loggerhead 5780 tracked via satellite in 1991 - 1992. POINT NO. corresponds to number points in Figure 11. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	10/28/85	18:57:45	36.4	75.4
2	11/03/85	23:50:49	35.7	75.6
3	11/09/85	13:30:57	35.6	75.6
4	11/09/85	18:32:34	35.6	75.6
5	11/15/85	20:49:51	35.5	75.7
6	11/15/85	22:22:00	35.5	75.7
7	11/17/85	13:36:11	35.5	75.7
8	11/17/85	20:28:29	35.4	75.7
9	11/19/85	20:04:44	35.4	75.8
10	11/23/85	19:23:53	35.3	75.8
11	11/25/85	18:59:11	35.3	75.9
12	11/29/85	20:00:56	35.2	75.9

Appendix 2. Data from loggerhead 5781 tracked via satellite in 1991 - 1992. POINT NO. corresponds to number points in Figure 13. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	11/27/85	18:36:24	35.2	75.5
2	12/06/85	22:17:02	34.7	76.3
3	12/14/85	22:22:57	34.0	76.7
4	12/16/85	20:22:21	33.9	76.5
5	12/30/85	19:30:58	36.1	73.9
6	12/30/85	22:38:35	36.1	73.9
7	12/31/85	22:13:55	36.7	73.5
8	01/02/86	17:18:31	37.8	73.2
9	01/08/86	19:36:54	37.4	74.0
10	01/15/86	20:01:48	36.1	74.5

Appendix 3. Data from loggerhead 5783 tracked via satellite in 1991 - 1992. POINT NO. corresponds to number points in Figure 15. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	10/09/86	19:19:24	37.1	76.2
2	10/16/86	01:26:53	36.4	75.7
3	10/18/86	19:25:56	35.5	75.4
4	10/18/86	21:04:01	35.5	75.4
5	10/31/86	18:43:59	34.9	75.6

Appendix 4. Data from loggerhead 5784 tracked via satellite in 1991 - 1992. corresponds to number points in Figure 17. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	12/03/87	19:22:26	35.6	74.9
2	12/22/87	19:16:10	36.5	66.9
3	12/27/87	18:23:08	37.5	64.6
4	12/27/87	20:03:00	37.4	64.5
5	01/10/88	19:12:40	36.6	64.3
6	01/18/88	17:47:15	35.7	64.0
7	01/23/88	18:32:13	34.9	64.7
8	01/31/88	13:04:08	34.8	65.9
9	02/01/88	18:34:00	34.8	66.1
10	02/04/88	13:14:00	35.1	66.9
11	02/04/88	18:03:00	35.1	66.9
12	02/09/88	13:09:00	35.3	67.8
13	02/09/88	18:49:00	35.3	67.9
14	02/09/88	20:29:00	35.3	67.9
15	02/10/88	14:24:00	35.4	68.2
16	02/10/88	18:40:00	35.3	68.3
17	02/10/88	26:18:00	35.3	68.3
18	02/15/88	14:16:00	34.7	69.2
19	02/19/88	14:29:00	34.3	69.5
20	02/22/88	18:07:00	33.2	69.9
21	03/02/88	13:31:00	31.4	72.3
22	03/08/88	12:58:00	31.3	73.2
23	03/08/88	14:38:00	31.3	73.2
24	03/08/88	18:46:00	31.3	73.3
25	03/08/88	20:25:00	31.3	73.3
26	03/09/88	14:16:00	31.4	73.7

POINT NO.	DATE	TIME (GMT)	LAT	LONG
27	03/12/88	13:13:00	31.6	74.4
28	03/12/88	19:43:00	31.6	74.4
29	03/14/88	19:21:00	31.6	74.5
30	03/18/88	14:21:00	30.8	74.8
31	03/19/88	14:00:00	31.0	74.9
32	03/22/88	19:33:00	31.2	75.6
33	03/23/88	14:13:00	31.3	75.7
34	03/23/88	19:25:00	31.3	75.8
35	03/24/88	13:49:00	31.5	75.7
36	03/24/88	19:14:00	31.5	75.8
37	03/25/88	13:31:00	31.7	75.8
38	03/25/88	19:02:00	31.7	75.8
39	03/26/88	18:51:00	32.0	75.7
40	03/26/88	20:34:00	32.0	75.7
41	03/29/88	13:42:00	32.7	75.0
42	03/29/88	18:21:00	32.7	75.1
43	03/29/88	20:01:00	32.8	75.1
44	03/30/88	13:23:00	32.9	75.3
45	03/30/88	15:00:00	32.9	75.3
46	03/30/88	19:50:00	32.9	75.4
47	03/31/88	14:36:00	32.7	75.5
48	03/31/88	19:41:00	32.6	75.6
49	04/01/88	14:16:29	32.0	75.7
50	04/01/88	19:28:13	31.9	75.9
51	04/02/88	13:56:50	32.2	76.6
52	04/02/88	19:18:21	32.3	76.7
53	04/03/88	13:34:50	32.4	76.7
54	04/03/88	19:07:05	32.4	76.6
55	04/03/88	20:46:01	32.4	76.6

POINT NO.	DATE	TIME (GMT)	LAT	LONG
56	04/04/88	20:35:42	32.8	76.3
57	04/07/88	13:47:12	32.5	75.5
58	04/11/88	14:00:01	31.5	76.6
59	04/11/88	19:18:45	31.5	76.7
60	04/17/88	19:55:15	33.2	76.6
61	04/26/88	13:34:24	33.3	76.3
62	04/27/88	14:49:00	33.7	76.1
63	04/27/88	19:47:39	33.8	76.0
64	04/28/88	19:36:52	34.3	75.5
65	05/01/88	13:19:38	36.2	72.6
66	05/02/88	20:34:29	36.3	71.4
67	05/08/88	14:11:00	35.1	72.5
68	05/08/88	19:29:15	35.0	72.6
69	05/09/88	13:50:25	35.0	72.8
70	05/09/88	19:18:28	34.9	72.9
71	05/16/88	14:36:39	33.9	73.2
72	05/16/88	19:45:34	33.8	73.0
73	05/20/88	19:01:00	34.4	72.1
74	05/25/88	14:41:43	34.7	71.7
75	05/27/88	13:57:44	34.3	71.7
76	05/27/88	19:22:59	34.2	71.6
77	05/28/88	13:35:16	34.0	71.5
78	05/28/88	19:13:35	34.0	71.4
79	05/29/88	13:15:09	33.5	71.4
80	05/30/88	14:31:37	33.1	71.0
81	05/30/88	18:52:28	33.1	71.0
82	05/31/88	14:11:10	32.8	71.1

Appendix 5. Data from loggerhead 4932 tracked via satellite in 1991 - 1992.POINT NO. corresponds to number points in Figure 19. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	11/10/89	05:21:42	36.7	75.7
2	11/11/89	06:57:45	36.4	75.4
3	11/12/89	06:46:34	36.2	75.3
4	11/12/89	14:21:53	36.2	75.3
5	11/13/89	18:01:33	36.3	75.6
6	11/16/89	07:36:35	36.1	75.5
7	11/17/89	14:05:53	36.0	75.6
8	11/17/89	17:13:08	36.0	75.6
9	11/17/89	18:54:31	36.0	75.6
10	11/18/89	07:21:08	35.8	75.5
11	11/20/89	16:41:51	35.2	75.5
12	11/21/89	14:20:26	35.2	75.5
13	11/22/89	18:01:23	35.1	75.7
14	11/25/89	07:42:11	34.6	76.3
15	11/26/89	07:37:15	34.6	76.6
16	11/26/89	17:17:51	34.5	76.5
17	11/27/89	18:50:53	34.5	76.7
18	11/28/89	16:58:19	34.5	77.0
19	11/29/89	05:24:30	34.4	77.3
20	12/01/89	19:48:04	34.1	77.5
21	12/04/89	06:11:56	33.8	77.7
22	12/04/89	07:46:49	33.8	77.7
23	12/08/89	05:28:32	33.3	78.0
24	12/08/89	07:10:16	33.3	78.0

POINT NO.	DATE	TIME (GMT)	LAT	LONG
25	12/08/89	14:34:37	33.2	78.1
26	12/08/89	18:32:46	33.1	78.3
27	12/10/89	19:55:40	33.0	78.8
28	12/11/89	19:45:09	32.8	78.9
29	12/13/89	07:58:20	32.7	79.0
30	12/13/89	14:22:07	32.7	79.0
31	12/13/89	17:39:48	32.6	79.0
32	12/14/89	14:05:19	32.6	78.6
33	12/17/89	18:33:45	32.4	79.5
34	12/19/89	18:10:32	32.0	80.7
35	12/20/89	18:5:30	31.6	80.4
36	12/21/89	19:40:01	31.3	80.4
37	12/22/89	06:21:47	31.3	80.5
38	12/22/89	08:00:28	31.3	80.5
39	12/22/89	14:20:21	31.2	80.5
40	12/22/89	17:43:16	31.1	80.7
41	12/23/89	17:33:19	30.7	80.8
42	12/24/89	06:00:34	30.4	80.8
43	12/24/89	19:02:52	30.2	80.8
44	12/26/89	14:34:09	29.9	80.7
45	12/30/89	02:19:40	29.9	80.8
46	12/30/89	06:33:12	29.9	80.8
47	12/30/89	18:02:19	29.8	80.8
48	12/31/89	06:25:19	29.8	80.8
49	12/31/89	14:22:20	29.8	80.6
50	12/31/89	17:44:51	29.8	80.7
51	12/31/89	19:25:57	29.8	80.8
52	01/02/90	06:06:24	29.6	80.8
53	01/04/90	02:08:14	29.3	80.7

POINT NO.	DATE	TIME (GMT)	LAT	LONG
54	01/05/90	18:31:32	29.3	81.0
55	01/06/90	18:22:50	29.2	80.8
56	01/10/90	17:46:29	28.8	80.6
57	01/13/90	07:34:15	28.5	80.1
58	01/17/90	14:36:53	28.3	80.3
59	01/17/90	19:53:33	28.3	80.5
60	01/18/90	14:07:26	28.1	80.1
61	01/19/90	19:29:18	28.3	80.3
62	01/20/90	06:18:05	28.3	80.4
63	01/21/90	14:39:44	28.2	80.4
64	01/23/90	18:46:01	28.2	80.5
65	01/26/90	19:53:22	28.2	80.5
66	01/27/90	06:45:12	28.1	80.5
67	01/31/90	07:41:37	27.6	80.0
68	02/02/90	18:37:05	27.6	80.1
69	02/03/90	14:47:07	27.5	80.1
70	02/04/90	19:57:23	27.4	80.1
71	02/05/90	06:49:15	27.1	80.1
72	02/05/90	18:01:43	27.0	80.0
73	02/06/90	19:37:31	26.4	79.9
74	02/08/90	14:37:10	26.1	80.0
75	02/10/90	18:49:32	25.9	80.0
76	02/13/90	06:56:47	25.6	80.2
77	02/13/90	14:22:57	25.6	80.2
78	02/14/90	19:48:50	25.6	80.2
79	02/16/90	08:06:19	25.4	80.3
80	02/17/90	02:11:21	25.4	80.2
81	02/17/90	08:01:32	25.4	80.2
82	02/17/90	14:31:28	25.3	80.2

POINT NO.	DATE	TIME (GMT)	LAT	LONG
83	02/20/90	18:46:53	25.3	80.2
84	02/21/90	18:36:59	25.2	80.3
85	03/02/90	18:40:21	25.0	80.3
86	03/03/90	18:25:42	25.1	80.3
87	03/05/90	18:02:38	25.0	80.3
88	03/16/90	06:25:46	25.0	80.4
89	03/18/90	07:49:15	24.9	80.5
90	03/20/90	18:47:58	24.9	80.5
91	03/22/90	07:01:35	24.9	80.5
92	03/24/90	19:39:48	25.0	80.4
93	03/26/90	19:18:22	25.0	80.4
94	03/31/90	07:05:55	24.9	80.5
95	03/31/90	20:05:47	25.0	80.4
96	04/01/90	18:14:31	25.0	80.4
97	04/03/90	19:34:56	25.0	80.4
98	04/11/90	06:55:03	25.0	80.6
99	04/13/90	06:31:28	25.0	80.5
100	04/15/90	17:28:54	24.9	80.5
101	04/17/90	18:41:18	25.0	80.5
102	04/24/90	06:10:46	25.0	80.4
103	05/06/90	07:24:41	25.0	80.5
104	05/07/90	07:14:17	25.0	80.4
105	05/10/90	06:37:13	25.0	80.4
106	05/10/90	19:35:01	25.0	80.4
107	05/12/90	07:57:57	25.0	80.4
108	05/17/90	18:23:07	25.0	80.4
109	05/21/90	14:22:37	25.0	80.5
110	05/28/90	06:42:07	25.0	80.5

Appendix 6. Data from loggerhead 4933 tracked via satellite in 1991 - 1992. POINT NO. corresponds to number points in Figure 21. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	11/09/89	20:19:59	36.8	75.7
2	11/10/89	11:45:56	36.6	75.6
3	11/11/89	08:34:27	36.7	75.4
4	11/11/89	22:44:17	36.6	75.8
5	11/13/89	01:43:56	36.6	75.3
6	11/14/89	15:14:59	36.7	75.7
7	11/15/89	13:17:51	37.0	75.0
8	11/16/89	19:06:29	36.6	75.8
9	11/19/89	01:04:21	36.2	75.7
10	11/20/89	00:39:37	35.9	75.5
11	11/25/89	07:48:46	35.0	75.9
12	11/25/89	14:29:30	35.0	75.8
13	11/27/89	17:09:11	34.6	76.5
14	11/27/89	18:50:16	34.5	76.5
15	11/28/89	00:57:44	34.5	76.7
16	12/02/89	13:34:13	34.3	77.0
17	12/03/89	19:31:42	33.8	77.1
18	12/04/89	07:54:37	34.0	77.7
19	12/07/89	13:21:21	33.6	77.9
20	12/07/89	18:40:57	33.6	78.0
21	12/08/89	00:36:06	33.6	78.0
22	12/08/89	11:15:35	33.5	78.3
23	12/08/89	18:32:48	33.5	78.4
24	12/10/89	18:08:22	33.3	78.9

POINT NO.	DATE	TIME (GMT)	LAT	LONG
25	12/12/89	13:09:15	32.9	78.6
26	12/14/89	06:08:27	32.7	79.5
27	12/14/89	14:01:24	32.7	79.4
28	12/17/89	07:16:41	32.3	80.0
29	12/17/89	14:31:02	32.3	79.9
30	12/17/89	16:57:56	32.3	80.0
31	12/17/89	18:40:18	32.2	80.0
32	12/18/89	14:07:12	32.1	80.2
33	12/19/89	06:55:35	32.1	80.5
34	12/19/89	08:30:49	32.1	80.5
35	12/19/89	13:52:17	32.1	80.3
36	12/20/89	13:27:19	31.8	80.7
37	12/20/89	19:43:39	31.8	80.8
38	12/21/89	14:45:54	31.6	80.8
39	12/23/89	19:18:54	31.0	81.1
40	12/23/89	20:56:15	31.1	81.0
41	12/24/89	13:36:29	30.8	81.2
42	12/24/89	20:45:35	30.8	81.1
43	12/26/89	08:59:43	30.6	81.1
44	12/27/89	01:41:54	30.5	81.3
45	12/27/89	12:26:57	30.6	81.2
46	12/28/89	12:04:20	30.5	81.1
47	12/28/89	23:23:34	30.5	81.2
48	12/29/89	19:46:56	30.4	81.1
49	12/31/89	12:38:47	30.3	81.1
50	01/04/90	14:30:00	29.4	81.0
51	01/06/90	20:01:23	29.3	81.0
52	01/08/90	19:45:16	29.2	81.0
53	01/14/90	17:01:07	28.9	80.7

POINT NO.	DATE	TIME (GMT)	LAT	LONG
54	01/14/90	23:33:30	28.8	80.6
55	01/18/90	14:13:36	28.6	80.5
56	01/20/90	01:01:35	28.6	80.6
57	01/26/90	00:22:23	28.9	80.2
58	01/30/90	14:37:12	28.6	80.5
59	02/01/90	12:12:05	28.5	80.2
60	02/01/90	20:34:14	28.5	80.0
61	02/02/90	16:58:26	28.7	80.6
62	02/02/90	20:20:20	28.7	80.5
63	02/03/90	22:44:38	28.7	80.5
64	02/05/90	19:48:09	28.6	80.4
65	02/06/90	11:58:23	28.4	80.3
66	02/08/90	09:37:24	28.4	80.1
67	02/10/90	20:35:10	28.6	80.4
68	02/11/90	13:28:48	28.6	80.5
69	02/14/90	18:05:23	28.7	80.6
70	02/15/90	19:41:02	28.6	80.5
71	02/19/90	13:52:43	28.8	80.1
72	02/21/90	00:41:48	28.8	80.2
73	02/21/90	20:21:14	28.7	80.3
74	02/24/90	17:59:54	29.1	80.7
75	02/27/90	01:47:42	28.8	80.4
76	02/28/90	17:17:54	28.9	80.4
77	02/28/90	20:41:59	28.8	80.5
78	03/07/90	19:29:58	28.6	80.4
79	03/15/90	13:03:40	28.6	80.6
80	03/20/90	14:31:52	29.4	80.9
81	03/29/90	20:32:18	30.7	81.3
82	03/30/90	08:58:57	30.7	81.2

POINT NO.	DATE	TIME (GMT)	LAT	LONG
83	03/30/90	14:03:48	30.8	81.2
84	03/31/90	13:40:50	30.7	81.1
85	04/01/90	20:05:48	31.2	80.7
86	04/03/90	08:16:42	31.6	81.0
87	04/03/90	12:30:15	31.6	80.9
88	04/03/90	19:41:40	31.7	81.0
89	04/04/90	08:02:13	31.7	81.0
90	04/05/90	07:54:04	31.8	80.8
91	04/05/90	19:11:23	31.9	80.8
92	04/07/90	00:24:48	31.7	81.0
93	04/07/90	19:00:40	31.5	81.1
94	04/09/90	23:11:12	32.5	80.2
95	04/12/90	01:49:25	32.6	79.3
96	04/12/90	06:36:58	32.7	79.5
97 .	04/14/90	08:00:46	33.0	78.3
98	04/17/90	09:07:33	33.1	78.7
99	04/18/90	07:12:57	33.4	78.7
100	04/19/90	18:28:42	33.5	78.7
101	04/28/90	08:42:07	33.6	78.5
102	04/28/90	20:13:14	33.7	78.3
103	05/02/90	17:51:41	33.8	78.0
104	05/03/90	17:34:52	34.4	77.4
105	05/05/90	13:41:58	34.5	77.0
106	05/07/90	22:39:19	34.8	76.1
107	05/08/90	08:43:00	34.9	76.0
108	05/08/90	18:21:17	35.0	76.0
109	05/08/90	23:48:57	35.0	75.9
110	05/09/90	01:31:33	35.0	75.9
111	05/10/90	19:35:41	35.4	75.1

POINT NO.	DATE	TIME (GMT)	LAT	LONG
112	05/17/90	07:00:05	36.9	76.1
113	05/17/90	20:04:51	37.2	76.3
114	05/18/90	06:48:06	37.2	76.2
115	05/18/90	13:48:57	37.3	76.1
116	05/19/90	19:47:15	37.4	76.1
117	05/20/90	22:40:20	37.5	76.1
118	05/22/90	19:07:07	37.7	76.2
119	05/23/90	05:52:12	37.6	76.1
120	05/23/90	17:17:38	37.6	76.1
121	05/29/90	06:26:54	37.9	76.0
122	05/29/90	14:34:58	38.0	76.2
123	05/29/90	19:32:19	38.0	76.1
124	05/31/90	17:31:50	37.9	76.3
125	06/03/90	08:51:53	37.8	76.2
126	06/03/90	12:41:07	37.9	76.2
127	06/04/90	13:55:19	37.9	76.3
128	06/11/90	14:38:41	37.8	76.2
129	06/12/90	00:18:32	37.9	76.0
130	06/12/90	01:58:52	37.9	76.0
131	06/12/90	07:17:38	37.9	76.3
132	06/12/90	14:15:59	37.9	76.1
133	06/13/90	07:07:58	38.0	76.3
134	06/13/90	08:47:12	38.0	76.2
135	06/14/90	01:09:25	38.1	76.3
136	06/14/90	20:04:42	38.1	76.2
137	06/15/90	18:06:58	38.1	76.2
138	06/16/90	00:24:59	38.1	76.2
139	06/22/90	08:53:20	38.1	76.4

POINT NO.	DATE	TIME (GMT)	LAT	LONG
140	06/22/90	20:14:28	37.9	76.1

Appendix 7. Data from loggerhead 4934 tracked via satellite in 1991 - 1992.POINT NO. corresponds to number points in Figure 23. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	10/24/91	09:26:20	36.9	75.3
2	10/24/91	20:49:59	36.8	75.5
3	10/25/91	09:10:43	36.5	75.7
4	10/25/91	14:21:27	36.4	75.4
5	10/25/91	20:36:59	36.4	75.4
6	10/26/91	09:01:05	36.2	75.5
7	10/26/91	12:16:06	36.2	75.6
8	10/26/91	18:45:09	36.0	75.5
9	10/26/91	23:34:05	36.0	75.3
10	10/27/91	07:09:42	35.9	75.4
11	10/27/91	11:55:47	35.8	75.3
12	10/27/91	13:36:40	35.8	75.3
13	10/29/91	00:36:43	35.1	75.2
14	10/29/91	06:41:40	35.1	75.5
15	10/29/91	19:46:40	35.0	75.7
16	10/30/91	00:12:58	34.9	75.9
17	10/30/91	12:35:19	34.6	76.1
18	10/30/91	14:11:36	34.6	76.1
19	10/30/91	17:52:09	34.5	76.1
20	10/31/91	12:09:32	34.2	76.2
21	11/01/91	07:53:37	34.1	76.7
22	11/01/91	11:50:27	34.0	76.7
23	11/01/91	17:34:49	33.9	76.7
24	11/02/91	17:21:19	33.9	76.7

POINT NO.	DATE	TIME (GMT)	LAT	LONG
25	11/03/91	02:08:39	34.1	77.0
26	11/05/91	13:54:19	34.1	76.7
27	11/06/91	11:46:30	33.7	76.8
28	11/06/91	19:56:58	33.8	76.8
29	11/09/91	12:20:43	33.8	76.9
30	11/10/91	01:27:16	33.7	77.0
31	11/10/91	12:08:23	33.8	77.1
32	11/11/91	15:04:50	33.7	76.9
33	11/12/91	18:51:22	33.9	76.8
34	11/14/91	18:20:52	33.6	77.1
35	11/15/91	08:25:08	33.8	77.4
36	11/20/91	11:51:49	33.6	76.7
37	11/21/91	18:38:40	33.6	76.9
38	11/25/91	17:50:26	33.5	77.3
39	11/28/91	12:33:33	33.5	76.5
40	11/29/91	13:51:01	33.8	76.9
41	11/30/91	11:49:12	33.7	77.2
42	12/04/91	17:49:32	33.6	76.9
43	12/06/91	19:04:01	33.8	77.0
44	12/06/91	22:36:29	33.8	77.1
45	12/08/91	18:47:38	33.8	76.9
46	12/09/91	10:29:45	33.8	76.8
47	12/11/91	18:10:16	33.7	77.0
48	12/12/91	12:31:10	33.6	77.2
49	12/13/91	17:46:13	33.8	77.1
50	12/13/91	21:08:06	33.7	76.9
51	12/14/91	19:09:00	33.7	77.2
52	12/14/91	20:49:33	33.8	77.2
53	12/15/91	00:49:51	33.8	77.1

POINT NO.	DATE	TIME (GMT)	LAT	LONG
54	12/16/91	12:54:10	33.8	77.0
55	12/19/91	08:30:33	33.8	77.2
56	12/22/91	07:53:00	33.8	76.8
57	12/27/91	12:22:53	33.8	77.0
58	12/28/91	21:31:14	33.8	76.7
59	12/30/91	00:31:15	34.2	77.0
60	12/30/91	22:33:12	33.8	77.1
61	12/31/91	17:32:03	33.8	77.1
62	01/01/92	07:39:21	33.8	77.0
63	01/03/92	11:34:55	33.8	77.0
64	01/03/92	14:50:34	33.8	77.0
65	01/03/92	18:37:07	33.8	77.0
66	01/04/92	00:34:24	33.7	76.9
67	01/05/92	19:51:22	33.8	76.9
68	01/07/92	13:30:05	33.7	76.9
69	01/07/92	17:54:32	33.7	76.8
70	01/10/92	20:42:17	33.7	76.6
71	01/14/92	14:26:19	33.7	76.9
72	01/14/92	18:09:40	33.8	77.0
73	01/20/92	07:12:55	33.8	76.5
74	01/22/92	19:52:16	33.7	77.0
75	01/23/92	19:47:58	33.8	76.6
76	01/24/92	12:32:17	33.7	76.8
77	01/27/92	13:11:38	33.8	76.8
78	02/02/92	12:44:16	33.8	76.9
79	02/02/92	14:21:41	33.7	76.9
80	02/04/92	20:49:41	33.5	76.8
81	02/07/92	08:47:03	33.5	77.1
82	02/07/92	12:40:03	33.5	77.2

POINT NO.	DATE	TIME (GMT)	LAT	LONG
83	02/07/92	20:10:42	33.5	77.1
84	02/12/92	22:12:10	33.6	77.2
85	02/17/92	14:13:22	33.7	76.5
86	02/19/92	17:47:01	33.6	77.2
87	02/20/92	19:21:18	33.6	77.2
88	02/23/92	12:04:04	33.6	77.2
89	02/24/92	18:24:58	33.6	77.2
90	02/27/92	19:33:00	33.5	77.3
91	03/01/92	09:12:05	34.0	77.1
92	03/02/92	07:27:43	33.9	77.0
93	03/02/92	14:09:44	33.7	76.7
94	03/03/92	01:33:07	33.9	76.7
95	03/04/92	10:21:12	34.0	76.6
96	03/05/92	22:46:33	34.3	76.4
97	03/06/92	11:08:16	34.5	76.2
98	03/07/92	14:04:43	34.9	76.0
99	03/08/92	09:29:32	35.1	75.7
100	03/09/92	23:09:18	34.5	75.7
101	03/11/92	02:04:26	35.2	75.0
102	03/12/92	00:06:08	35.3	74.7
103	03/17/92	12:19:31	35.3	75.3
104	03/20/92	22:33:13	35.0	75.6
105	03/21/92	06:58:20	34.9	75.8
106	03/21/92	10:19:40	34.8	75.8
107	03/21/92	12:32:06	34.8	75.9
108	03/22/92	01:24:58	34.5	76.2
109	03/23/92	06:33:49	34.1	76.2
110	03/23/92	09:59:59	34.1	76.1
111	03/24/92	00:43:28	34.1	76.3

POINT NO.	DATE	TIME (GMT)	LAT	LONG
112	03/24/92	13:06:39	33.9	76.3
113	03/24/92	21:08:44	33.8	76.6
114	03/25/92	00:31:08	33.8	76.5
115	03/26/92	12:30:57	33.6	76.6
116	03/26/92	20:40:05	33.7	76.8
117	03/28/92	08:59:30	33.7	76.9
118	03/29/92	00:36:44	34.0	76.6
119	03/31/92	00:04:16	33.2	77.3
120	03/31/92	12:17:40	33.5	77.0
121	04/01/92	09:47:04	33.6	77.1
122	04/02/92	01:00:37	33.5	77.2
123	04/03/92	19:12:40	34.2	76.6
124	04/05/92	13:54:40	33.7	77.0
125	04/06/92	13:36:31	33.7	76.9
126	04/06/92	23:10:13	33.8	77.0
127	04/07/92	18:23:50	33.6	77.1
128	04/08/92	18:8:44	33.6	77.0
129	04/09/92	01:49:11	33.6	76.8
130	04/10/92	19:25:48	34.0	76.8
131	04/12/92	20:43:10	34.5	76.2
132	04/17/92	08:18:56	35.5	75.3
133	04/18/92	17:52:15	35.8	75.2
134	04/20/92	20:49:22	35.6	75.3
135	04/21/92	22:53:09	35.5	75.2
136	04/23/92	23:51:34	35.4	75.3
137	04/29/92	23:25:20	35.3	75.3
138	05/02/92	18:27:36	35.3	75.5
139	05/19/92	01:01:16	35.7	75.2
140	05/26/92	10:34:30	36.0	75.5

POINT NO.	DATE	TIME (GMT)	LAT	LONG
141	05/30/92	00:31:21	36.1	75.2
142	05/31/92	19:18:23	36.7	75.8
143	06/01/92	01:26:39	36.8	75.8
144	06/10/92	20:40:40	37.3	76.2
145	06/10/92	23:33:21	37.4	76.2
146	06/11/92	01:13:21	37.4	76.2
147	06/11/92	07:22:42	37.4	76.2
148	06/11/92	10:44:23	37.4	76.2
149	06/11/92	11:51:23	37.4	76.2
150	06/11/92	13:32:04	37.4	76.2
151	06/11/92	20:28:46	37.3	76.3
152	06/11/92	23:11:26	37.3	76.3
153	06/12/92	00:53:47	37.3	76.3
154	06/12/92	10:30:49	37.4	76.2
155	06/12/92	18:36:31	37.3	76.3
156	06/12/92	20:17:51	37.3	76.3
157	06/12/92	22:50:32	37.3	76.3
158	06/13/92	00:30:52	37.3	76.3
159	06/13/92	08:38:34	37.3	76.2
160	06/13/92	12:49:35	37.3	76.2
161	06/13/92	18:24:17	37.3	76.3
162	06/14/92	08:27:40	37.3	76.3
163	06/14/92	18:13:03	37.3	76.3
164	06/15/92	19:41:09	37.3	76.3

Appendix 8. Data from loggerhead 4937 tracked via satellite in 1991 - 1992. POINT NO. corresponds to number points in Figure 25. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	10/23/91	23:01:15	37.2	76.4
2	10/24/91	00:38:44	37.2	76.4
3	10/24/91	07:42:24	37.1	76.2
4	10/24/91	12:58:53	37.0	76.2
5	10/24/91	14:38:41	36.9	76.2
6	10/24/91	17:24:44	36.9	76.1
7	10/24/91	19:07:06	36.9	76.1
8	10/25/91	07:29:44	36.7	75.8
9	10/25/91	09:09:34	36.7	75.8
10	10/26/91	20:25:43	36.1	75.4
11	10/27/91	20:11:34	35.7	75.4
12	10/28/91	00:56:02	35.6	75.3
13	10/29/91	14:37:14	34.8	75.7
14	10/30/91	12:34:34	34.6	76.3
15	10/31/91	21:03:47	34.5	76.9
16	11/04/91	01:50:23	34.0	77.1
17	11/04/91	14:09:19	34.0	77.2
18	11/05/91	12:11:37	33.9	77.3
19	11/05/91	18:26:10	33.8	77.1
20	11/06/91	11:49:42	33.8	77.2
21	11/09/91	09:39:20	33.7	77.0
22	11/12/91	14:38:57	33.7	77.2
23	11/13/91	08:48:19	33.8	77.5
24	11/13/91	14:23:18	33.7	77.3

POINT NO.	DATE	TIME (GMT)	LAT	LONG
25	11/14/91	07:03:48	34.0	77.6
26	11/15/91	19:49:58	33.6	77.2
27	11/17/91	14:38:45	33.7	77.3
28	11/18/91	14:17:52	33.6	77.3
29	11/19/91	13:56:15	33.6	77.3
30	11/20/91	11:52:26	33.6	77.3
31	11/23/91	14:17:22	33.7	77.2
32	11/26/91	07:57:55	33.6	77.0
33	11/26/91	21:03:56	33.7	77.2
34	11/27/91	17:33:28	33.7	77.3
35	11/29/91	09:08:14	33.7	77.2
36	11/29/91	20:27:06	33.7	77.3
37	11/30/91	01:08:16	33.7	77.2
38	12/02/91	19:49:49	33.7	77.4
39	12/04/91	01:25:34	33.6	77.2
40	12/04/91	08:12:30	33.5	77.0
41	12/06/91	00:45:27	33.6	77.6
42	12/10/91	13:17:52	33.7	77.2
43	12/23/91	19:02:56	33.7	77.1
44	12/25/91	14:39:17	33.7	77.5
45	12/31/91	01:54:15	33.6	77.1
46	01/01/92	13:57:14	33.6	77.2
47	01/05/92	01:54:34	33.7	77.2
48	01/09/92	07:46:21	33.7	77.2
49	01/09/92	20:47:17	33.7	77.3
50	01/10/92	01:43:59	33.7	77.1
51	01/12/92	15:04:32	33.8	77.2
52	01/25/92	23:28:56	33.7	77.2
53	01/26/92	13:27:42	33.7	77.3

POINT NO.	DATE	TIME (GMT)	LAT	LONG
54	01/30/92	13:43:23	33.8	77.4
55	02/03/92	12:26:04	33.7	77.3
56	02/05/92	13:25:01	33.6	77.3
57	02/06/92	14:40:19	33.5	77.2
58	02/07/92	7:08:23	33.6	77.5
59	02/07/92	12:39:05	33.6	77.3
60	02/07/92	18:26:49	33.6	77.3
61	02/07/92	20:08:00	33.5	77.3
62	02/09/92	13:37:35	33.5	77.2
63	02/14/92	20:29:31	33.7	77.4
64	02/16/92	22:29:27	33.7	77.4
65	02/20/92	22:44:27	33.7	77.3
66	02/25/92	22:39:22	33.6	77.4
67	02/27/92	08:15:14	33.7	77.1
68	02/27/92	17:53:11	33.6	77.3
69	03/01/92	12:50:31	33.7	77.1
70	03/01/92	20:34:37	33.7	77.3
71	03/06/92	09:54:22	33.6	77.2
72	03/07/92	00:08:38	33.6	77.5
73	03/08/92	17:36:35	33.7	77.3
74	03/08/92	23:27:09	33.6	77.3
75	03/20/92	22:30:02	33.8	77.2
76	03/22/92	01:28:03	33.7	77.3
77	03/23/92	01:09:41	33.7	77.2
78	03/25/92	02:05:09	33.7	77.2
79	03/25/92	19:16:39	33.7	77.2
80	04/01/92	09:49:08	33.6	77.3
81	04/02/92	21:05:41	33.5	76.9
82	04/04/92	18:56:01	33.8	77.2

POINT NO.	DATE	TIME (GMT)	LAT	LONG
83	04/04/92	20:36:15	33.9	77.2
84	04/05/92	07:24:48	33.9	77.3
85	04/06/92	01:15:46	34.0	77.0
86	04/08/92	08:26:04	34.4	76.9
87	04/08/92	14:29:58	34.4	76.8
88	04/09/92	21:15:37	34.4	76.5
89	04/10/92	23:25:11	34.5	76.4
90	04/11/92	01:05:46	34.5	76.4
91	04/11/92	09:35:17	34.5	76.4
92	04/15/92	18:27:59	34.4	76.9
93	04/16/92	13:21:02	33.9	76.6
94	04/17/92	09:59:45	34.2	76.4
95	04/18/92	22:16:39	34.5	76.6
96	04/19/92	13:55:49	34.3	76.7
97	04/19/92	19:18:08	34.4	76.7
98	04/20/92	11:55:10	34.2	76.7
99	04/21/92	00:51:22	34.3	76.7
100	04/22/92	12:55:12	34.4	77.0
101	04/23/92	14:12:33	34.4	77.1
102	04/23/92	20:11:15	34.3	77.2
103	04/23/92	23:50:42	34.3	77.3
104	04/24/92	10:16:38	34.3	77.3
105	04/24/92	12:13:39	34.3	77.4
106	04/25/92	01:09:33	34.2	77.4
107	04/25/92	13:26:43	34.2	77.5
108	04/25/92	18:07:34	34.2	77.5
109	04/25/92	21:26:30	34.3	77.4
110	04/27/92	21:04:12	34.2	77.7
111	04/28/92	12:25:32	33.8	77.6

POINT NO.	DATE	TIME (GMT)	LAT	LONG
112	04/28/92	20:50:11	33.9	77.7
113	04/29/92	01:24:53	33.9	77.6
114	04/29/92	09:16:52	33.8	77.6
115	05/03/92	01:42:36	34.3	77.1
116	05/03/92	13:58:35	34.3	77.3
117	05/09/92	11:51:48	34.4	76.2
118	05/15/92	22:44:35	35.4	75.4
119	05/18/92	12:03:48	35.7	75.5
120	05/19/92	01:02:46	35.8	75.4
121	05/19/92	13:23:50	35.9	75.6
122	05/31/92	20:59:08	37.2	76.2
123	06/07/92	09:53:01	37.2	76.1
124	06/13/92	10:18:10	37.2	76.5
125	06/15/92	19:41:18	37.2	76.2
126	06/22/92	14:37:34	37.1	76.3
127	06/25/92	11:54:25	37.1	76.2
128	07/07/92	08:54:38	37.1	76.1
129	07/13/92	12:11:28	36.9	76.3
130	07/17/92	14:07:06	36.9	76.1

Appendix 9. Data from loggerhead 4935 tracked via satellite in 1991 - 1992.POINT NO. corresponds to number points in Figure 27. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	10/29/91	00:33:20	36.6	75.8
2	10/29/91	10:05:55	36.4	75.6
3	10/29/91	19:47:26	36.4	75.6
4	10/30/91	06:31:53	36.2	75.7
5	10/31/91	09:41:19	35.8	75.4
6	10/31/91	12:10:57	35.7	75.3
7	10/31/91	17:43:54	35.7	75.4
8	11/01/91	09:30:46	35.3	75.2
9	11/02/91	22:45:47	35.2	75.0
10	11/05/91	06:57:07	35.0	75.1
11	11/05/91	23:28:11	35.0	75.7
12	11/06/91	11:44:08	35.0	75.5
13	11/06/91	19:53:08	35.0	75.8
14	11/07/91	00:45:50	35.1	75.8
15	11/07/91	06:36:15	34.9	75.5
16	11/08/91	19:31:19	35.0	76.0
17	11/09/91	12:22:00	34.9	75.5
18	11/10/91	01:27:33	34.9	75.7
19	11/10/91	12:05:11	34.9	76.2
20	11/12/91	18:45:18	35.0	75.8
21	11/12/91	22:40:08	35.1	75.7
22	11/13/91	20:16:31	35.0	75.5
23	11/14/91	18:24:01	34.9	75.1
24	11/15/91	13:40:47	35.2	75.0

POINT NO.	DATE	TIME (GMT)	LAT	LONG
25	11/15/91	19:53:26	35.3	75.1
26	11/16/91	11:41:09	35.4	75.4
27	11/16/91	14:58:33	35.4	75.2
28	11/16/91	19:38:09	35.5	75.3
29	11/19/91	13:50:45	35.3	75.3
30	11/19/91	20:41:04	35.1	75.4
31	11/23/91	12:32:11	35.3	75.3
32	11/24/91	08:21:54	35.3	75.4
33	11/24/91	12:13:31	35.3	75.5
34	11/28/91	07:29:17	35.5	74.8
35	11/28/91	20:38:53	35.3	75.3
36	11/30/91	13:23:34	35.1	75.1
37	12/01/91	18:21:51	35.3	75.3
38	12/01/91	20:03:09	35.3	75.3
39	12/04/91	19:29:51	35.1	75.3
40	12/06/91	17:23:48	35.2	75.6
41	12/07/91	18:52:04	35.2	75.1
42	12/09/91	10:27:17	34.9	75.4
43	12/10/91	06:55:33	35.0	75.4
44	12/14/91	09:34:11	35.0	74.8
45	12/16/91	07:26:40	35.0	75.6
46	12/16/91	11:11:36	35.0	75.6
47	12/17/91	20:14:11	35.1	75.6
48	12/19/91	10:10:32	34.8	75.8
49	12/19/91	19:54:57	35.0	75.5
50	12/20/91	14:47:38	34.9	75.5
51	12/21/91	14:29:35	35.0	75.3
52	12/22/91	09:37:01	34.9	75.5
53	12/23/91	07:43:02	34.9	75.5

POINT NO.	DATE	TIME (GMT)	LAT	LONG
54	12/24/91	09:12:43	35.1	75.2
55	12/25/91	08:58:01	35.1	75.6
56	12/30/91	09:47:03	35.1	75.2
57	12/30/91	14:36:31	35.1	75.4
58	12/30/91	17:44:48	35.1	75.4
59	12/30/91	22:36:19	35.1	75.4
60	01/02/92	18:52:49	35.0	75.5
61	10/04/92	18:26:23	35.1	75.5
62	01/04/92	20:07:21	35.2	75.5
63	01/06/92	10:00:37	35.1	75.8
64	01/12/92	13:24:40	35.0	75.7
65	01/12/92	18:38:14	34.9	75.9
66	01/15/92	14:04:22	35.0	75.5
67	01/21/92	10:24:35	34.9	76.1
68	01/23/92	10:02:08	35.0	75.6
69	01/23/92	18:06:04	35.1	75.7
70	01/31/92	18:10:58	35.2	75.4
71	02/03/92	09:38:40	35.0	75.3
72	02/03/92	17:37:15	35.0	75.5
73	02/03/92	19:15:33	35.0	75.5
74	02/04/92	07:41:06	34.9	75.4
75	02/04/92	09:22:14	34.9	75.4
76	02/04/92	12:01:07	34.9	75.4
77	02/04/92	13:42:16	34.9	75.5
78	02/05/92	01:01:00	35.0	75.5
79	02/05/92	18:51:46	35.0	75.4
80	02/11/92	00:31:05	34.8	76.0
81	02/13/92	01:35:19	34.7	75.8
82	02/16/92	12:52:06	34.9	76.1

POINT NO.	DATE	TIME (GMT)	LAT	LONG
83	02/24/92	14:58:22	34.9	76.2
84	02/26/92	18:03:20	34.9	76.1
85	02/28/92	08:05:21	35.1	76.0
86	02/29/92	11:32:58	35.0	76.1
87	03/08/92	12:07:05	35.0	76.1
88	03/08/92	19:12:01	35.1	76.2
89	03/09/92	20:46:28	35.0	75.9
90	03/12/92	10:26:48	34.8	75.8
91	03/16/92	23:55:18	35.1	75.9
92	03/17/92	07:45:12	35.1	76.0
93	03/17/92	09:28:32	35.2	75.9
94	03/18/92	01:15:57	35.1	75.9
95	03/18/92	07:33:35	35.0	75.9
96	03/18/92	23:11:45	35.2	75.9
97	03/19/92	22:54:03	51.3	76.1
98	03/20/92	07:13:04	35.2	76.2
99	03/21/92	07:02:19	35.3	76.4
100	03/23/92	08:14:23	34.9	75.6
101	03/24/92	08:02:57	34.7	75.8
102	03/25/92	19:12:45	35.1	75.8
103	03/26/92	07:38:41	35.0	75.9
104	03/26/92	19:01:48	35.0	75.9
105	03/28/92	20:19:43	34.9	75.8
106	03/30/92	12:38:09	34.9	75.8
107	03/31/92	18:01:28	34.9	75.8
108	04/01/92	01:19:22	35.0	75.7
109	04/09/92	14:10:16	34.9	75.7
110	04/11/92	01:10:35	34.7	75.5
111	04/12/92	00:41:31	34.9	75.9

POINT NO.	DATE	TIME (GMT)	LAT	LONG
112	04/16/92	19:56:27	35.0	75.5
113	04/18/92	12:35:19	35.1	75.5
114	04/20/92	13:35:50	35.1	75.4
115	04/21/92	09:15:57	35.2	75.3
116	04/29/92	12:07:48	35.4	75.4
117	04/29/92	20:37:17	35.2	75.4
118	04/30/92	09:00:39	35.2	75.5
119	04/30/92	18:47:38	35.1	75.3
120	04/30/92	20:27:03	35.1	75.3
121	04/30/92	23:03:12	35.1	75.3
122	05/01/92	00:42:38	35.1	75.3
123	05/01/92	11:22:23	35.2	75.3
124	05/03/92	08:26:57	35.2	75.1
125	05/05/92	00:56:17	35.4	75.4
126	05/07/92	12:33:58	35.4	75.4
127	05/08/92	01:35:39	35.5	75.3
128	05/08/92	09:13:31	35.4	75.0
129	05/10/92	08:47:26	35.6	75.2
130	05/13/92	01:30:33	35.6	75.1
131	05/15/92	00:45:37	35.7	75.5
132	05/15/92	20:47:06	35.9	75.4
133	05/16/92	00:28:21	35.9	75.4
134	05/16/92	09:14:22	36.0	75.5
135	05/16/92	20:37:30	36.0	75.6
136	05/18/92	20:12:41	36.0	75.6
137	05/19/92	01:01:40	36.0	75.6
138	05/19/92	13:18:05	36.0	75.6
139	05/23/92	01:19:04	35.9	75.4

POINT NO.	DATE	TIME (GMT)	LAT	LONG
140	05/24/92	00:56:29	35.8	75.5

Appendix 10. Data from Kemp's ridley 1229 tracked via satellite in 1991. POINT NO. corresponds to numbered points in Figure 5. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	10/24/91	09:21:42	36.6	75.9
2	10/24/91	22:38:38	36.6	75.8
3	10/25/91	00:22:14	36.6	75.8
4	10/25/91	09:13:35	36.6	75.8
5	10/25/91	17:14:47	36.6	75.8
6	10/26/91	12:18:51	36.6	75.8
7	10/26/91	13:58:15	36.6	75.8
8	10/26/91	20:23:27	36.5	75.8
9	10/26/91	23:41:27	36.5	75.8
10	10/27/91	11:56:17	36.5	75.8
11	10/27/91	13:38:13	36.5	75.8
12	10/27/91	15:14:23	36.4	75.8
13	10/27/91	18:27:57	36.4	75.8
14	10/27/91	20:11:57	36.4	75.8
15	10/27/91	23:11:21	36.4	75.8
16	10/28/91	08:37:36	36.3	75.7
17	10/28/91	13:17:29	36.2	75.7
18	10/28/91	14:53:33	36.2	75.7
19	10/28/91	20:00:16	36.1	75.7
20	10/28/91	22:55:28	36.0	75.6
21	10/29/91	08:24:30	35.8	75.5
22	10/29/91	14:34:37	35.7	75.4
23	10/29/91	18:08:09	35.6	75.4
24	10/29/91	19:48:41	35.5	75.4

POINT NO.	DATE	TIME (GMT)	LAT	LONG
25	10/30/91	00:15:22	35.4	75.4
26	10/30/91	01:55:23	35.4	75.4
27	10/30/91	06:31:58	35.3	75.4
28	10/30/91	09:53:59	35.2	75.4
29	10/30/91	12:32:59	35.2	75.4
30	10/30/91	14:13:57	35.1	75.4
31	10/30/91	17:55:21	35.1	75.4
32	10/30/91	22:13:10	35.0	75.4
33	10/30/91	23:53:48	34.9	75.5
34	10/31/91	01:33:37	34.9	75.5
35	10/31/91	06:19:10	34.8	75.6
36	10/31/91	07:59:51	34.8	75.6
37	10/31/91	09:42:33	34.7	75.7
38	10/31/91	12:13:35	34.7	75.7
39	10/31/91	13:54:06	34.7	75.7
40	10/31/91	17:45:07	34.6	75.8
41	10/31/91	19:23:25	34.7	75.8
42	11/01/91	01:12:22	34.6	76.0
43	11/01/91	07:50:23	34.6	76.1
44	11/01/91	09:32:12	34.6	76.1
45	11/01/91	11:53:11	34.5	76.2
46	11/01/91	13:32:23	34.5	76.2
47	11/01/91	17:34:26	34.5	76.2
48	11/01/91	20:53:15	34.5	76.3
49	11/02/91	13:13:59	34.5	76.3
50	11/02/91	14:50:31	34.5	76.3
51	11/02/91	17:21:52	34.5	76.3
52	11/02/91	18:59:43	34.6	76.3
53	11/02/91	20:42:22	34.6	76.3

POINT NO.	DATE	TIME (GMT)	LAT	LONG
54	11/02/91	22:52:52	34.6	76.3
55	11/03/91	12:50:57	34.7	76.3
56	11/03/91	14:29:05	34.7	76.3
57	11/03/91	18:52:20	34.7	76.3
58	11/03/91	20:30:38	34.7	76.3
59	11/04/91	20:19:10	34.7	76.4
60	11/05/91	01:30:56	34.7	76.4
61	11/05/91	07:02:57	34.6	76.4
62	11/05/91	08:44:14	34.6	76.4
63	11/05/91	10:23:60	34.6	76.4
64	11/05/91	13:49:11	34.6	76.5
65	11/05/91	18:25:31	34.5	76.5
66	11/05/91	20:07:08	34.5	76.5
67	11/05/91	23:27:48	34.5	76.6
68	11/06/91	01:07:30	34.5	76.6
69	11/06/91	06:52:59	34.5	76.6
70	11/06/91	08:32:03	34.5	76.6
71	11/06/91	10:12:25	34.5	76.6
72	11/06/91	11:48:52	34.5	76.7
73	11/06/91	13:28:26	34.5	76.7
74	11/06/91	15:06:55	34.5	76.6
75	11/06/91	18:14:57	34.5	76.7
76	11/06/91	19:52:31	34.5	76.7
77	11/06/91	23:06:42	34.5	76.7
78	11/07/91	00:46:46	34.5	76.7
79	11/07/91	06:39:12	34.5	76.8
80	11/07/91	10:01:07	34.5	76.8
81	11/07/91	11:27:45	34.5	76.8
82	11/07/91	13:07:28	34.5	76.8

POINT NO.	DATE	TIME (GMT)	LAT	LONG
83	11/07/91	14:45:53	34.5	76.8
84	11/07/91	18:03:15	34.5	76.8
85	11/07/91	19:42:31	34.5	76.8
86	11/07/91	22:46:39	34.5	76.8
87	11/08/91	00:26:15	34.5	76.8
88	11/08/91	02:06:33	34.5	76.9
89	11/08/91	12:47:03	34.5	76.9
90	11/08/91	14:26:06	34.5	76.9
91	11/08/91	17:49:13	34.5	76.9
92	11/08/91	19:30:44	34.5	76.9
93	11/08/91	21:11:42	34.5	76.9
94	11/08/91	22:26:06	34.5	77.0
95	11/09/91	00:05:20	34.5	77.0
96	11/09/91	01:47:43	34.5	77.0
97	11/09/91	07:56:38	34.5	77.0
98	11/09/91	09:38:23	34.4	77.0
99	11/09/91	12:26:15	34.4	77.1
100	11/09/91	14:02:50	34.4	77.1
101	11/09/91	19:21:14	34.4	77.1
102	11/09/91	21:02:23	34.4	77.1
103	11/09/91	23:43:57	34.3	77.2
104	11/10/91	01:24:36	34.3	77.2
105	11/10/91	07:45:28	34.2	77.3
106	11/10/91	09:26:38	34.2	77.4
107	11/10/91	12:05:21	34.2	77.4
108	11/10/91	13:45:04	34.2	77.4
109	11/10/91	19:08:30	34.2	77.4
110	11/10/91	20:49:56	34.2	77.4
111	11/10/91	23:22:24	34.2	77.4

POINT NO.	DATE	TIME (GMT)	LAT	LONG
112	11/11/91	01:03:58	34.2	77.4
113	11/11/91	07:35:18	34.2	77.4
114	11/11/91	09:14:56	34.2	77.4
115	11/11/91	11:43:39	34.2	77.4
116	11/11/91	13:21:45	34.2	77.4
117	11/11/91	15:03:21	34.2	77.4
118	11/11/91	18:56:32	34.2	77.4
119	11/11/91	20:37:30	34.2	77.4
120	11/11/91	23:01:48	34.2	77.4
121	11/12/91	00:43:15	34.2	77.4
122	11/12/91	13:04:21	34.2	77.4
123	11/12/91	14:42:11	34.2	77.4
124	11/12/91	18:44:35	34.2	77.5
125	11/12/91	20:26:02	34.2	77.5
126	11/12/91	22:41:58	34.2	77.5
127	11/13/91	00:20:46	34.2	77.5
128	11/13/91	02:02:18	34.2	77.5
129	11/13/91	07:08:20	34.2	77.5
130	11/13/91	08:51:15	34.2	77.5
131	11/13/91	12:42:51	34.2	77.5
132	11/13/91	14:21:55	34.2	77.5
133	11/13/91	18:33:34	34.1	77.5

Appendix 11. Data from Kemp's ridley 4938 tracked via satellite in 1991 - 1992. POINT NO. corresponds to numbered points in Figure 7. LAT = north latitude, LONG = west longitude.

POINT NO	DATE	TIME (GMT)	LAT	LONG
1	10/28/91	19:56:56	36.7	75.8
2	10/28/91	22:54:25	36.6	75.8
3	10/29/91	12:56:53	36.7	75.6
4	10/30/91	09:50:55	36.7	75.7
5	10/31/91	09:39:54	36.4	75.6
6	11/01/91	07:53:13	35.9	75.4
7	11/01/91	11:52:56	35.8	75.4
8	11/01/91	13:32:14	35.8	75.4
9	11/02/91	00:46:13	35.8	75.3
10	11/02/91	09:14:39	35.8	75.4
11	11/02/91	13:12:11	35.7	75.3
12	11/03/91	11:13:09	35.6	75.3
13	11/04/91	08:49:49	35.5	75.3
14	11/04/91	14:09:21	35.5	75.3
15	11/04/91	18:37:29	35.4	75.3
16	11/05/91	07:07:03	35.4	75.3
17	11/05/91	12:12:10	35.4	75.3
18	11/05/91	18:30:49	35.3	75.3
19	11/05/91	20:10:07	35.4	75.2
20	11/06/91	06:53:25	35.3	75.1
21	11/06/91	11:49:01	35.3	75.2
22	11/06/91	13:29:14	35.3	75.2
23	11/06/91	18:17:32	35.3	75.3
24	11/07/91	08:22:00	35.4	75.4

POINT NO	DATE	TIME (GMT)	LAT	LONG
25	11/07/91	11:25:40	35.4	75.4
26	11/07/91	18:04:30	35.4	75.4
27	11/08/91	12:46:18	35.2	75.4
28	11/08/91	19:32:14	35.0	75.5
29	11/09/91	00:05:13	35.0	75.5
30	11/09/91	14:02:51	35.0	75.7
31	11/09/91	19:21:33	34.9	75.7
32	11/10/91	13:40:55	34.7	76.2
33	11/10/91	20:52:33	34.7	76.3
34	11/11/91	15:00:17	34.6	76.4
35	11/12/91	18:45:11	34.4	76.6
36	11/12/91	20:23:58	34.4	76.6
37	11/13/91	00:19:49	34.4	76.7
38	11/13/91	18:28:14	34.3	77.0
39	11/14/91	12:20:38	34.3	77.1
40	11/14/91	18:20:39	34.4	77.1
41	11/14/91	20:04:26	34.4	77.2
42	11/17/91	14:37:44	34.4	77.4
43	11/18/91	09:32:56	34.2	77.5
44	11/18/91	12:40:15	34.2	77.6
45	11/18/91	19:15:53	34.2	77.7
46	11/19/91	07:36:08	34.1	77.7
47	11/19/91	12:14:42	34.1	77.8
48	11/19/91	13:58:52	34.0	77.8
49	11/19/91	18:58:39	34.0	77.8
50	11/19/91	23:40:41	34.0	77.8
51	11/20/91	20:28:50	34.0	77.8
52	11/21/91	07:17:29	33.8	77.9
53	11/21/91	18:41:42	33.8	77.9

POINT NO	DATE	TIME (GMT)	LAT	LONG
54	11/22/91	07:10:34	33.7	78.1
55	11/22/91	14:30:38	33.7	78.1
56	11/23/91	18:13:33	33.7	77.9
57	11/24/91	12:11:06	33.6	78.2
58	11/24/91	18:05:56	33.5	78.3
59	11/24/91	21:27:59	33.5	78.3
60	11/25/91	06:31:23	33.6	78.3
61	11/25/91	13:32:31	33.6	78.4
62	11/25/91	21:16:45	33.5	78.4
63	11/25/91	23:09:39	33.5	78.4
64	11/26/91	14:47:12	33.5	78.5
65	11/26/91	22:49:25	33.4	78.5
66	11/27/91	07:50:10	33.4	78.6
67	11/27/91	09:27:34	33.4	78.6
68	11/27/91	12:50:04	33.4	78.6
69	11/27/91	14:30:13	33.4	78.6
70	11/27/91	17:32:14	33.4	78.7
71	11/27/91	19:10:44	33.4	78.7
72	11/28/91	07:40:49	33.3	78.7
73	11/28/91	12:25:56	33.4	78.8
74	11/28/91	14:08:31	33.3	78.8
75	11/29/91	01:22:04	33.3	78.8
76	11/30/91	08:52:38	33.3	79.0
77	12/01/91	13:03:16	33.1	79.0
78	12/02/91	12:40:37	33.0	79.2
79	12/02/91	18:13:24	33.0	79.1
80	12/03/91	12:28:56	32.9	79.1
81	12/03/91	17:58:02	33.0	79.0
82	12/03/91	23:38:19	32.9	79.0

POINT NO	DATE	TIME (GMT)	LAT	LONG
83	12/04/91	08:13:24	32.7	79.0-
84	12/04/91	19:32:56	32.9	79.1
85	12/05/91	13:24:41	32.9	79.1
86	12/05/91	15:02:10	32.9	79.1
87	12/05/91	17:37:52	32.8	79.1
88	12/05/91	19:16:54	32.8	79.1
89	12/05/91	20:59:21	32.8	79.1
90	12/06/91	13:01:06	32.7	79.3
91	12/06/91	19:04:01	32.7	79.3
92	12/07/91	14:17:48	32.7	79.3
93	12/07/91	18:58:33	32.7	79.4
94	12/08/91	12:21:05	32.7	79.4
95	12/09/91	08:44:52	32.7	79.4
96	12/09/91	18:30:57	32.7	79.5
97	12/10/91	13:22:26	32.7	79.2
98	12/11/91	18:04:55	32.6	79.6
99	12/12/91	14:19:42	32.5	79.7
100	12/12/91	23:53:13	32.5	79.7
101	12/13/91	09:45:43	32.5	79.7
102	12/13/91	19:28:18	32.5	79.7
103	12/14/91	15:15:00	32.6	79.7
104	12/15/91	18:59:20	32.5	79.8
105	12/16/91	12:46:25	32.6	79.8
106	12/18/91	07:00:44	32.5	79.8
107	12/20/91	06:40:36	32.4	79.8
108	12/20/91	21:22:52	32.3	80.0
109	12/20/91	22:46:20	32.3	80.0
110	12/24/91	11:46:42	32.2	80.0
111	12/25/91	00:37:02	32.2	80.0

POINT NO	DATE	TIME (GMT)	LAT	LONG
112	12/25/91	13:05:20	32.2	80.1
113	12/25/91	14:42:53	32.2	80.1
114	12/25/91	18:43:51	32.2	80.1
115	12/25/91	20:24:44	32.1	80.1
116	12/26/91	12:46:10	32.0	80.3
117	12/26/91	14:21:42	32.0	80.3
118	12/26/91	18:30:18	32.0	80.4
119	12/26/91	20:17:03	31.9	80.4
120	12/27/91	12:19:32	31.8	80.5
121	12/27/91	18:21:00	31.8	80.5
122	12/28/91	13:41:31	31.6	80.6
123	12/28/91	18:09:06	31.5	80.7
124	12/28/91	21:31:53	31.5	80.7
125	12/29/91	01:02:59	31.5	80.7
126	12/30/91	12:58:22	31.5	80.6
127	12/31/91	02:00:07	31.5	80.6
128	12/31/91	14:16:56	31.4	80.6
129	12/31/91	19:10:19	31.4	80.7
130	12/31/91	20:54:55	31.3	80.7
131	01/01/92	07:38:28	31.2	80.8
132	01/01/92	13:57:17	31.1	80.8
133	01/02/92	09:03:32	31.0	80.8
134	01/02/92	13:37:44	30.9	80.8
135	01/02/92	18:50:35	30.8	80.8
136	01/02/92	20:34:37	30.8	80.8
137	01/05/92	18:15:52	30.6	80.8
138	01/05/92	19:55:27	30.6	80.8
139	01/06/92	18:04:05	30.5	80.8
140	01/06/92	19:40:44	30.5	80.7

POINT NO	DATE	TIME (GMT)	LAT	LONG
141	01/08/92	21:01:00	30.5	80.7
142	01/12/92	20:15:14	30.5	80.7
143	01/12/92	23:03:58	30.5	80.7
144	01/14/92	18:10:57	30.5	80.7
145	01/15/92	14:05:18	30.5	80.7
146	01/18/92	20:37:29	30.3	80.8

Appendix 12. Data from Kemp's ridley 4939 tracked via satellite in 1991 - 1992. POINT NO. corresponds to numbered points in Figure 9. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	10/30/91	09:54:06	36.1	75.3
2	10/30/91	14:13:49	36.0	75.2
3	10/30/91	17:55:54	35.9	75.2
4	10/30/91	23:52:49	35.8	75.1
5	10/31/91	09:44:27	35.5	74.9
6	10/31/91	12:12:49	35.5	75.0
7	10/31/91	13:51:39	35.5	74.9
8	10/31/91	17:44:10	35.4	74.9
9	10/31/91	19:24:41	35.4	74.8
10	11/01/91	01:10:46	35.3	74.8
11	11/01/91	11:52:40	35.2	74.8
12	11/01/91	13:33:56	35.2	74.9
13	11/01/91	17:32:48	35.2	75.0
14	11/01/91	23:10:40	35.2	74.9
15	11/02/91	13:10:33	35.2	75.1
16	11/02/91	18:59:50	35.4	75.0
17	11/03/91	20:32:41	35.4	75.1
18	11/03/91	22:28:42	35.4	75.1
19	11/04/91	12:30:04	35.3	75.2
20	11/04/91	14:12:39	35.3	75.2
21	11/04/91	20:23:33	35.4	75.2
22	11/05/91	20:05:54	34.9	75.4
23	11/06/91	06:45:46	35.1	75.6
24	11/06/91	11:51:45	35.0	75.7

POINT NO.	DATE	TIME (GMT)	LAT	LONG
25	11/06/91	18:13:15	35.0	75.8
26	11/06/91	19:55:15	35.0	75.8
27	11/08/91	12:44:59	35.0	76.0
28	11/09/91	06:15:15	34.7	76.1
29	11/09/91	12:25:52	34.8	76.2
30	11/09/91	14:06:17	34.7	76.2
31	11/09/91	17:40:04	34.6	76.3
32	11/09/91	19:20:47	34.6	76.4
33	11/09/91	21:01:18	34.5	76.4
34	11/10/91	13:44:16	34.4	76.7
35	11/11/91	18:55:05	34.4	77.1
36	11/12/91	18:45:21	34.2	77.0
37	11/13/91	18:35:49	34.3	77.3
38	11/13/91	20:16:43	34.3	77.4
39	11/13/91	22:21:57	34.3	77.3
40	11/14/91	13:59:37	34.2	77.4
41	11/14/91	18:24:14	34.2	77.5
42	11/15/91	12:00:31	34.2	77.5
43	11/15/91	13:39:47	34.2	77.5
44	11/15/91	18:07:42	34.2	77.5
45	11/15/91	19:52:22	34.2	77.6
46	11/16/91	01:03:09	34.1	77.6
47	11/16/91	06:32:19	34.1	77.6
48	11/16/91	09:53:22	34.1	77.7
49	11/16/91	13:23:11	34.1	77.6
50	11/17/91	12:58:27	34.0	77.8
51	11/17/91	14:37:07	33.9	77.8
52	11/18/91	07:57:47	33.7	77.8
53	11/18/91	19:19:09	33.6	77.8

POINT NO.	DATE	TIME (GMT)	LAT	LONG
54	11/19/91	12:18:16	33.5	78.1
55	11/19/91	19:02:06	33.6	78.1
56	11/19/91	20:41:54	33.6	78.1
57	11/20/91	13:35:19	33.6	78.1
58	11/20/91	18:51:47	33.6	78.2
59	11/20/91	20:31:08	33.6	78.3
60	11/21/91	08:54:10	33.6	78.3
61	11/21/91	20:20:41	33.6	78.4
62	11/22/91	12:53:34	33.7	78.6
63	11/24/91	18:05:09	33.6	78.8
64	11/25/91	17:56:59	33.5	78.9
65	11/26/91	00:49:18	33.5	78.9
66	11/26/91	07:59:46	33.4	78.9
67	11/26/91	22:47:13	33.3	79.0
68	11/27/91	12:53:33	33.2	79.0
69	11/27/91	19:07:27	33.1	79.0
70	11/27/91	22:27:34	33.1	79.0
71	11/28/91	14:08:28	33.0	79.1
72	11/28/91	20:40:29	32.9	79.1
73	11/29/91	13:48:00	32.8	79.2
74	11/30/91	01:09:01	32.8	79.3
75	11/30/91	11:46:47	32.8	79.4
76	11/30/91	20:16:37	32.8	79.4
77	12/01/91	11:22:46	32.8	79.6
78	12/01/91	18:25:20	32.7	79.5
79	12/03/91	12:23:01	32.7	79.8
80	12/03/91	17:57:52	32.5	79.7
81	12/04/91	12:02:22	32.7	79.5
82	12/04/91	13:42:44	32.6	79.5

POINT NO.	DATE	TIME (GMT)	LAT	LONG
83	12/04/91	19:30:56	32.6	79.6
84	12/05/91	11:44:27	32.5	79.6
85	12/05/91	19:16:03	32.4	79.6
86	12/05/91	23:01:17	32.4	79.6
87	12/06/91	14:40:59	32.3	79.8
88	12/06/91	19:09:26	32.3	79.8
89	12/06/91	22:38:40	32.2	79.9
90	12/07/91	14:16:35	32.2	79.8
91	12/07/91	18:53:54	32.2	79.8
92	12/07/91	20:34:22	32.2	79.7
93	12/08/91	07:17:02	32.2	80.0
94	12/08/91	18:43:03	32.2	79.7
95	12/08/91	20:22:50	32.2	79.8
96	12/09/91	01:13:52	32.2	79.6
97	12/09/91	11:56:30	32.2	79.8
98	12/09/91	20:10:36	32.1	79.8
99	12/10/91	11:33:57	32.1	79.9
100	12/10/91	14:57:27	32.2	80.0
101	12/10/91	22:55:57	32.1	80.0
102	12/11/91	13:00:17	32.1	80.0
103	12/12/91	23:54:52	31.9	80.1
104	12/15/91	11:33:47	32.1	80.6
105	12/18/91	08:43:54	31.7	80.6
106	12/19/91	06:51:31	31.7	80.6
107	12/19/91	08:33:25	31.7	80.7
108	12/20/91	14:48:20	31.3	80.8
109	12/21/91	19:33:35	30.8	81.1
110	12/22/91	12:26:24	30.9	81.0
111	12/22/91	20:59:02	30.8	81.0

POINT NO.	DATE	TIME (GMT)	LAT	LONG
112	12/23/91	13:51:33	30.8	80.9
113	12/23/91	20:52:58	30.7	80.9
114	12/24/91	07:36:45	30.7	81.0
115	12/25/91	18:45:39	30.6	81.1
116	12/26/91	12:45:27	30.4	81.2
117	12/26/91	20:11:43	30.3	81.2
118	12/27/91	06:55:52	30.2	81.2
119	12/29/91	00:59:23	29.7	81.2
120	12/29/91	14:57:25	29.6	81.1
121	01/02/92	23:08:55	28.8	80.6
122	01/04/92	07:08:07	28.5	80.5

Appendix 13. Data from Kemp's ridley 1230 tracked via satellite in 1993. POINT NO. corresponds to numbered points in Figure 9. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	9/15/93	12:34:49	36.8	75.8
2	9/15/93	22:15:24	36.8	76.0
3	9/16/93	8:4:46	36.8	76.0
4	9/16/93	9:45:44	36.8	76.0
5	9/17/93	11:49:59	37.2	76.3
6	9/23/93	14:41:47	37.4	76.1
7	9/24/93	2:1:50	37.5	76.2
8	9/25/93	22:42:57	37.5	76.1
9	9/26/93	11:5:51	37.5	76.1
10	9/26/93	13:39:56	37.6	76.1
11	9/27/93	9:14:16	37.6	76.1
12	9/27/93	22:16:55	37.5	76.0
13	9/27/93	22:53:58	37.5	76.0
14	9/28/93	11:11:31	37.6	76.0
15	9/28/93	22:34:40	37.6	76.1
16	9/29/93	12:35:52	37.6	76.0
17	9/30/93	8:33:34	37.6	76.1
18	10/1/93	10:6:54	37.5	76.0
19	10/1/93	13:29:19	37.6	76.0
20	10/1/93	21:28:26	37.6	76.1
21	10/2/93	8:12:42	37.6	76.0
22	10/2/93	11:30:30	37.6	76.0
23	10/2/93	21:17:46	37.6	76.1
24	10/3/93	0:29:34	37.6	76.1

POINT NO.	DATE	TIME (GMT)	LAT	LONG
25	10/3/93	12:46:51	37.5	76.1
26	10/5/93	13:40:25	37.5	76.2
27	10/5/93	20:40:44	37.5	76.2
28	10/6/93	10:48:45	37.5	76.3
29	10/6/93	22:11:42	37.5	76.1
30	10/6/93	23:1:27	37.5	76.1
31	10/7/93	0:45:29	37.5	76.1
32	10/7/93	18:35:37	37.5	76.1

Appendix 14. Data from Kemp's ridley 1231 tracked via satellite in 1993. POINT NO. corresponds to numbered points in Figure 9. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	9/15/93	1:57:19	36.7	75.9
2	9/15/93	12:38:1	36.6	75.7
3	9/17/93	11:48:42	36.4	75.7
4	9/17/93	13:31:26	36.4	75.7
5	9/18/93	13:9:56	36.1	75.7
6	9/19/93	11:8:22	36.1	75.7
7	9/23/93	8:18:31	36.0	75.7
8	9/23/93	22:40:18	35.9	75.7
9	9/24/93	11:26:10	35.9	75.7
10	9/24/93	19:33:38	35.8	75.7
11	9/25/93	0:1:9	35.8	75.7
12	9/25/93	21:0:47	35.8	75.7
13	9/27/93	13:15:26	35.8	75.7
14	9/29/93	12:37:57	35.9	75.7
15	10/1/93	1:14:11	35.8	75.7
16	10/1/93	21:27:10	35.7	75.7
17	10/9/93	10:4:31	35.6	75.7
18	10/17/93	19:52:1	35.6	75.7
19	10/18/93	9:59:12	35.6	75.7
20	10/18/93	21:20:59	35.5	75.7
21	10/20/93	11:12:59	35.4	75.7
22	10/21/93	22:41:50	35.3	75.7
23	10/22/93	14:21:2	35.3	75.7
24	10/23/93	20:22:55	35.3	75.7

POINT NO.	DATE	TIME (GMT)	LAT	LONG
25	10/23/93	23:32:39	35.3	75.7
26	10/25/93	19:50:55	35.3	75.7
27	10/26/93	22:31:57	35.3	75.7
28	10/27/93	11:27:42	35.2	75.7
29	10/27/93	12:29:20	35.1	75.7
30	10/28/93	12:9:55	35.1	75.7
31	10/28/93	13:44:11	35.1	75.7
32	10/29/93	1:8:2	34.9	75.7
33	11/1/93	21:50:47	35.1	75.2
34	11/2/93	10:17:51	35.2	75.3
35	11/3/93	15:0:12	35.2	75.3
36	11/3/93	19:44:5	35.3	75.3
37	11/4/93	22:35:7	35.2	75.6
38	11/7/93	23:15:19	35.3	75.4
39	11/10/93	1:48:41	35:1	75:4
40	11/11/93 3	19:51:48	35.1	75.2

Appendix 15. Data from Kemp's ridley 1233 tracked via satellite in 1993. POINT NO. corresponds to numbered points in Figure 9. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	9/14/93	19:53:9	36.7	75.8
2	9/14/93	21:35:12	36.7	75.8
3	9/14/93	22:31:38	36.7	75.8
4	9/15/93	12:28:58	36.7	75.8
5	9/15/93	21:25:27	36.7	75.8
6	9/16/93	12:8:19	36.7	75.8
7	9/16/93	13:50:42	36.7	75.8
8	9/17/93	13:32:9	36.7	75.8
9	9/17/93	19:14:42	36.7	75.8
10	9/18/93	0:54:19	36.7	75.8
11	9/18/93	11:24:31	36.7	75.8
12	9/19/93	10:52:26	36.7	75.8
13	9/19/93	11:5:36	36.7	75.8
14	9/19/93	22:25:47	36.7	75.8
15	9/20/93	12:30:35	36.7	75.8
16	9/20/93	22:0:7	36.7	75.8
17	9/20/93	23:45:57	36.7	75.8
18	9/22/93	11:46:4	36.7	75.8
19	9/22/93	15:0:54	36.7	75.8
20	9/25/93	0:0:49	36.7	75.8
21	9/26/93	1:20:59	36.7	75.8
22	9/27/93	1:1:29	36.7	75.8
23	9/27/93	10:52:48	36.7	75.8
24	9/27/93	11:35:20	36.7	75.8
25	9/27/93	13:19:50	36.7	75.8

POINT NO.	DATE	TIME (GMT)	LAT	LONG
26	9/30/93	19:59:30	36.7	75.8
27	9/30/93	21:40:44	36.7	75.8
28	10/5/93	13:47:0	36.7	75.8
29	10/6/93	13:20:58	36.7	75.8
30	10/9/93	8:28:35	36.7	75.8

Appendix 16. Data from Kemp's ridley 1234 tracked via satellite in 1993. POINT NO. corresponds to numbered points in Figure 9. LAT = north latitude, LONG = west longitude.

POINT NO.	DATE	TIME (GMT)	LAT	LONG
1	9/14/93	20:0:27	36.7	75.8
2	9/14/93	22:37:51	36.7	75.8
3	9/15/93	8:15:51	36.7	75.8
4	9/15/93	9:55:24	36.7	75.8
5	9/15/93	21:22:20	36.7	75.8
6	9/16/93	1:35:21	36.7	75.8
7	9/16/93	11:23:23	36.7	75.8
8	9/16/93	13:54:28	36.7	75.8
9	9/16/93	19:27:5	36.7	75.8
10	9/16/93	21:53:15	36.7	75.8
11	9/17/93	7:56:42	36.7	75.8
12	9/17/93	11:55:13	36.7	75.8
13	9/17/93	13:31:23	36.7	75.8
14	9/19/93	9:11:40	36.7	75.8
15	9/20/93	22:4:50	36.7	75.8
16	9/21/93	20:13:56	36.7	75.8
17	9/22/93	11:42:8	36.7	75.8
18	9/22/93	13:25:14	36.7	75.8
19	9/22/93	15:2:18	36.7	75.8
20	9/23/93	0:44:14	36.7	75.8
21	9/23/93	8:22:11	36.7	75.8
22	9/24/93	14:20:6	36.7	75.8
23	9/25/93	1:40:51	36.7	75.8
24	9/25/93	7:52:0	36.7	75.8
25	9/26/93	1:18:8	36.7	75.8

POINT NO.	DATE	TIME (GMT)	LAT	LONG
26	9/26/93	23:15:45	36.7	75.8
27	9/27/93	22:59:18	36.7	75.8
28	9/29/93	21:52:23	36.7	75.8
29	10/1/93	11:44:43	36.7	75.8
30	10/3/93	0:33:1	36.7	75.8
31	10/6/93	11:45:23	36.7	75.8
32	10/6/93	14:59:24	36.7	75.8
33	10/6/93	18:45:21	36.7	75.8
34	10/7/93	10:34:29	36.7	75.8
35	10/11/93	13:14:46	36.7	75.8
36	10/11/93	14:51:1	36.7	75.8
37	10/12/93	9:26:54	36.7	75.8
38	10/12/93	14:33:43	36.7	75.8
39	10/12/93	20:52:14	36.7	75.8
40	10/13/93	14:7:34	36.7	75.8
41	10/15/93	18:39:22	36.7	75.8
42	10/15/93	21:58:58	36.7	75.8
43	10/16/93	14:48:33	36.7	75.8
44	10/17/93	12:41:35	36.7	75.8
45	10/19/93	1:25:21	36.7	75.8

Appendix 17. Aerial surveys performed in 1985 - 1989 by line, linear kilometers flown, and number of turtles seen on each line.

Date	Line	Linear Km	Loggerheads	Leatherbacks
18 Apr 85	32	8.4	0	0
	31	25.0	1	0
	30	18.5	9	0
	29	18.5	5	0
	28	18.5	1	0
	27	18.5	8	0
	26	18.5	7	0
	25	18.5	1	0
	24	18.5	3	0
	23	18.5	2	0
26 Apr 85	23	18.5	3	0
	21	18.5	3	0
	19	18.5	1	0
	16	18.5	1	0
	15	18.5	2	0
	13	18.5	3	0
	11	18.5	1	0
	9	18.5	0	0
	7	18.5	1	0
	5	18.5	0	0
01 May 85	7	24.1	1	0
	8	44.5	22	0
02 May 85	7	24.1	10	0
	8	44.5	13	0
25 May 85	8	44.5	1	0

Date	Line	Linear Km	Loggerheads	Leatherbacks
06 Aug 85	7	24.1	4	1
	8	35.2	6	0
05 Sep 85	7	24.1	0	0
	8	44.5	1	0
10 Oct 85	7	24.1	1	0
	8	44.5	7	0
15 Oct 85	23	18.5	1	0
	21	18.5	0	0
	19	18.5	0	0
	16	18.5	0	0
	15	18.5	2	0
	13	18.5	3	0
	11	18.5	6	0
11 Nov 85	24	18.5	0	0
	23	18.5	2	0
	21	18.5	1	0
	19	18.5	0	0
	16	18.5	0	0
	15	18.5	3	0
	13	18.5	4	0
	11	18.5	11	0
	7	24.1	2	0
	8	35.2	2	0
20 Nov 85	29	18.5	2	0
	27	18.5	1	0
	25	18.5	1	0
07 May 86	32	8.3	0	0
	31	25.0	0	0
	30	18.5	0	0

Date	Line	Linear Km	Loggerheads	Leatherbacks
	29	18.5	0	0
	28	18.5	0	0
	27	18.5	0	0
	26	18.5	0	0
	25	18.5	2	0
	24	18.5	1	0
	23	18.5	6	0
	22	18.5	4	0
	19	27.8	1	0
	17	18.5	2	0
	15	27.8	1	0
	14	18.5	1	0
	11	27.8	2	0
16 May 86	7	24.1	1	0
	8	35.2	6	0
19 May 86	23	18.5	5	0
	22	18.5	8	0
	19	27.8	5	0
	17	18.5	5	0
	15	27.8	7	0
	14	18.5	13	0
	11	27.8	13	0
	9	12.9	8	0
	7	24.1	6	0
30 May 86	23	18.5	3	0
	22	18.5	1	1
	19	27.8	4	0
	17	18.5	0	0
	15	27.8	12	0

Date	Line	Linear Km	Loggerheads	Leatherbacks
	14	18.5	4	0
	11	27.8	12	0
	9	12.9	5	0
	7	24.1	18	0
	6	18.5	2	0
	3	27.8	10	0
	8	35.2	15	0
19 Jun 86	15	27.8	1	0
	14	18.5	0	0
	11	27.8	1	0
	9	12.9	0	0
	7	24.1	0	0
	6	18.5	0	0
	3	27.8	2	0
	8	35.2	1	0
04 Jul 86	15	27.8	5	0
	14	18.5	5	0
	11	27.8	3	0
	9	12.9	1	0
	7	24.1	9	3
	6	18.5	11	0
	3	27.8	2	0
	8	35.2	5	0
10 Jul 86	15	27.8	0	0
	14	18.5	0	0
	11	27.8	2	0
	9	12.9	0	0
	7	24.1	1	0
	6	18.5	0	0

Date	Line	Linear Km	Loggerheads	Leatherbacks
	3	27.8	0	0
	8	35.2	3	0
26 Jul 86	7	24.1	2	0
	6	18.5	1	0
	3	27.8	2	0
	8	35.2	2	0
04 Aug 86	15	27.8	5	1
	14	18.5	3	0
	11	27.8	5	0
	9	12.9	0	0
	7	24.1	2	0
	6	18.5	1	0
	3	27.8	2	0
	8	35.2	5	0
15 Aug 86	15	27.8	0	0
	14	18.5	6	0
	11	27.8	0	0
	9	12.9	4	0
	7	24.1	4	0
	6	18.5	3	0
	3	27.8	5	0
	8	35.2	5	0
21 Aug 86	15	27.8	1	0
	14	18.5	2	0
	11	27.8	1	0
	9	12.9	2	0
	7	24.1	3	0
	6	18.5	1	0
	3	27.8	2	0

Date	Line	Linear Km	Loggerheads	Leatherbacks
	8	35.2	1	0
05 Sep 86	19	27.8	2	0
	17	18.5	2	0
	15	27.8	2	0
	14	18.5	4	0
	11	27.8	1	0
	9	12.9	2	0
	7	24.1	3	0
	8	35.2	3	0
23 Sep 86	23	18.5	0	0
	22	18.5	2	0
	19	27.8	0	0
	17	18.5	1	0
	15	27.8	0	0
	14	18.5	1	0
	11	27.8	0	0
	9	12.9	1	0
	7	24.1	1	0
	6	18.5	1	0
	3	27.8	1	0
	8	35.2	2	0
23 Oct 86	23	18.5	0	0
	22	18.5	1	0
	19	27.8	1	0
	17	18.5	3	0
	15	27.8	0	0
	14	18.5	1	0
	11	27.8	0	0
	9	12.9	0	0

Date	Line	Linear Km	Loggerheads	Leatherbacks
	7	24.1	1	0
	8	35.2	2	0
24 Oct 86	32	8.3	0	0
	31	25.0	1	0
	30	18.5	0	0
	29	18.5	3	0
	28	18.5	1	0
	27	18.5	0	0
	26	18.5	5	0
	25	18.5	1	0
	24	18.5	3	0
20 Nov 86	32	8.3	1	0
	31	25.0	2	0
	30	18.5	2	0
	29	18.5	7	0
	28	18.5	0	0
	27	18.5	2	0
	26	18.5	0	0
	25	18.5	0	0
	24	18.5	0	0
23 Nov 86	23	18.5	0	0
	22	18.5	1	0
	19	27.8	6	2
	17	18.5	1	0
	15	27.8	1	0
	14	18.5	5	0
	11	27.8	0	0
	9	12.9	1	0
	7	24.1	1	0

Date	Line	Linear Km	Loggerheads	Leatherbacks
	6	18.5	0	0
	3	27.8	0	0
	8	35.2	1	0
06 Dec 86	32	8.3	0	0
	31	25.0	4	0
	30	18.5	3	0
	29	18.5	0	0
	28	18.5	0	0
	27	18.5	0	0
	26	18.5	1	0
	25	18.5	0	0
	24	18.5	0	0
16 Sep 87	23	27.8	3	0
	20	18.5	1	0
	19	27.8	2	0
	18	20.4	5	0
	15	27.8	7	0
	12	20.4	2	0
	11	27.8	0	0
	10	18.5	0	0
	7	24.1	3	0
03 Dec 87	23	27.8	0	0
	20	18.5	0	0
	19	27.8	0	0
	18	20.4	0	0
	15	27.8	0	0
	12	20.4	0	0
	11	27.8	0	0
	10	18.5	0	0

Date	Line	Linear Km	Loggerheads	Leatherbacks
	7	24.1	0	0
	4	18.5	0	0
	3	27.8	0	0
07 Jun 88	23	27.8	6	0
	20	18.5	0	0
	19	27.8	4	0
	18	20.4	5	0
	15	27.8	10	0
	12	20.4	0	0
	11	27.8	6	0
	10	16.7	0	0
	7	24.1	2	0
	8	35.2	3	0
14 Jul 88	23	27.8	0	0
	20	18.5	4	0
	19	27.8	3	0
	18	20.4	0	0
	15	27.8	3	0
	12	20.4	0	0
	11	27.8	0	0
	10	16.7	2	0
	7	24.1	2	0
	8	35.2	1	0
15 Jul 88	23	27.8	2	0
	20	18.5	14	0
	19	27.8	8	1
	18	20.4	2	0
	15	27.8	6	0
	12	20.4	2	2

Date	Line	Linear Km	Loggerheads	Leatherbacks
	11	27.8	3	0
	10	16.7	3	0
	7	24.1	4	0
	4	18.5	1	1
	3	27.8	9	0
	2	18.5	4	0
	1	27.8	2	0
	8	35.2	11	1
29 Jul 88	23	27.8	5	0
	20	18.5	10	0
	19	27.8	6	0
	18	20.4	2	0
	15	27.8	7	0
	12	20.4	5	0
	11	27.8	2	0
	10	13.0	5	0
	7	24.1	3	0
	4	18.5	2	0
	3	27.8	10	0
	2	18.5	4	0
	1	27.8	3	0
	8	35.2	16	1
11 Aug 88	23	27.8	4	0
	20	18.5	0	0
	19	27.8	0	0
	18	20.4	1	0
	15	27.8	1	0
	12	20.4	0	0
	11	27.8	2	0

Date	Line	Linear Km	Loggerheads	Leatherbacks
	10	13.0	1	0
	7	24.1	3	0
	8	53.7	6	0
27 Oct 88	23	27.8	4	1
	20	18.5	2	0
	19	27.8	6	0
	18	20.4	4	1
	15	27.8	4	0
	12	20.4	4	0
	11	27.8	3	1
	10	18.5	1	1
	7	24.1	0	0
	4	18.5	0	0
	3	27.8	0	0
	2	18.5	1	0
	1	27.8	0	0
	8	53.7	0	0
25 Jul 89	32	8.3	0	0
	31	25.0	1	0
	30	18.5	0	0
	29	18.5	0	0
	28	18.5	1	0
	27	18.5	0	0
	26	18.5	0	0
	25	18.5	0	0
	24	18.5	1	0
	23	18.5	0	0
	20	18.5	0	0
	19	27.8	1	0

Date	Line	Linear Km	Loggerheads	Leatherbacks
	18	20.4	0	0
	15	27.8	0	0
	12	20.4	0	0
	11	27.8	1	0
	10	13.0	0	0
	7	24.1	1	0
	8	53.7	1	0

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places;
and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.