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**INTERESTING MOVEMENTS OF LOGGERHEAD (*CARETTA
CARETTA*) SEA TURTLES IN VIRGINIA, USA**

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ABSTRACT

Virginia is the northern most nesting region regularly utilized by loggerhead sea turtles (*Caretta caretta*) along the eastern coast of the United States. Along the southern shoreline of Virginia, between two and ten nests have been recorded annually since 1989 within Back Bay National Wildlife Refuge and False Cape State Park. Since 1992, the Virginia Institute of Marine Science (VIMS) has attached eight satellite transmitters to nesting loggerhead sea turtles in order to monitor their interesting movements and fall/winter migrations. VIMS has tracked the same nesting loggerhead three separate times during the 1993, 1995 and 1997 nesting seasons. This turtle has been observed to migrate into the Delaware Bay and Chesapeake Bay between nesting events and prior to her fall migrations. This project has demonstrated that nesting loggerhead sea turtles return to Virginia over subsequent seasons to nest, and utilize the Chesapeake and Delaware Bays as internesting and post-nesting habitat. Late season nesters tracked by VIMS have migrated south after their last recorded Virginia nesting event and have traveled along the coasts of North and South Carolina, in two cases establishing fall residency off the Carolinas. Three turtles have been tracked as far south as eastern Florida, with two entering the Gulf of Mexico before satellite transmissions ceased.

The tracking data generated by this project suggest that the adult turtles utilizing Virginia as nesting habitat preferentially utilize either the North Atlantic region or South Atlantic region as over-wintering habitat. Temperature ranges within which tagged turtles have remained range between 13° and 31° C. Three tagged turtles have remained in Virginia's waters until sea surface temperatures dropped to between 13° and 16° C before migrating south.

INTRODUCTION

Virginia, is one of the northernmost nesting area regularly utilized by loggerhead sea turtles (*Caretta caretta*) on the East Coast of the United States. While it is rare for female loggerheads to nest north of Cape Hatteras, North Carolina, Virginia typically records between two and ten nests annually. Virginia's nesting season begins in late May, continuing through mid to late August (BBNWR, 1993). These nests have been historically documented on the southern shoreline of Virginia, within Back Bay National Wildlife Refuge (BBNWR), False Cape State Park (FCSP) and adjacent beaches near Sandbridge, and Virginia Beach (Figure 1). In addition to this nesting activity, up to 10,000 juvenile loggerhead sea turtles inhabit the Chesapeake Bay each summer (Byles, 1988; Keinath et al., 1987; Keinath and Musick, 1991; Lutcavage, 1981; Lutcavage and Musick, 1985; Musick, 1988; Musick et al., 1985). Adult female loggerheads have been observed to utilize the Chesapeake Bay as an internesting or foraging habitat, and compose approximately five percent of the turtle population within the Bay (Musick and Limpus, 1997).

The U.S. Army Corps of Engineers (ACOE) has utilized hopper dredges off the coast of Virginia to obtain sand for placement on oceanfront beaches along Virginia Beach for over a decade. Hopper dredging and beach nourishment are activities which have the potential to adversely affect sea turtles, either directly by encounters with dredging equipment or indirectly by alteration of nesting habitat (Coston-Clements and Hoss, 1983). This potential threat can be minimized by gathering life history data on the sea turtles inhabiting Virginia's waters and nesting along the shoreline. These data in turn may be applied to the refinement of time constraints for offshore dredging operations as well as to help determine other alternatives that may prove useful in protecting the turtles and their habitat.

The Sea Turtle Program at the Virginia Institute of Marine Science (VIMS) has monitored over 25 sea turtles, including loggerheads, Kemp's ridleys (*Lepidochelys kempii*) and leatherback (*Dermochelys coriacea*) sea turtles with satellite telemetry since 1985 (Keinath, 1993). This tracking system has provided valuable information regarding the at-sea movements of nesting loggerhead turtles within Virginia's waters and within the proximity of the ACOE's dredging activities. Since 1992, VIMS has tracked female turtles found nesting within Back Bay National Wildlife Refuge in order to better understand the interesting movements of these turtles. The primary objectives of this study are to determine whether Virginia nesters are utilizing the Chesapeake Bay as interesting habitat, and to better define the temporal distribution of nesting sea turtles within Virginia's waters using satellite telemetry.

METHODS

Between May and continuing through September of each year (1992-2000), personnel and volunteers from the Back Bay National Wildlife Refuge (BBNWR) and the Virginia Marine Science Museum conducted a combination of daytime and nighttime sea turtle nesting patrols on the beaches from the northern limit of Sandbridge Beach to the southern limit of BBNWR at the North Carolina border. All loggerheads encountered were allowed to complete their nesting sequence. After nesting, turtles were restrained until VIMS personnel could access the refuge and attach a satellite transmitter to the nesting turtle. Telonics ST-14 and ST-6 satellite transmitters were used to track the at-sea movements of these turtles.

Prior to tag application, the turtle's scutes were lightly sanded with 100 grit sandpaper and then cleaned with acetone. Quick setting Power-Fast™ marine epoxy resin, amine hardener and Fibre Hair Body Fillert™ fiberglass resin were used to attach the transmitter to the turtle. The satellite transmitter was placed on the turtle's carapace at the second vertebral scute. We have utilized this method successfully on over 25 turtles (Keinath, 1993). After tag application, each turtle was immediately released at the nesting site location.

Satellite telemetry uses UHF transmitters that transmit signals to a satellite. The satellite in turn relays the signals 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). A salt-water switch turns off the transmitter while underwater in order to extend the battery life from 25 - 30 days to up to a year of operation. Data are accessed via the internet and email. Location, day and time of reception, and probability of location accuracy are among the data received, as are data on sea surface temperature, pressure, dive count and duration of last dive. All transmitter data were archived and sorted based on accuracy of transmission. Movements and behavior were monitored until positions were no longer received and transmission ceased.

RESULTS

Since 1992, VIMS has attached eight satellite tags to female turtles found nesting within Back Bay National Wildlife Refuge. The first turtle was tagged on July 30 of 1992, and was observed to travel from Virginia Beach down to the northern coast of Florida within a two-month timeframe (Figure 2). Between August 5 and 10, the turtle remained off shore of Cape Hatteras, North Carolina, after which she slowly moved south. By the 4th of September, the turtle appeared to remain off the east coast of Florida until transmission failed on September 8, 1992 (Keinath, 1993).

In 1993, a turtle was tagged on July 12 and subsequently remained within Virginia waters just off shore of BBNWR and FCSP until July 28, 1993. Upon last transmission (16 days after tag attachment), this turtle had moved slightly north to the southern tip of the Eastern Shore (Figure 3). This same turtle was found nesting on August 14, 1995, and was again tagged and tracked by VIMS. This time the turtle moved directly north into Delaware Bay where she remained until the transmitter failed on September 7, 1995 (Figure 4). On July 15 1997, this turtle returned to nest a third time at BBNWR and VIMS had the unique opportunity to tag and track this turtle for a third season. The transmitter was activated early in the nesting season and the turtle was tracked through a second nesting event (confirmed by BBNWR personnel). Shortly after her first nesting event, this turtle moved up into the Chesapeake Bay where she remained until her second nesting event on BBNWR on July 31, 1997. After her second nest, she was tracked up to the Delaware Bay where she remained for the rest of the summer. After the first cold snap (October 18, 1997) she began her southern winter migration. The last transmission was received off of Cape Hatteras, NC on November 1, 1997 (Figure 5).

In addition to the four tracks listed above, a nesting turtle was tagged on July 8, 1994 and observed to move south in late July, rounding Cape Hatteras on July 12th. She continued to travel south, remaining near shore and entered Florida's waters by mid-August. Continuing south past Cape Canaveral by August 24th, this turtle eventually stopped transmitting mid-October west of Key West, Florida (Figure 6). On August 25, 1996, another nesting female was tagged and tracked in the coastal waters immediately adjacent to BBNWR, FCSP and the northern shoreline of North Carolina for two months before migrating south on November 3rd. She continued to move south past Cape Hatteras on November 11th, finally entering Florida waters on December 6, 1996 where she continued to travel south along the shoreline. After rounding the southern tip of Florida on February 14, 1997, the final transmissions for this turtle were received on February 22, 1997 off the west coast of Florida in the Gulf of Mexico (Figure 7). A second nesting female was tracked by VIMS on July 22, 1997. This turtle remained close to shore in the waters adjacent to BBNWR, FCSP and northern North Carolina until October 18, 1997 when the last transmissions were received (Figure 8).

During the summers of 1998 and 1999, several turtle crawls and nests were recorded within BBNWR. However, due to difficulties experienced by BBNWR personnel and volunteers, nighttime patrolers did not physically encounter a nesting turtle during 1998 or 1999. As a result, VIMS was unable to utilize satellite telemetry to monitor the at-sea movements and behavior of loggerhead turtles nesting during the 1998 and 1999 seasons. On July 12, 2000 season, nighttime patrollers were successful in encountering a nesting turtle. This turtle immediately moved south remaining very close

to the shoreline of the Outer Banks, North Carolina. On August 4th she entered into Pamlico Sound through Oregon Inlet, moving between the Sound and Inlet several times between the 4th and 16th of August. Temperature data from the satellite transmitter coupled with NOAA Buoy and sea surface satellite data confirmed her presence in the warmer waters of the Sound. Transmission ceased on August 16, 2000, thirty six days after tag application (Figure 9).

Mean curved carapace lengths (CCL) for all nesting turtles tracked by this project (n=8) was 97.80 cm +/- 7.73 cm. CCL measurements ranged between 90.1 cm and 109 cm, with four satellite tags applied to turtles with a CCL less than 95.5 cm. Temperature ranges within which tagged turtles remained range between 13° and 31° C with a mean temperature of 23.09 +/- 3.18° C. Three tagged turtles remained in Virginia's waters until sea surface temperatures dropped to between 13° and 16° C before migrating south.

DISCUSSION

The 1997 tracking season produced some exciting data: having tracked the same turtle three separate times during the 1993, 1995 and 1997 nesting seasons, these tracks indicate that this turtle executed all nesting activity on Virginia beaches and then migrated north to her internesting habitat. This is also the first nesting female we have satellite-tracked for more than one nesting event. These data illustrate that some loggerhead sea turtles consistently use Virginia's beaches as a suitable nesting site and utilize the Chesapeake and Delaware Bays as internesting habitat.

Some of the adults tracked moved south immediately after their nesting event in Virginia. Three of the tracked turtles southward movements began in late July. The turtle tracked in the year 2000 traveled as far as North Carolina, however, satellite transmissions failed in mid-October prior to the first cold snaps of the season. Unfortunately we are unable to determine whether she would establish winter residency in North Carolina's waters or would continue to travel south. The remaining two turtles traveled south to Florida where winter residency was established prior to transmission failure. These adults began their southward migration much sooner than juveniles tracked by VIMS in the early 1990's (Keinath et al. 1992; Keinath, 1993). It is possible that some adults may only use Virginia's waters and beaches as nesting habitat, moving south after the last nesting event, or to nest again on southern beaches. Other turtles, however, like the turtle we tracked over the 1993, 1995 and 1997 seasons, utilize the Chesapeake Bay and Delaware Bay as interesting and possibly foraging habitat.

No data have been collected to determine the genetic stock of the adult nesters in Virginia. Juveniles utilizing the Chesapeake Bay as summer foraging grounds are comprised of both the South Atlantic and North Atlantic loggerhead sub-populations (Norrgard, 1995). Virginia hosts the northern most nesting beaches along the east coast of the United States. This would suggest that Virginia nesters should belong to the northern population. However, over-wintering patterns allow the possibility that both northern and southern loggerhead populations are represented. Future work should include a genetic analysis of Virginia's nesting stocks.

Transmitter failure after only a few weeks or days leads to questions regarding our tag attachment methodology. However, after successfully retrieving one tag with

antenna damage from an adult foraging turtle, other factors should also be considered. These include vulnerability of the tag's antenna to damage, turtle behavior that may contribute to causing damage to the tag and antenna, battery life of the transmitters and turtle mortality due to fisheries interactions. Future work will also include analyzing dive and pressure data, and more data will be collected to better define the nesting behavior and patterns, as well as interesting movements for adult female loggerheads in Virginia waters.

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Figure 1. Location of study site: Back Bay National Wildlife Refuge, False Cape State Park, Virginia Beach, Virginia, USA

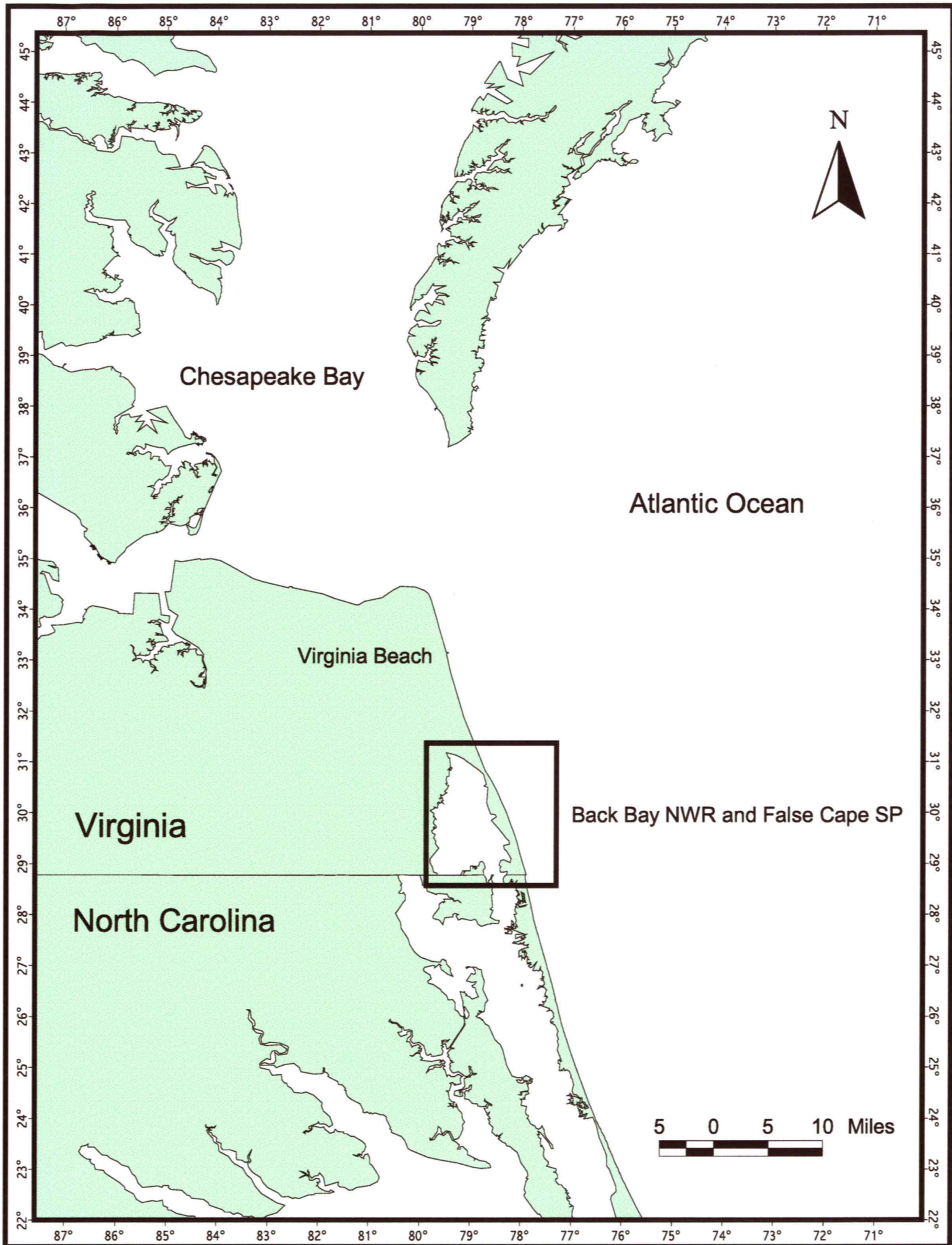
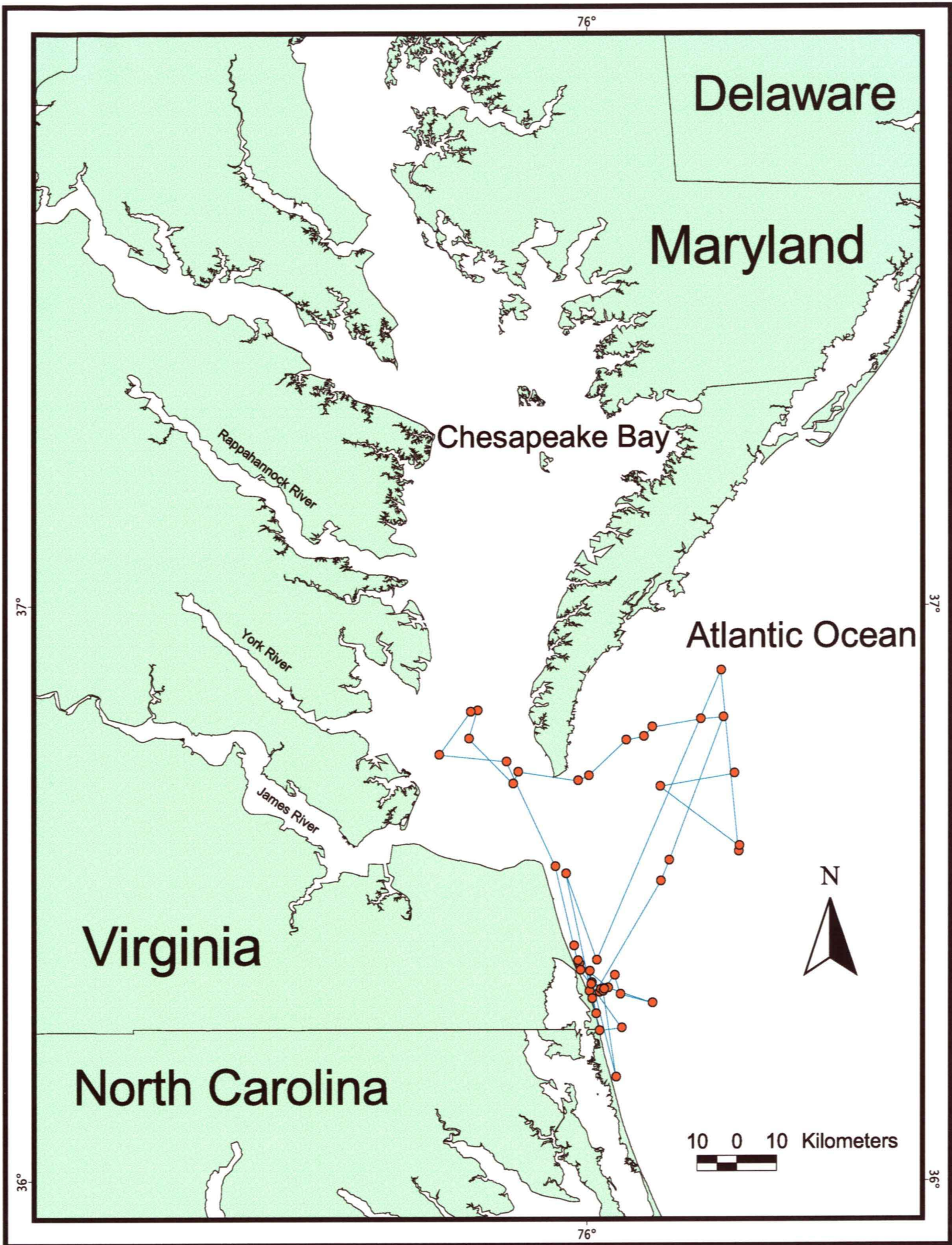


Figure 2. Satellite tracks of nesting loggerhead, July 30-September 8, 1992



Figure 3. Satellite tracks of nesting loggerhead, July 12-July 28, 1993



**Figure 4 . Satellite tracks of nesting loggerhead (originally tagged in 1993),
August 14-September 7, 1995**

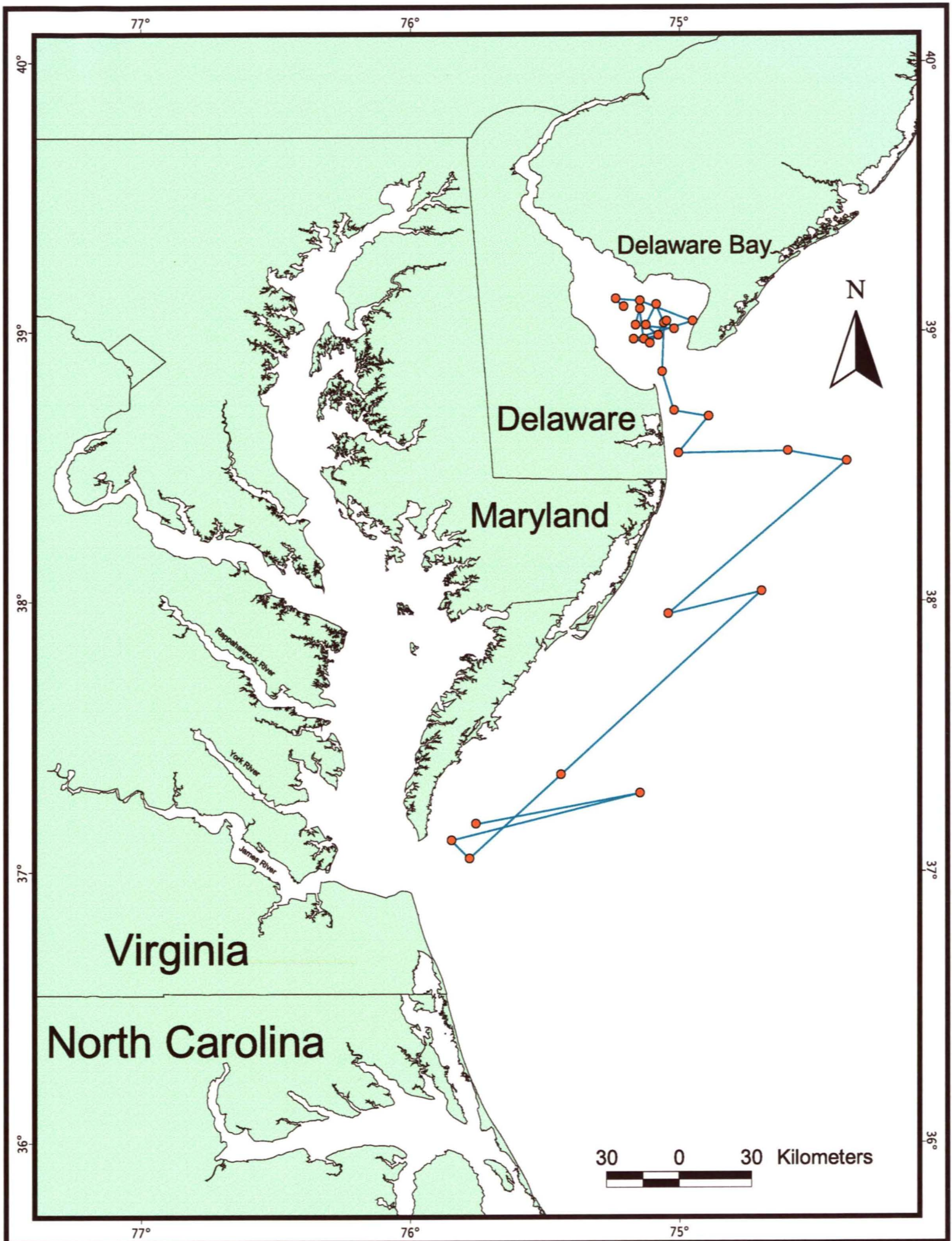


Figure 5 . Satellite tracks of nesting loggerhead (originally tagged in 1993), July 15-November 1, 1997

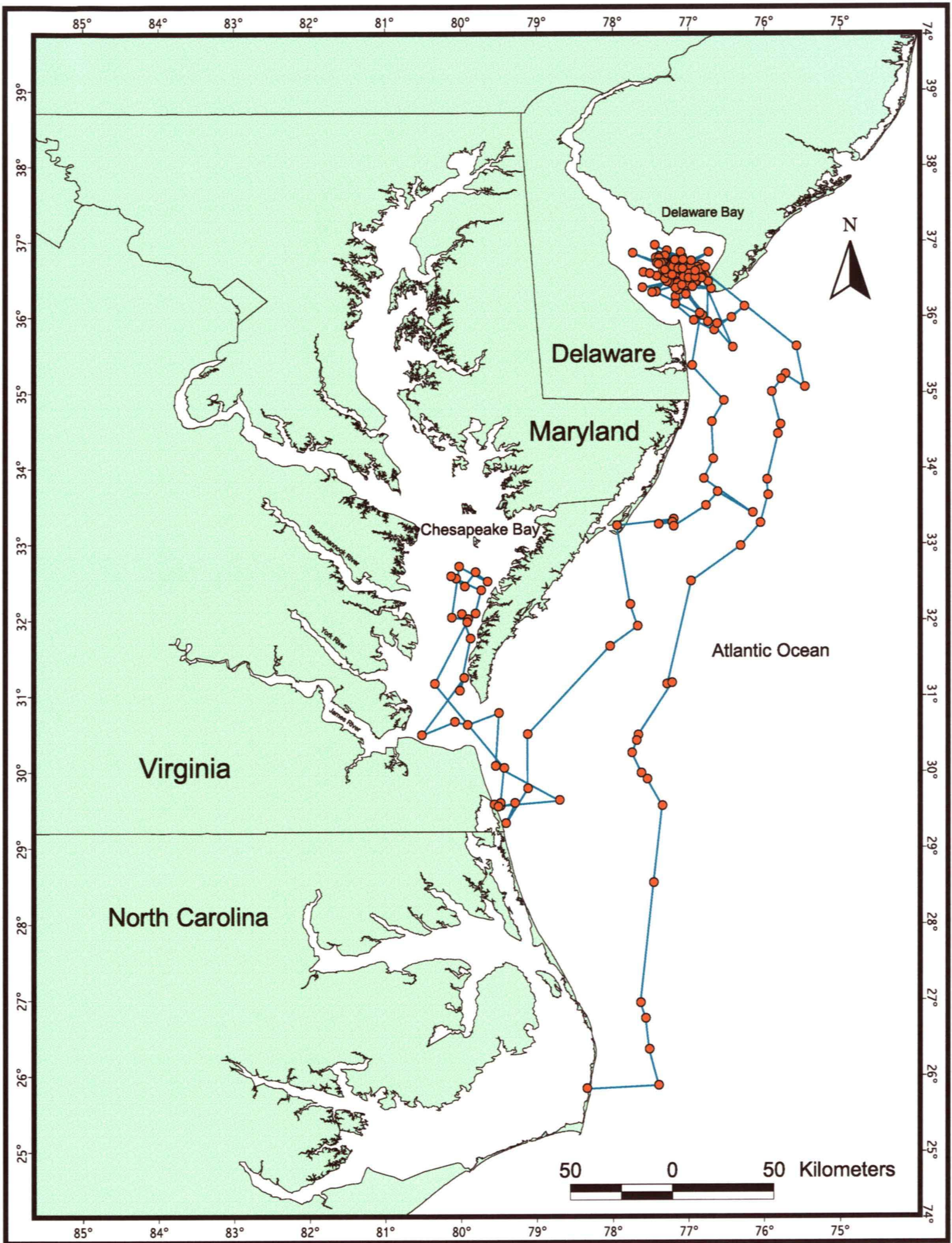


Figure 6. Satellite tracks of nesting loggerhead, July 8-October, 1994



Figure 7. Satellite tracks of nesting loggerhead, August 25, 1996-February 22, 1997



Figure 8. Satellite tracks of nesting loggerhead, July 22-October 18, 1997