NOAA Technical Memorandum NMFS-SEFSC-381

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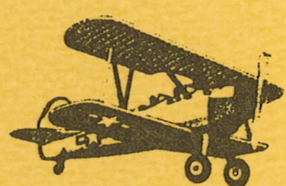

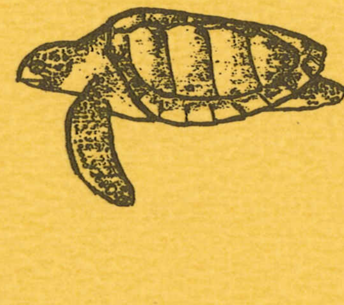

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NOTICE

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Introduction

There is little information concerning the distribution, abundance, and habitat utilization of pelagic sea turtles (National Research Council, 1990), particularly on the effects of sea surface temperatures, convergence zones, warm core rings, and thermal fronts. Information collected from aerial surveys has been helpful in understanding the interactions of these environmental parameters on sea turtle distributions in the pelagic habitat, but most pelagic surveys off the east coast of the U.S. are regional. Schroeder and Thompson described the seasonal distribution and abundance of leatherback and loggerhead turtles near Cape Canaveral, Florida (1987), Thompson and Huang summarized leatherback distributions along the U.S. southeast Atlantic coast (1993), Musick et al. reported abundance estimates for Cape Hatteras turtles (1994), and Shoop and Kenny provided abundance estimates, and thermal preferences, of loggerhead and leatherback turtles off the northeastern U.S. coast (1992). This paper describes the distribution and relative abundance of sea turtles off the eastern coast of the U.S. based on 1963-1969 aerial surveys. This historic information provides base-line information and adds to the growing body of scientific literature necessary for formulating conservation and management strategies as mandated by the Endangered Species Act and the Fishery Conservation and Management Act of 1976.

Materials and Methods

Airborne infrared thermometer (IRT) surveys were conducted monthly along the continental shelf off the eastern coast of the United States from February 1963 to June 1969. The main purpose of the IRT surveys was to monitor major sea surface isotherms, and secondarily to observe and record conspicuous pelagic fauna. Aerial sea surface temperatures were taken from a U.S. Coast Guard operated Grumman UF2G "Albatross" fixed wing search and rescue aircraft, and animal observations were made by personnel from the National Marine Fisheries Service (NMFS). The transects were typically flown along predetermined courses away from the coast over the continental shelf, then paralleled the coastline before returning to the coast (Figure 1).

The aerial surveys were conducted monthly at an altitude of 150 m and the flight days were scheduled close together to provide near synoptic coverage over the entire survey area. Flights were cancelled over areas during extremely inclement weather. From February 1963 to June 1965, monthly IRT flight coverage was between Montauk Point, New York, and Cape May, New Jersey. In July 1965, the survey was extended north to Cape Cod, Massachusetts and south to Cape Fear, North Carolina. The survey was extended south to Miami, Florida in July 1966, and was finally discontinued in June 1969. Flight observers recorded sightings of turtles, sharks, rays, sunfish, whales, and porpoises on the temperature strip chart. The time and LORAN-A position of each sighting were also recorded and were then plotted on National Ocean Survey nautical charts to determine the corresponding depths.

The Barnes Engineering Company infrared thermometer, Model IT-2, was used to take sea surface temperatures. The sensitivity of this instrument was calibrated at 0.1°C. Temperatures were continuously recorded in degrees Celsius on a Varian, Model G-14, strip chart recorder. The IRT was calibrated before and after each flight and also after each transect.

The observational data have been summarized by month, and by depth and geographic zones in order to observe seasonal changes in relative abundance, thermal and geographic distribution. Four depth zones were arbitrarily selected and defined as: shallow shelf (0-37 m), intermediate shelf (38-91 m), deep shelf (92-180 m) and non-shelf (182+ m). Three geographic zones were selected that reflect major thermal transitional zones as described by Parr (1933), Schroeder (1966), and Deaver (1975). The northern zone is from Cape Cod, Massachusetts to Cape Hatteras, North Carolina; the central zone is from Cape Hatteras to Jacksonville, Florida; and the southern zone is from Jacksonville to Miami, Florida.

Results and Discussion

There were 2,505 sea turtles recorded by airborne observers during the IRT survey, but they were not identified to species. There are five sea turtle species that occur in the western North Atlantic: leatherback (Dermochelys coriacea), green (Chelonia mydas), hawksbill (Eretmochelys imbricata), Kemp's ridley (Lepidochelys kempi), and loggerhead (Caretta caretta). All turtle species occur in the south and central zones of the survey area, but the green and hawksbill turtles are relatively uncommon with tropical distributions and are not likely to be found in significant numbers (Shoop and Kenney, 1992; Teas, 1994). The Kemp's ridley turtle is difficult to see from an aerial platform because of its small size and because of its preference for shallow turbulent coastal habitats. Previous pelagic aerial surveys by Schroeder and Thompson (1987) and Shoop and Kenny (1992) have indicated that the most commonly observed turtles in the area are loggerhead (95%) and leatherback (5%).

Turtles were observed year-round in the southern zone and in relatively larger numbers compared to the other zones (Figure 2, Table 1). The peak months March through August, coincide with the loggerhead mating and nesting season. The northern zone had the fewest turtles, with the July through August peak consisting of subadult and non-nesting transient turtles.

Sea turtles were observed in a wide range of sea temperatures (Figures 3 and 4), and the mean monthly temperatures became progressively warmer from the northern to central and southern zones; 18.9°C, 21.0°C, and 23.4°C, respectively. The overall mean temperature associated with turtle sightings was 21.26°C (SD 4.12, range 13.4°C-27.4°C). The northern distribution of sea turtles is seasonally related to warmer water temperatures in the summer months, and turtles were not seen in this zone in winter temperatures below 14°C, suggesting that these turtles actively avoid cold temperatures. It is unknown how pelagic specimens react to these low temperatures, but coastal specimens are frequently cold stunned during severe winters (Lazell, 1980; Witherington and Ehrhart, 1989; Burke and Standora, 1991), Coles et al. (1994) reported that turtles at Cape Hatteras inhabited temperature ranges of 14°C to 28°C, although Epperly et al. (1995) reported turtles inhabiting nearby inshore North Carolina bays in temperatures as low as 11°C. Preferred temperature ranges are undoubtedly variable depending on season, species, and body size. Leatherback turtles, however, are apparently able to thermoregulate and are able to routinely inhabit exceptionally cold northern waters (Mrosovsky and Pritchard, 1971; Greer et al., 1973; Mrosovsky, 1980) where they forage on large pelagic scyphomedusae. Shoop and Kenney (1992) reported that loggerhead and leatherback turtles in the northern distributional zone were found in surface temperatures averaging 22.2°C and 20.4°C, respectively.

The predominantly inshore distribution of sea turtles is most apparent in the southern and central zones (Figure 5). The turtles were often distributed in aggregations within the 0 to 37 m isobath with the largest aggregations located at Cape Canaveral, Florida. These aggregations are probably associated with nesting activities. The majority of the turtles were observed over the 0 to 37 m depth range in all geographic zones. However, the percentage of turtles in this shallow depth zone decreases in the central zone and is lowest in the northern zone, indicating a tendency of some turtles to move farther offshore as they move north. The turtles in the shallow southern depth range is similar to the range reported by Hoffman and Fritts (1982) off the east Florida coast in August. They believed that these turtles actively avoided transport northwards in the Gulf Stream and preferred to remain in the shallower inshore foraging habitats. Shoop and Kenney (1992) observed no significant differences in loggerhead and leatherback depth distributions, with the modal depth interval as 21-40 m.

The tendency of some turtles to move offshore in the northern zone may be to seek the warmer Gulf Stream temperatures (Bleakney, 1965), or warm-core rings. It is these offshore turtles that are being impacted by the U.S. pelagic longline fleet for tuna and swordfish (Witzell and Cramer, 1995).

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Literature Cited

Bleakney, J.S. 1965. Reports of marine turtles from New England and eastern Canada. Can. Field-Nat. 79:120-128.

Burke, V.J. and E.A. Standora. 1991. Factors affecting strandings of cold-stunned juvenile Kemp's ridley and loggerhead sea turtles in Long Island, New York. Copeia 1991:1136-1138.

Coles, W.C., J.A. Keinath, D.E. Barnard, J.A. Musick. 1994. Sea surface temperatures and sea turtle position correlations. Pages 211-212 in B.A. Schroeder and B.E. Witherington (Compilers), Proceedings of the thirteenth annual symposium on sea turtle biology and conservation. U.S. Dep. Commer.NOAA Tech. Memo. NMFS-SEFSC-341, 281 pp.

Deaver, J.W. 1975. Aerial oceanographic observations, July 1969 - June 1970, Cape Cod, Massachusetts to Miami, Florida. Oceanogr. Rep. CG373-68: 27 pp.

Epperly, S.P., J. Braun, A.J. Chester, F.A. Cross, J.V. Merriner and P.A. Tester. 1995. Winter distribution of sea turtles in the vicinity of Cape Hatteras and their interactions with the summer flounder trawl fishery. Bull. Mar. Sci. 56:547-568.

Greer, A.E., J.D. lazell, and R.M. Wright. 1973. Anatomical evidence for countercurrent heat exchanger in the leatherback turtle (Dermochelys coriacea). Nature 244:181.

Hoffman, W. and Fritts. 1982. Sea turtle distribution along the boundary of the Gulf Stream. Herpetologica 38:405-409.

Lazell, J.D. 1980. New England waters: critical habitat for marine turtles. Copeia 1980:290-295.

Mrosovsky, N. 1980. Thermal biology of sea turtles. Am. Zool. 20:531-547.

Mrosovsky, N. and P.C.H. Pritchard. 1971. Body temperature of Dermochelys coriacea and other sea turtles. Copeia 1971:642-631.

Musick, J.A., D.E. Barnard, and J.A. Keinath. 1994. Aerial estimates of seasonal distribution and abundance of sea turtles near the Cape Hatteras faunal barrier. Pages 121-123 in B.A. Schroeder and B.E. Witherington (Compilers), Proceedings of the thirteenth annual symposium on sea turtle biology and conservation. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SEFSC-341, 281 pp.

National Research Council. 1990. Decline of the sea turtles. Causes and Prevention. National Academy Press, Wash. D.C., 259 pp.

Parr, A.E. 1933. A geographic-ecological analysis of the seasonal changes in temperature conditions in shallow water along the Atlantic coast of the United States. Bull. Bingham Oceanogr. Collect. Yale Univ. 4 (Art.3):1-90.

Schroeder, B.A. and N.B. Thompson. 1987. Distribution of the loggerhead turtle, Caretta caretta, and the leatherback turtle, Dermochelys coriacea, in the Cape Canaveral, Florida area: Results of Aerial Surveys. Pages 45-53 in: W.N. Witzell (ed.) Ecology of east Florida sea turtles: proceedings of the Cape Canaveral, Florida sea turtle workshop Miami, Florida February 26-27, 1985. U.S. Dep. Commer. NOAA Tech. Rep. NMFS 53, 80 pp.

Schroeder, E.H. 1966. Average surface temperatures of the western north Atlantic. Bull. Mar. Sci. 16:302-323.

Shoop, C.R. and R.D. Kenney. 1992. Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. Herpetol. Monogr. 6:43-67.

Teas, W.G. 1994. 1993 Annual report of the sea turtle stranding and salvage network. Atlantic and Gulf coasts of the United States, January - December 1993. U.S. Dept. Commer., NOAA-NMFS-SEFSC Miami Lab. Contrib. MIA-94/95-12, 46 pp.

Thompson, N.B. and H. Huang. 1993. Leatherback turtles in southeast U.S. waters. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SEFSC-318, 25 pp.

Witherington, B.E. and L.M. Ehrhart. 1989. Hypothermic stunning and mortality of marine turtles in the Indian River lagoon system, Florida. Copeia 1989:696-703.

Witzell, W.N. and J. Cramer. 1995. Estimates of sea turtle by-catch by the U.S. pelagic longline fleet in the western North Atlantic Ocean. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SEFSC-359, 14 pp.

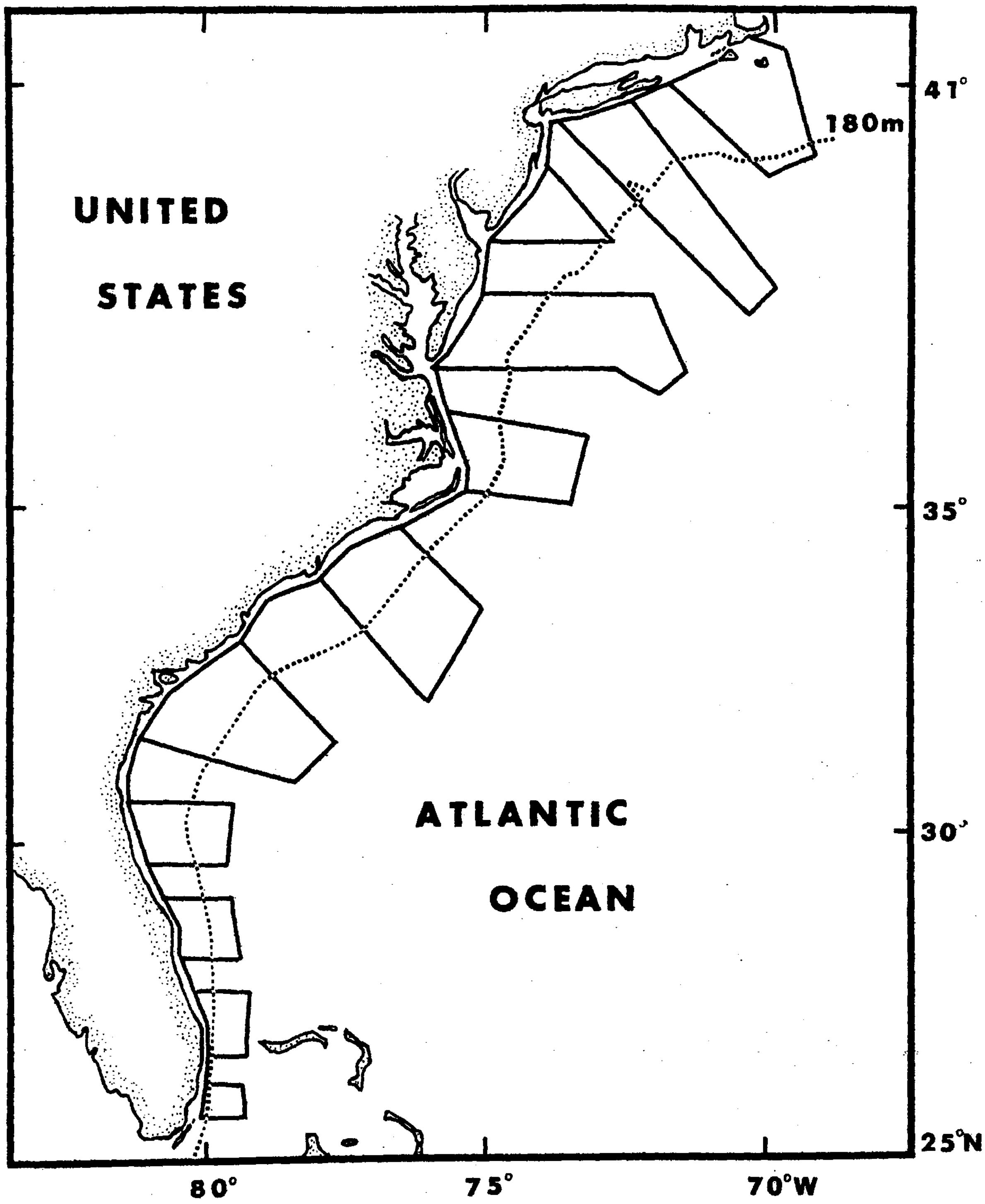

Figure 1. IRT flight transect patterns off the Atlantic coast of the United States.

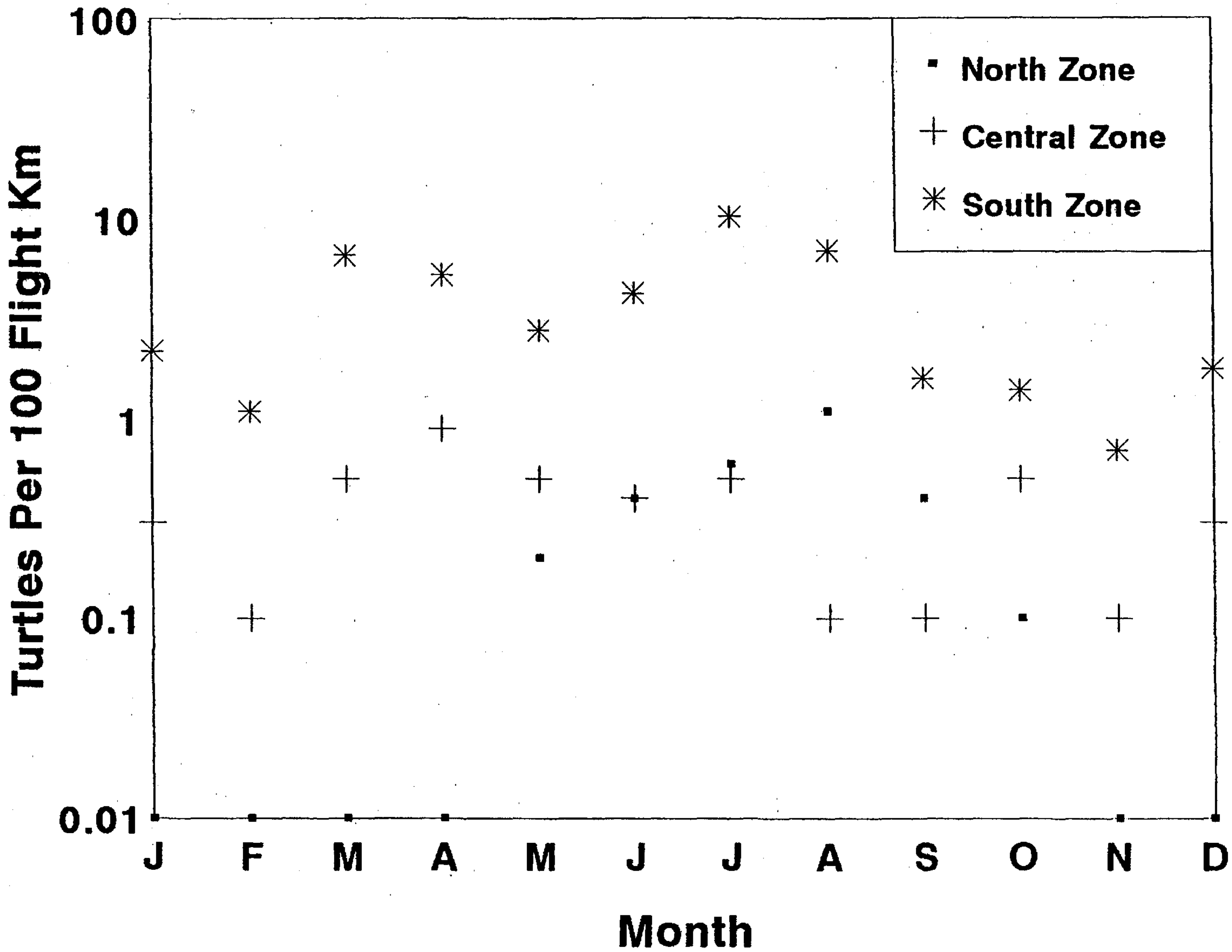

Figure 2. Relative abundance of observed sea turtles by month, by geographic zone from IRT aerial surveys.

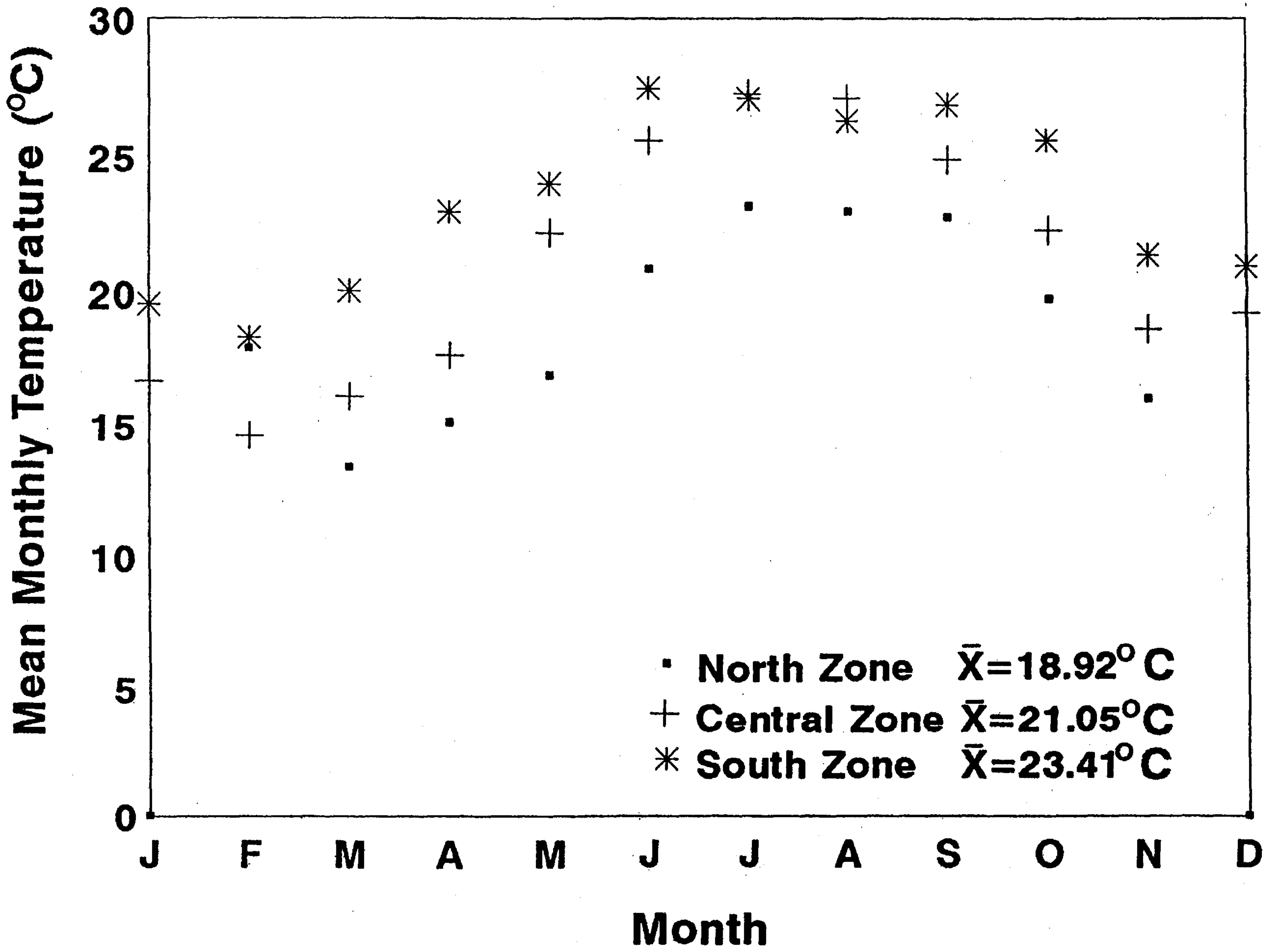

Figure 3. Mean monthly sea surface temperatures associated with sea turtle observations from IRT surveys.

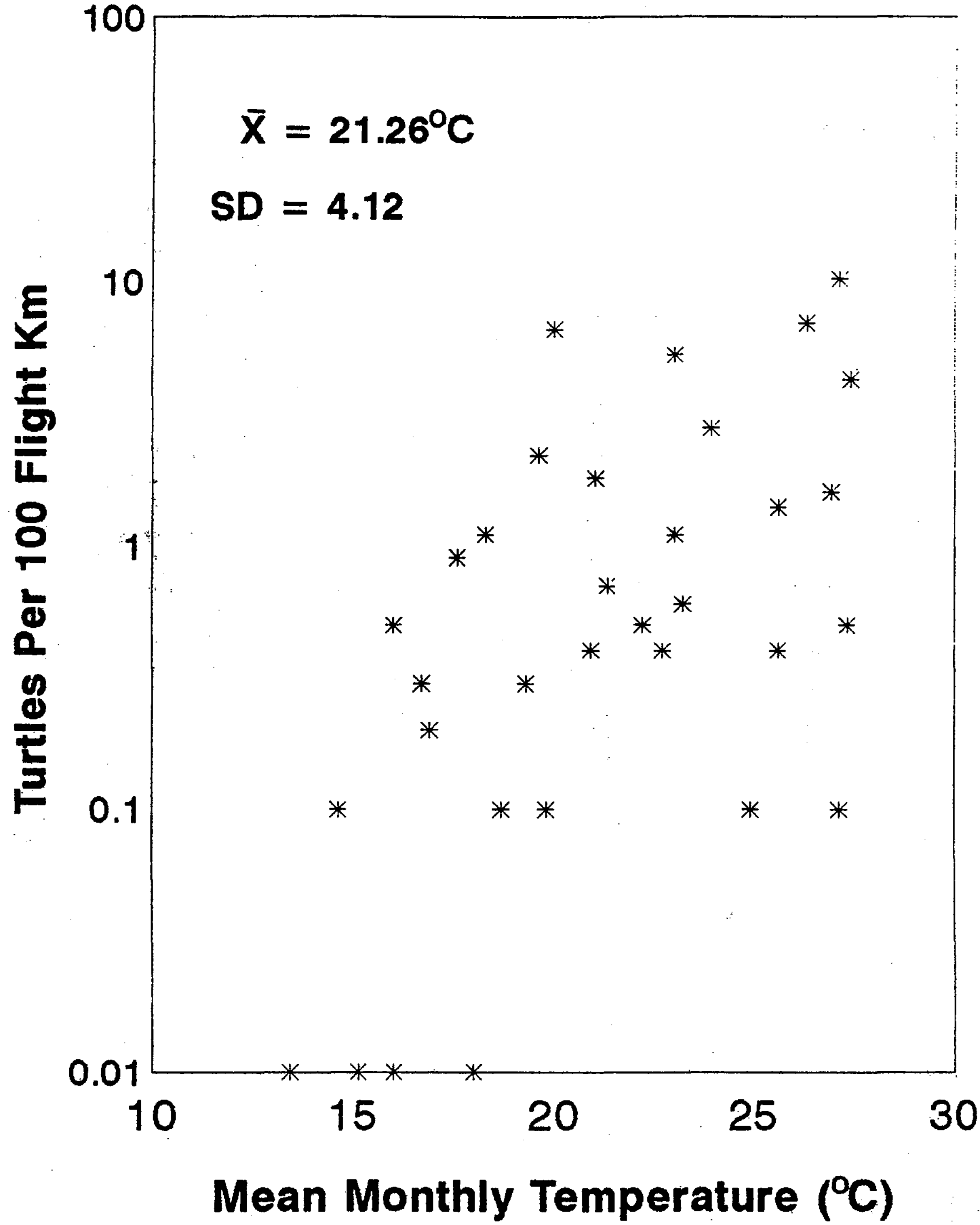

Figure 4. Sea surface temperature preferences of sea turtles from IRT aerial surveys.

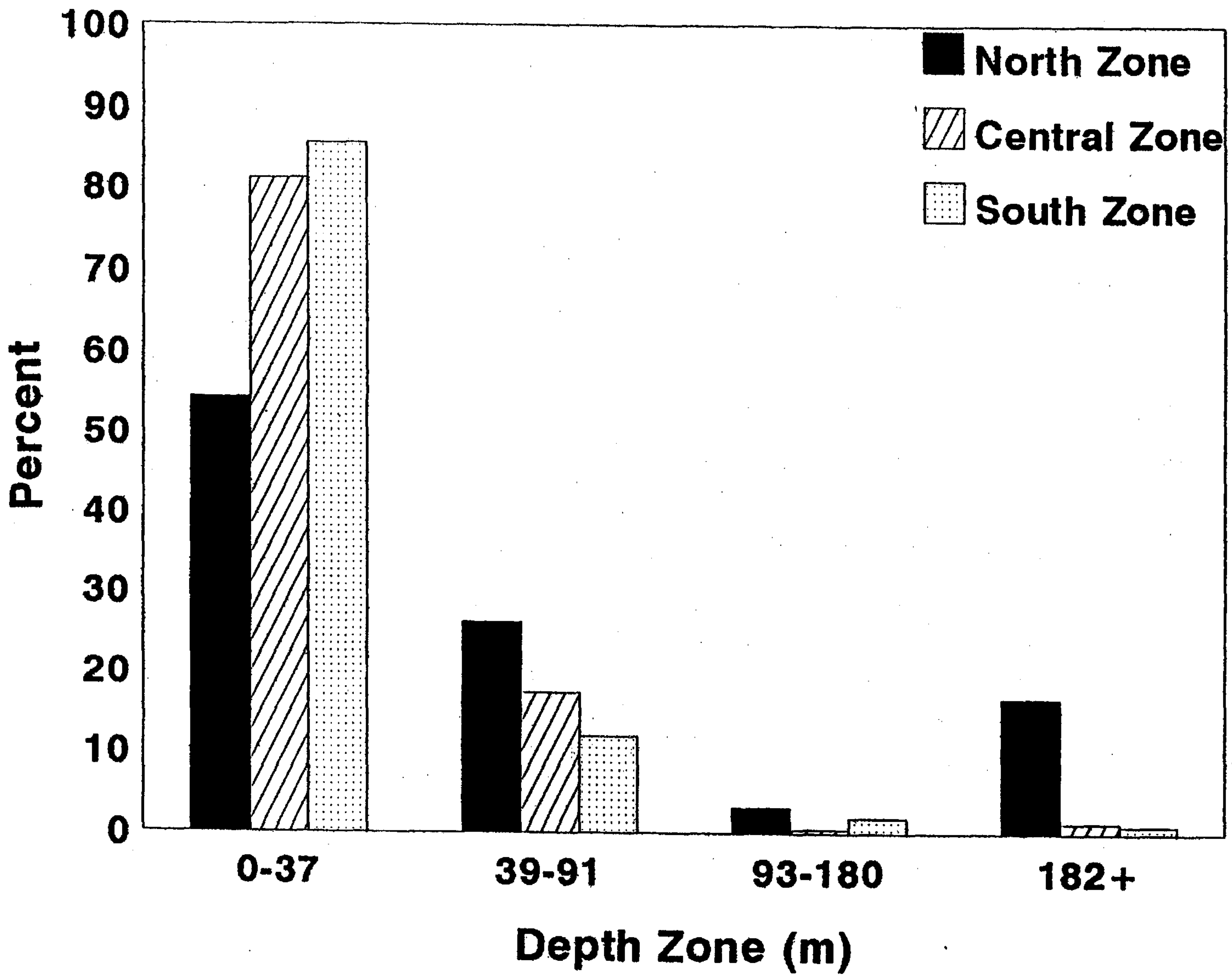

Figure 5. Depth zones of sea turtle observations from IRT aerial surveys.

Table 1. The number of turtles, flight distances, and mean sea surface temperatures, by geographic zone, observed during the IRT aerial surveys.

NORTHERN ZONE

MONTH	#TURTLES	FLIGHT LENGTH (KM)	TURTLES/100 KM	MEAN TEMPERATURE (°C)
JAN	0	15,528	0.0	---
FEB	1	19,797	0.0	18.0
MAR	1	17,784	0.0	13.4
APR	6	17,689	0.0	14.1
MAY	35	20,601	0.2	16.9
JUN	62	17,612	0.4	20.9
JUL	115	18,547	0.6	23.2
AUG	194	17,543	1.1	23.0
SEP	76	22,544	0.4	22.7
OCT	26	20,034	0.1	19.8
NOV	2	16,804	0.0	16.0
DEC	0	13, 284	0.0	---

CENTRAL ZONE

MONTH	#TURTLES	FLIGHT LENGTH (KM)	TURTLES/100 KM	MEAN TEMPERATURE (°C)
JAN	13	5,081	0.3	16.7
FEB	5	4,893	0.1	14.6
MAR	29	5,710	0.5	16.0
APR	59	6,282	0.9	17.6
MAY	34	6,796	0.5	22.2
JUN	24	5,562	0.4	25.6
JUL	34	6,280	0.5	27.3
AUG	7	5,418	0.1	27.1
SEP	9	6,508	0.1	24.9
OCT	27	5,659	0.5	22.2
NOV	5	4,788	0.1	18.7
DEC	14	5,001	0.3	19.3

SOUTHERN ZONE

MONTH	#TURTLES	FLIGHT LENGTH (KM)	TURTLES/100 KM	MEAN TEMPERATURE (°C)
JAN	91	4,162	2.2	19.6
FEB	48	4,197	1.1	18.3
MAR	292	4,430	6.6	20.0
APR	207	3,920	5.3	23.0
MAY	162	5,768	2.8	23.9
JUN	164	3,805	4.3	27.4
JUL	323	3,134	10.3	27.1
AUG	207	2,954	7.0	26.3
SEP	71	4,438	1.6	26.9
OCT	61	4,518	1.4	25.6
NOV	20	2,967	0.7	21.3
DEC	81	4,426	1.8	21.0