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THE IMPACTS OF ANTHTHROPOGENIC DEBRIS ON MARINE TURTLES IN THE WESTERN NORTH ATLANTIC OCEAN

BY

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INTRODUCTION

Early information on sea turtle feeding habits indicated that sea turtles were capable of eating large amounts of non-nutritional items. Carr (1952) reported that a hawksbill turtle was found with two pounds of "dead bark and wood" in its stomach, an interesting observation for an animal which is now believed to be a strict spongivore (Meylan, 1988). It was 23 years later that Carr and Stancyk (1975) reported large amounts of plastics being eaten by Caribbean hawksbills, a disturbing omen of what was happening to the World's oceans.

As sea turtle scientists pursue studies concerning population dynamics and habitat requirements, an important undertaking is to determine the feeding ecology of sea turtles. Unfortunately, whether it be by lavage or necropsy, these important projects range from "messy" to "disgusting" and are usually overlooked by researchers for projects that are more glamorous. There are a few researchers, however, who have undertaken the task of pioneering the underappreciated art of sea turtle stomach content analysis and important information regarding sea turtle feeding ecology is now emerging from turtles stranded along the U.S. coast. Among other things, it is becoming obvious that sea turtles of all sizes and species apparently consume a wide variety of anthropogenic items such as plastics and tar.

The documentation of debris ingestion and entanglement has been fairly extensive (Appendix 1), but overall estimates of the magnitude of sea turtle/debris interactions are lacking and need to be addressed (Witzell, 1989). The results of various sea turtle and marine debris interactions have recently been summarized (Balazs, 1985; Carr, 1987; Laist, 1987; Gramentz, 1988; Hutchinson and Simmonds, 1991; Laws, 1993).

The impacts of marine debris on threatened and endangered sea turtles must be assessed for resource managers to formulate sound recovery and management plans as mandated by the Endangered Species Act of 1973 and subsequent amendments. This report summarizes the impacts of marine debris on sea turtles, by species, by geographic subregion, in the western north Atlantic from stranding data.

MATERIALS AND METHODS

The data used in this analysis are from the National Marine Fisheries Service (NMFS) Sea Turtle Stranding and Salvage Network (STSSN) database. This network was established in 1980 to document sea turtle strandings along the U.S. Atlantic and Gulf of Mexico coasts, Puerto Rico, and the U.S. Virgin Islands. Data are collected by volunteers who record stranding events in their respective areas and contribute those data to a centralized database located at the NMFS Miami Laboratory.

The data collected by the STSSN are very useful for documenting the impacts of debris on sea turtles, and care should be exercised when interpreting these data. For instance, coastal coverage has not been continuously synoptic throughout the entire STSSN area and may vary temporally and/or spatially, and some debris related interactions may not have been recorded in the early years (1980-85) due to the inexperience of the STSSN participants. Additionally, documenting the ingestion of anthropogenic marine debris by sea turtles is only reported to the STSSN by a few of the researchers interested in performing necropsies.

The STSSN data were summarized, by geographic subregion (Figure 1) and by species (Table 1), into three categories; 1) entanglement, 2) ingestion, and 3) petroleum impacts.

RESULTS

The STSSN data were summarized by species (Table 1) and by geographic region (Figure 1). From 1980 through 1992, a total of 22,547 turtles stranded throughout the area. All sea turtle species commonly occurring in the area were found stranded in the following proportions: loggerhead *Caretta* (72.4%), Kemps ridley *Lepidochelys kempi* (9.5%), green *Chelonia mydas* (8.7%), leatherback *Dermochelys coriacea* (4.3%), hawksbill *Eretmochelys imbricata* (1.5%), and unidentified species (3.5%). We believe that the relative abundance of these strandings reflects the overall relative abundance of the sea turtle species naturally occurring in coastal U.S. Atlantic and Caribbean waters.

Of the 22,547 stranded turtles, 676 (3%) were affected in some way by debris (Table 2): loggerhead (38.47%), green (30.77%), leatherback (12.28%), hawksbill (11.09%), Kemps ridley (5.17%), and unidentified (2.22%). These figures are proportionate to the stranding figures with the exception of the Kemps ridley which, although it is the second most commonly stranded turtle, appears to be the least affected by debris. It appears that, although these ridleys are apparently susceptible to inshore fishing activities, for some unknown reasons they may be less susceptible to the adverse impacts of debris than the other turtle species. This lower level of debris impact may be because many of these ridleys are juveniles and subadults (Teas, 1993), and inhabit remote inshore developmental environments where they actively feed on benthic crustaceans.

The southeastern U.S. had the highest number of strandings affected by debris (49.1%), followed by the Gulf of Mexico (35.9%), the northeastern U.S. (11.9%), and the U.S. Caribbean (2.9%). These figures also reflect what is currently known about the distribution and relative abundance of sea turtles in the western north Atlantic Ocean and are proportionate with the total stranding figures.

ENTANGLEMENT

The entanglement data used in this analysis involving fishing gear are those data for inactive or derelict fishing equipment. Limited information are available on turtles caught in active fishing gear, but are listed in the STSSN as "by-catch" and is not discussed here. However, it is difficult to separate turtles that were incidentally caught in active gear from turtles that stranded from inactively fished debris. Turtles listed as entangled with hooks and/or monofilament line and turtles entangled in trap lines are probably the two predominant categories of turtles impacted by active fisheries that eventually strand.

A total of 416 sea turtles were affected by entanglement. In some cases the cause of mortality was fairly obvious, but in many cases it is unknown exactly how, or if, the entanglement contributed to the demise of the turtles. Of these, 182 turtles were impacted by fish hooks and/or monofilament fishing line (Figure 2). Loggerhead and green turtles were impacted the most, with the southeastern and Gulf of mexico areas having the highest levels of incidence, respectively. These hook and line strandings were undoubtedly turtles hooked by commercial and recreational gear and eventually stranded. Of the 416 entangled turtles, 74 turtles were entangled in fish net material (Figure 3), and most of these were green and loggerhead turtles from the southeast. A total of 114 turtles were found entangled in commercial trap lines (crab and lobster) and rope (Figure 4). Most of these turtles were leatherback turtles from the northeast and loggerhead turtles from the Gulf of Mexico. A total of 46 turtles were reported entangled in various non-fishing gear items, consisting mainly of: plastic fiber "onion" sacks, burlap sacks, plastic bags, 6-pack yokes, packing twine, steel cable, and aluminum beach chairs (Figure 5). The majority of these occurrences were hawksbill, green, and Kemps ridley turtles from the Gulf of Mexico.

Some turtle species were possibly more prone to entanglement in certain areas than other species (Figure 6). This, however, is difficult to surmise with any certainty because of the inherent bias in the STSSN data set due to the discrepancies of volunteer data collection. Hawksbill and green turtles from the southeastern U.S., Gulf of Mexico, and Caribbean, and leatherbacks from the northeastern U.S. appear more likely to be impacted by entanglement. Relative to these turtles, Kemps ridley and loggerhead turtles were not significantly affected.

Hawksbill turtles in particular may be the most severely impacted by entanglement in discarded fishing line and synthetic rope. Amos (1989a,b) found an unexpected number of entangled on Texas beaches, many of these animals still alive. Redfoot et al. (1985) also reported a live entangled hawksbill turtle from Brevard County, Florida, and reviewed several similar cases from the eastern coast. Hawksbill turtles are relatively infrequent visitors in U.S. mainland coastal waters and it is alarming to find a high percentage of them entangled and stranded.

Leatherback entanglements in the northeast are undoubtedly due to interactions with active coastal crab and lobster trap fisheries (Sadove and Morreale, 1990) that became unmoored as the powerful leatherback turtles drag them through the water until eventually weakened and killed.

Plotkin and Amos (1988, 1990) reported that 30 of 400 (7.5%) turtles stranded on the south Texas coast were entangled: 13 (3.25%) Kemps ridleys, 7 (1.75%) loggerheads, 6 (1.5%) hawksbills, 3 (0.75%) green, and 1 (0.25%) leatherback. They speculated that the prevailing wind and currents concentrate marine debris in coastal waters from the offshore oil industry, cargo ships, research vessels, and commercial and recreational fishing boats.

INGESTION

A total of 197 turtles necropsied had ingested debris: 103 ingested plastic pieces or balloons (Figure 7), and 94 ingested fish hooks and/or monofilament fishing line (Figure 8). Plastic/balloons and fish hooks/monofilament line were commonly consumed by loggerheads in the Gulf of mexico and southeastern U.S., respectively.

Some turtle species are apparently more prone to ingest debris than other species (Figure 9). Hawksbill and loggerhead turtles from the Gulf of Mexico, and leatherback turtles from the southeastern U.S. were likely to have been impacted by ingestion. However, these figures are undoubtedly biased from inadequate sampling because necropsies were performed opportunistically by only a few researchers and much of these data were not submitted to the STSSN.

Necropsy results often seem to have differing results, depending on species, size, location, and season. Wershoven and Wershoven (1992) reported "no plastic or foreign matter, other than fishing hooks and line, in any of 42 necropsied juvenile greens in Broward and Palm Beach Counties, Florida, but Bjorndal et al. (1994) reported finding debris in 24 of 43 green turtles also from Florida. Additionally, 48 (30%) post hatchling loggerhead turtles off Brevard County, Florida were found to have eaten plastic items (Anon., 1994).

Although the STSSN data suggest leatherbacks were more likely to ingest items in the southeast, it appears that these turtles may consume large amounts of plastic bags in the northeastern area. Sadove and Morreale (1990) reported bags in 10 of 33 leatherbacks examined. Unfortunately, these data were not submitted to the STSSN.

Several debris/entanglement studies have been recently conducted in the western Gulf of Mexico. Plotkin and Amos (1988, 1990), Stanley et al. (1988), Plotkin et al. (1993), and Shaver (1993) reported high levels of debris ingestion by all cheloniid species ranging from: 87.5% (hawksbill), 51.2% (loggerhead), 46.7% (green), 34% (Kemps ridley).

An encouraging note is that juvenile Kemps ridleys in the northeast appear to consume little or no plastic debris (Sadove and Morreale, 1990: Burke et al., 1994), and no debris was found in juvenile Florida ridleys (Bjorndal et al., 1994). The apparent lack of debris in these ridleys is encouraging and Bjorndal et al. (1994) speculated that this might be due to the fact that ridleys consume more active prey than the other turtle species and were less likely to ingest debris. This might also explain why ridleys are less likely to become entangled.

The STSSN figures on ingestion only report occurrence of debris ingestion. Studies quantifying the amounts of debris ingested suggest that absolute quantities are low. Shaver reported 0.08% dry mass of gut content for Texas ridleys (N=101), Plotkin et al. (1993) reported 0.4% dry mass for Texas loggerheads (N=82), and Bjorndal et al. (1994) reported an average of 0.52% wet gut content mass for Florida greens (N=43). However, small sample sizes and different sampling and analytical methods may be responsible for the observed differences.

The impacts of debris ingestion, even in small quantities, are unknown but potentially dangerous (Lutz, 1990), because these small objects can accumulate in the gut for long periods.

TAR/OIL

A total of 118 (0.05%) turtles in the STSSN were reported as being affected by tar and/or oil (Figure 10). Surprisingly, green and hawksbill turtles appear most likely to be impacted by tar or oil, followed by loggerhead, and kemp's ridley turtles. Rabalais and Rabalais (1980) reported several juvenile greens stranded on Padre and Mustang islands, TX were heavily fouled with oil, and suggested that they were victims of the Ixtoc I oil well disaster in the Bay of Campeche. No leatherbacks were found impacted by either tar or oil.

The STSSN figures appear intuitively biased low. For instance, Whistler (1989) reported only 8 of 298 (2.68%) Texas ridley strandings had evidence of tar, but Plotkin and Amos (1990) reported 7 of 11 (6.3%) turtles stranded on south Texas had evidence of tar. Particularly alarming is that fact that 81 (51%) of 160 post hatchling loggerheads off Brevard County, Florida were impacted by tar in their mouths or stomachs (Anon., 1994). The physiological effects of petroleum on sea turtles were found to be potentially serious, and could have devastating effects on turtle populations, particularly Kemp's ridley turtles in the petroleum rich Gulf of Mexico (Lutz and Lutcavage, 1989).

ACKNOWLEDGMENTS

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Table 1. The number of sea turtles stranded by region, by species, from 1980 through 1992. The number of turtles necropsied are in parentheses.

SPECIES	GULF OF MEXICO	SE US ATLANTIC	NE US ATLANTIC	US CARIBBEAN	TOTAL
LOGGERHEAD	2908 (232)	11564 (441)	1855 (223)	0 (0)	16327 (896)
KEMPS RIDLEY	1169 (150)	533 (52)	438 (52)	0 (0)	2140 (389)
GREEN	578 (70)	1263 (178)	33 (14)	86 (16)	1960 (278)
LEATHERBACK	105 (9)	403 (17)	462 (89)	8 (1)	978 (116)
HAWKSBILL	168 (12)	89 (6)	1 (0)	92 (13)	350 (31)
UNIDENTIFIED	263 (0)	445 (0)	76 (0)	8 (0)	792 (0)
TOTAL	5191 (473)	14297 (694)	2865 (513)	194 (30)	22547 (1710)

Table 2. The number of turtles affected by anthropogenic debris, by species, from 1980 through 1992

SPECIES	NUMBER OF TURTLES IMPACTED BY DEBRIS	% TOTAL TURTLES STRANDED	% TOTAL TURTLES IMPACTED
LOGGERHEAD	260	1.15	38.47
GREEN	208	0.92	30.77
LEATHERBACK	83	0.37	12.28
HAWKSBILL	75	0.33	11.09
KEMPS RIDLEY	35	0.15	5.17
UNIDENTIFIED	15	0.06	2.22
TOTAL	676	3.00%	100.00%

Table 3. The number of sea turtles affected by anthropogenic debris, by geographic area, from 1980 through 1992

AREA	NUMBER OF TURTLES IMPACTED BY DEBRIS	%TOTAL TURTLES STRANDED	%TOTAL TURTLES IMPACTED
GULF OF MEXICO	243	1.07	35.95
SOUTHEASTERN U.S.	332	1.47	49.11
NORTHEASTERN U.S.	81	0.36	11.98
U.S. CARIBBEAN	20	0.09	2.96
TOTAL	676	3.00%	100.00%

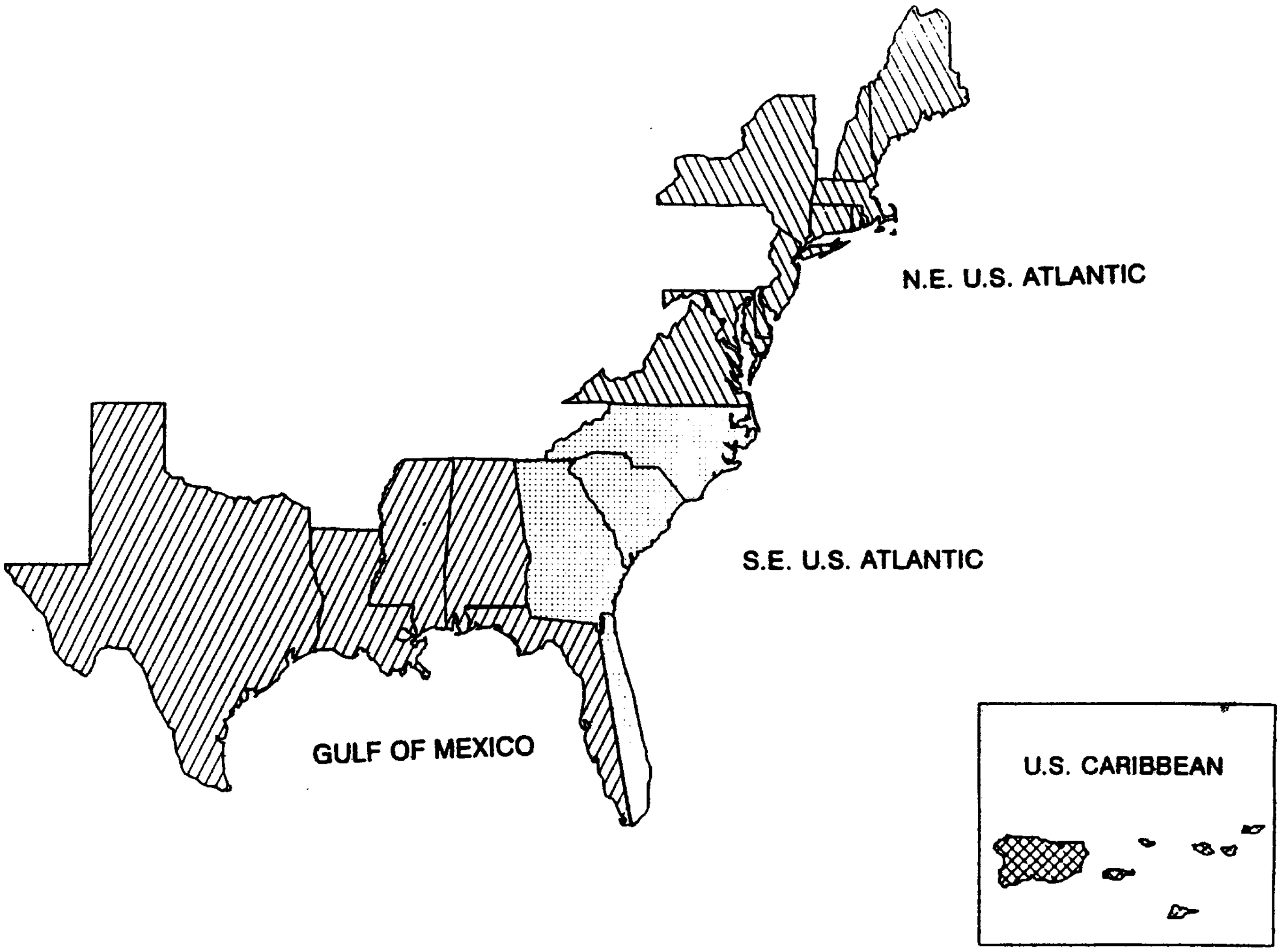

Figure 1. The geographic areas used in the STSSN entanglement/debris analysis.

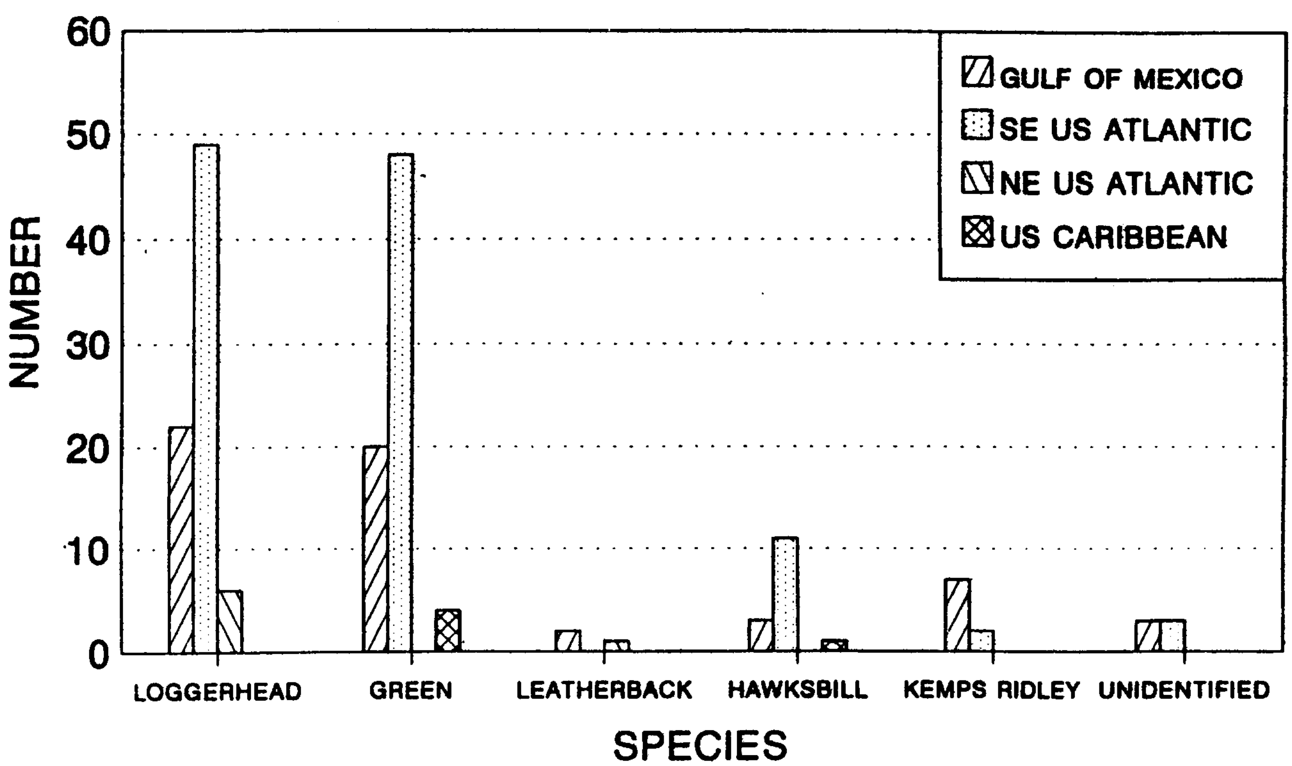

Figure 2. The number of stranded turtles, by species, by geographic, entangled with fish hooks and/or monofilament line.

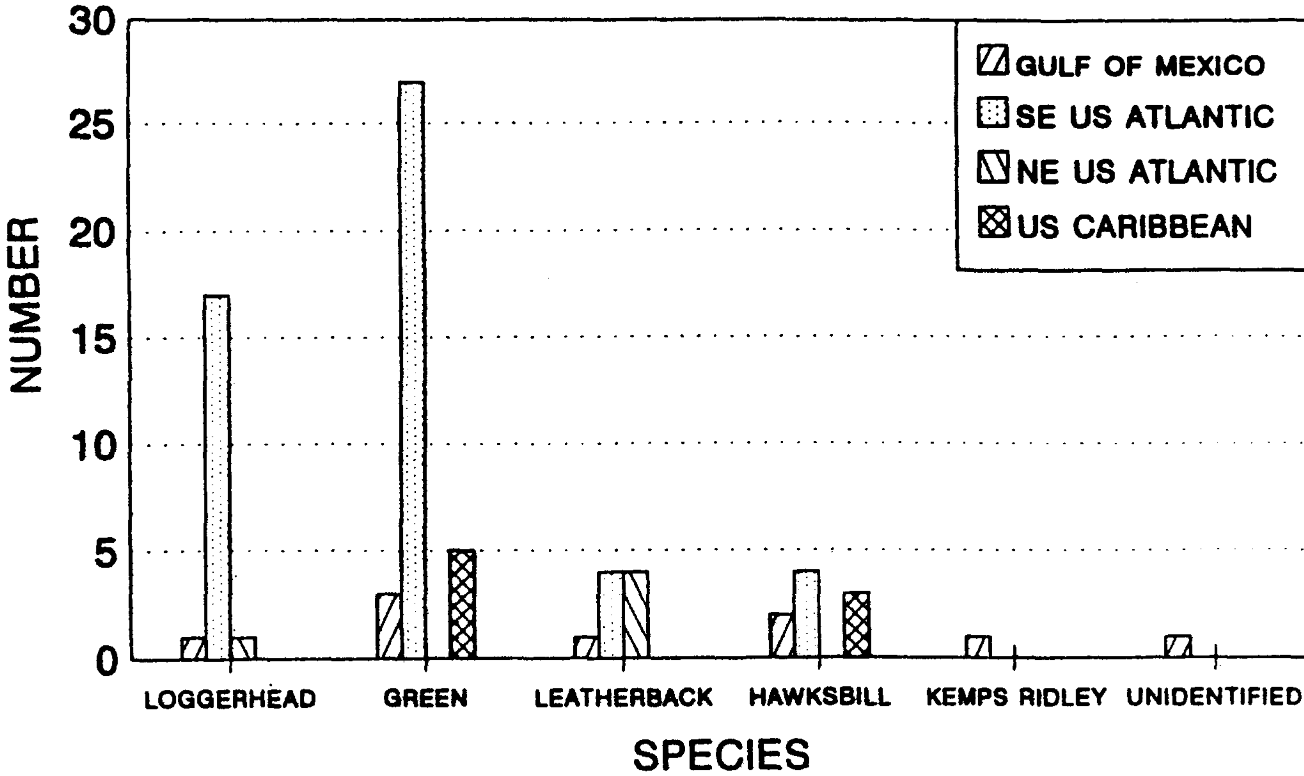

Figure 3. The number of stranded turtles, by species, by geographic area, entangled in fishing net.

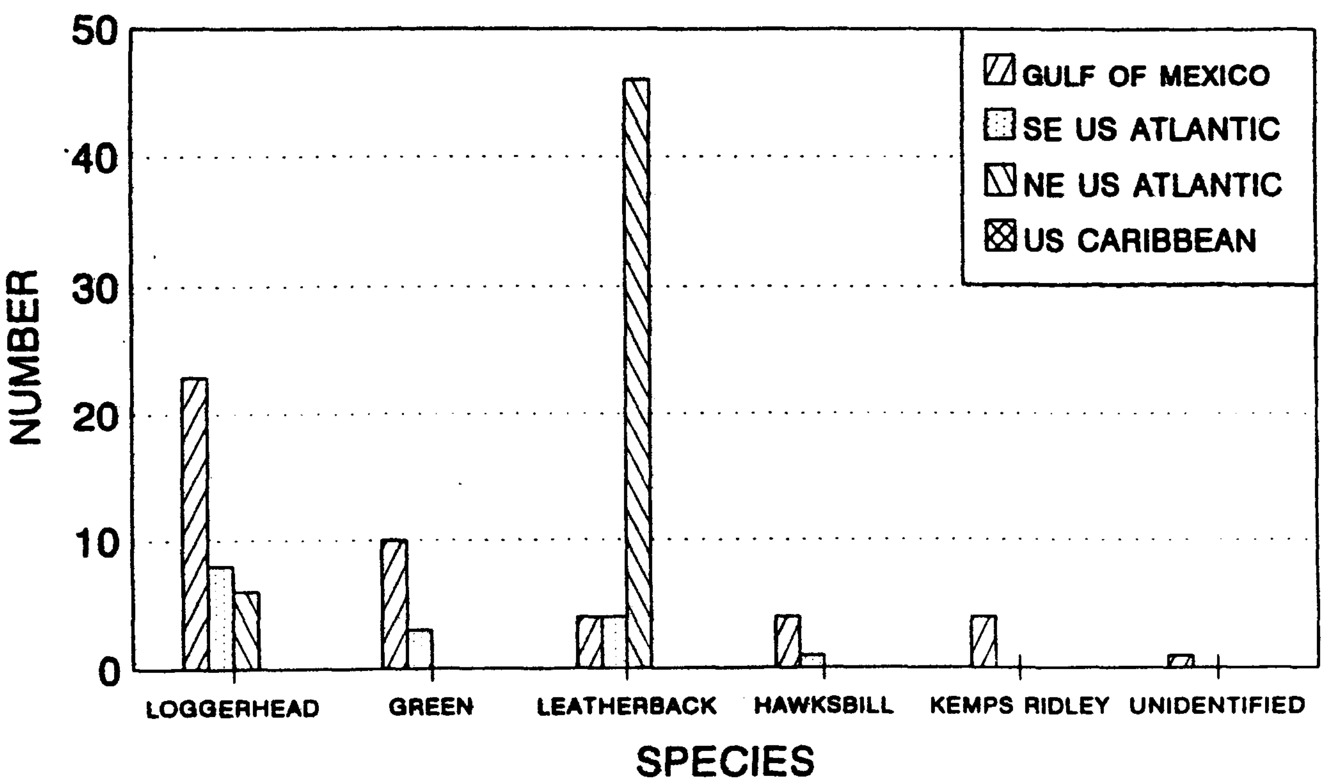

Figure 4. The number of stranded turtles, by species, by geographic area, entangled in fishing trap lines/rope.

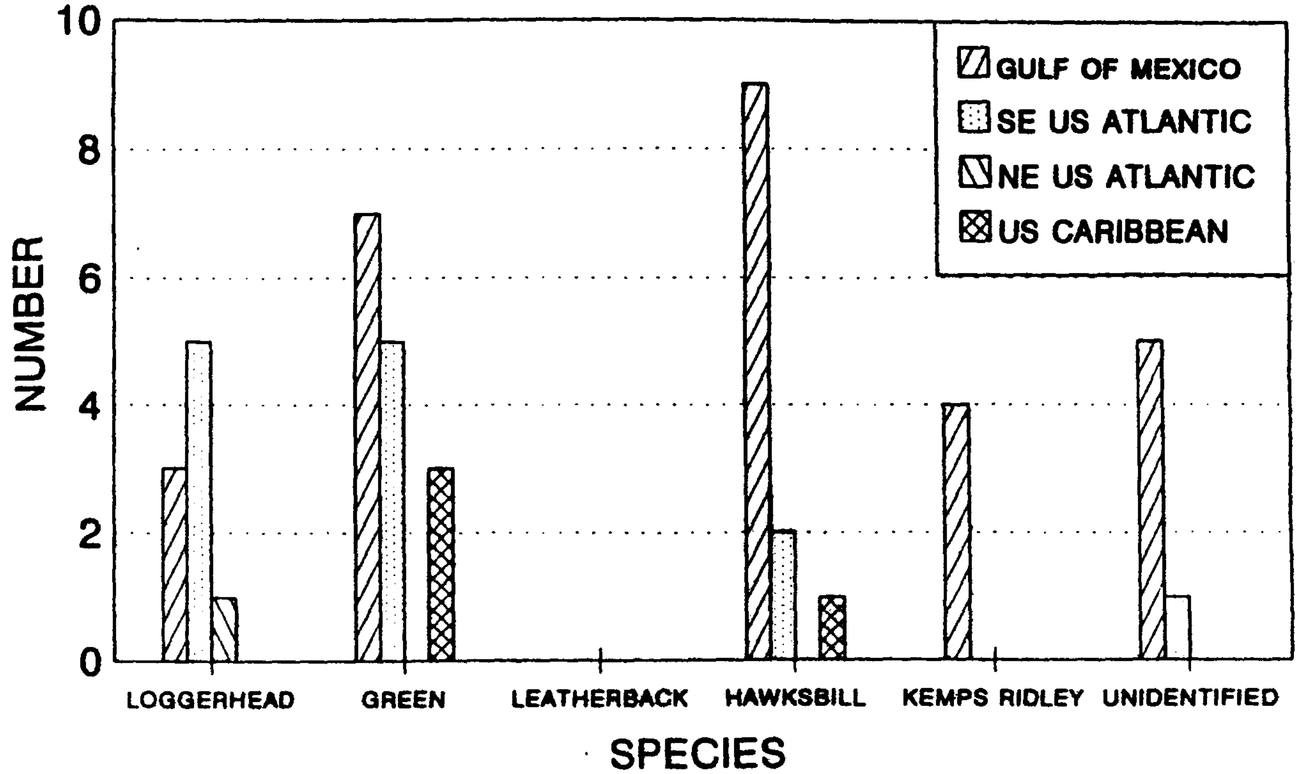

Figure 5. The number of stranded turtles, by species, by geographic area, entangled in non-fishing gear.

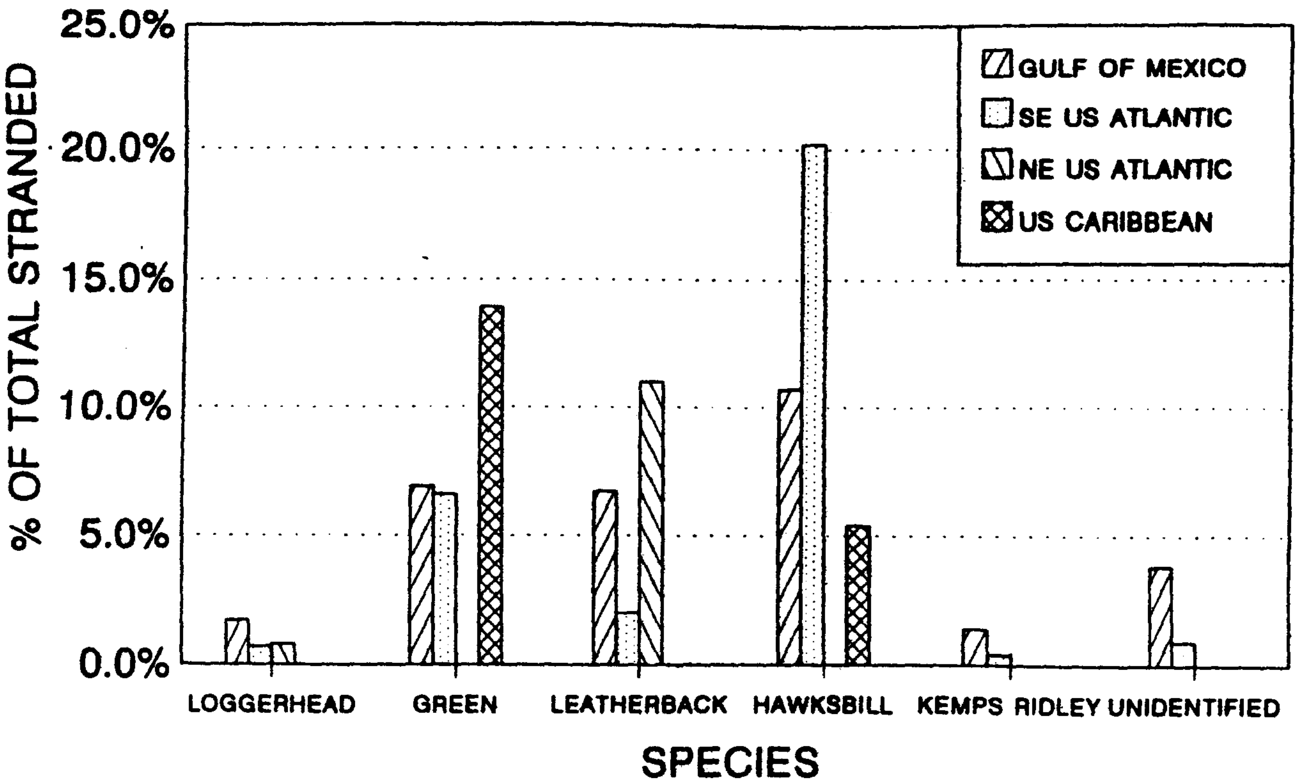

Figure 6. The percentage of stranded turtles affected by debris, by species, entangled in all categories combined by geographic area.

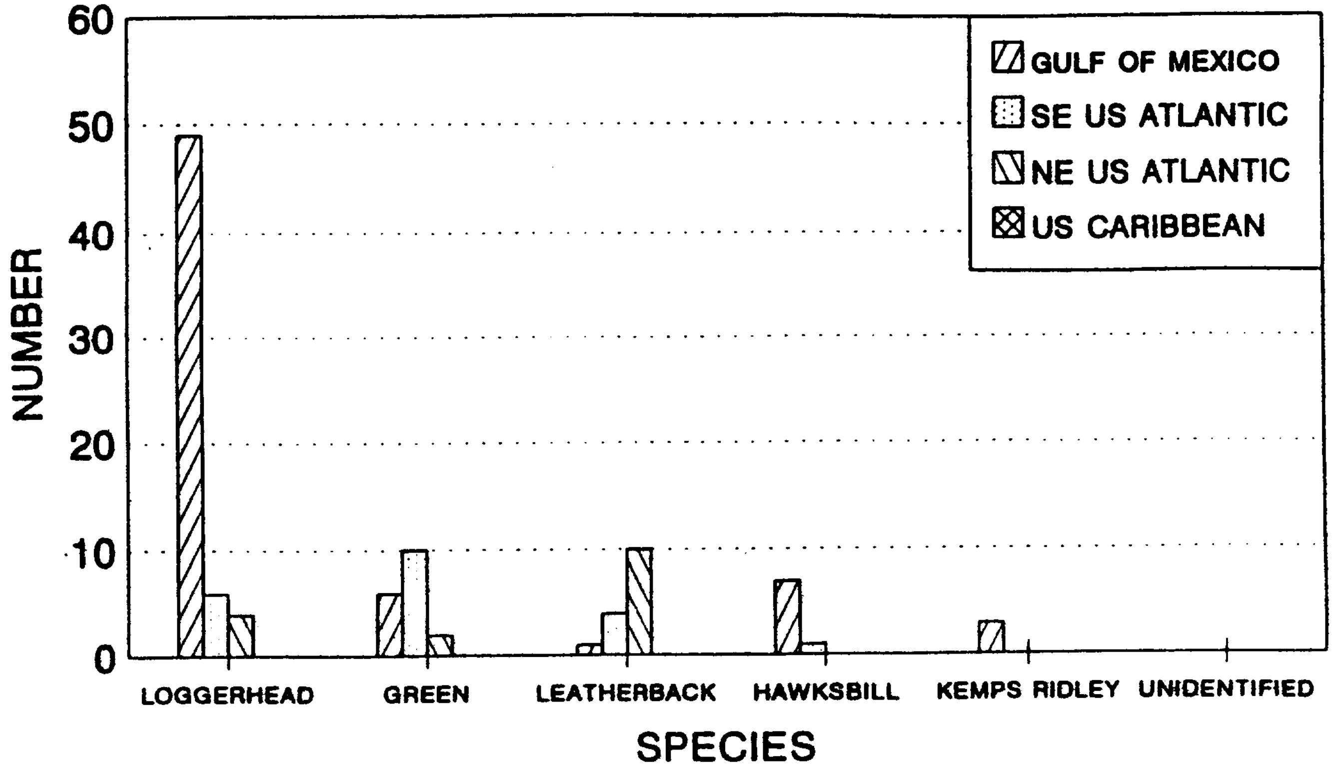

Figure 7. The number of stranded turtles, by species, by geographic area, that ingested plastic and/or balloons.

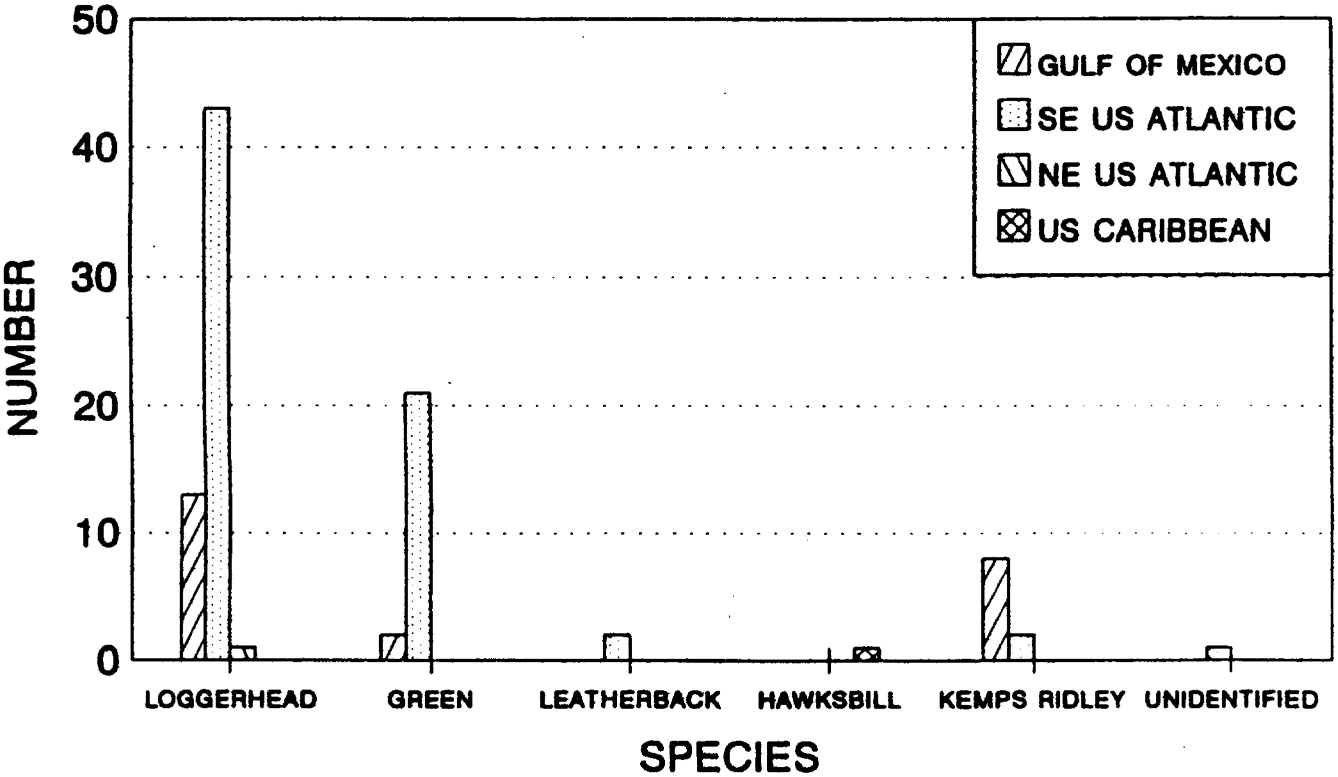

Figure 8. The number of stranded turtles, by species, by geographic area, that ingested hooks and/or monofilament line.

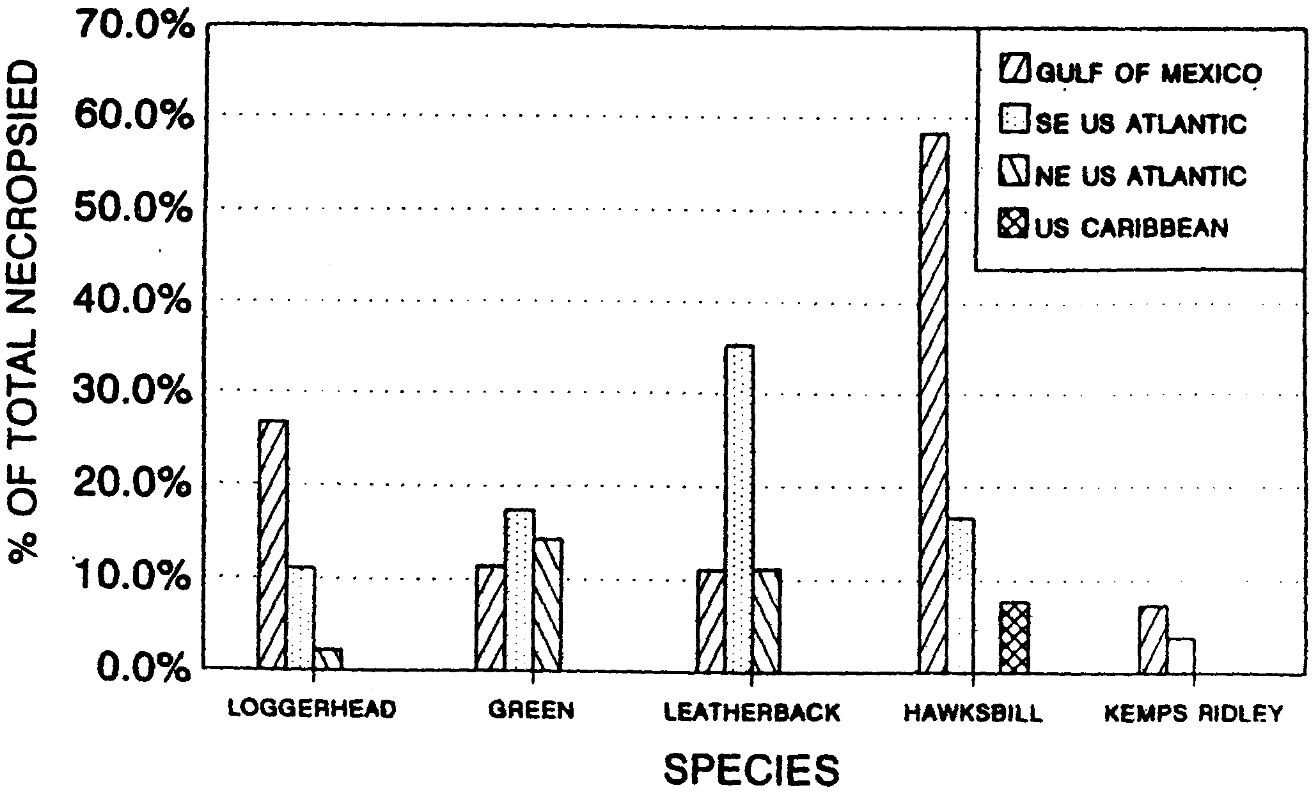

Figure 9. The percentage of necropsied turtles ingesting debris, by species, by geographic area.

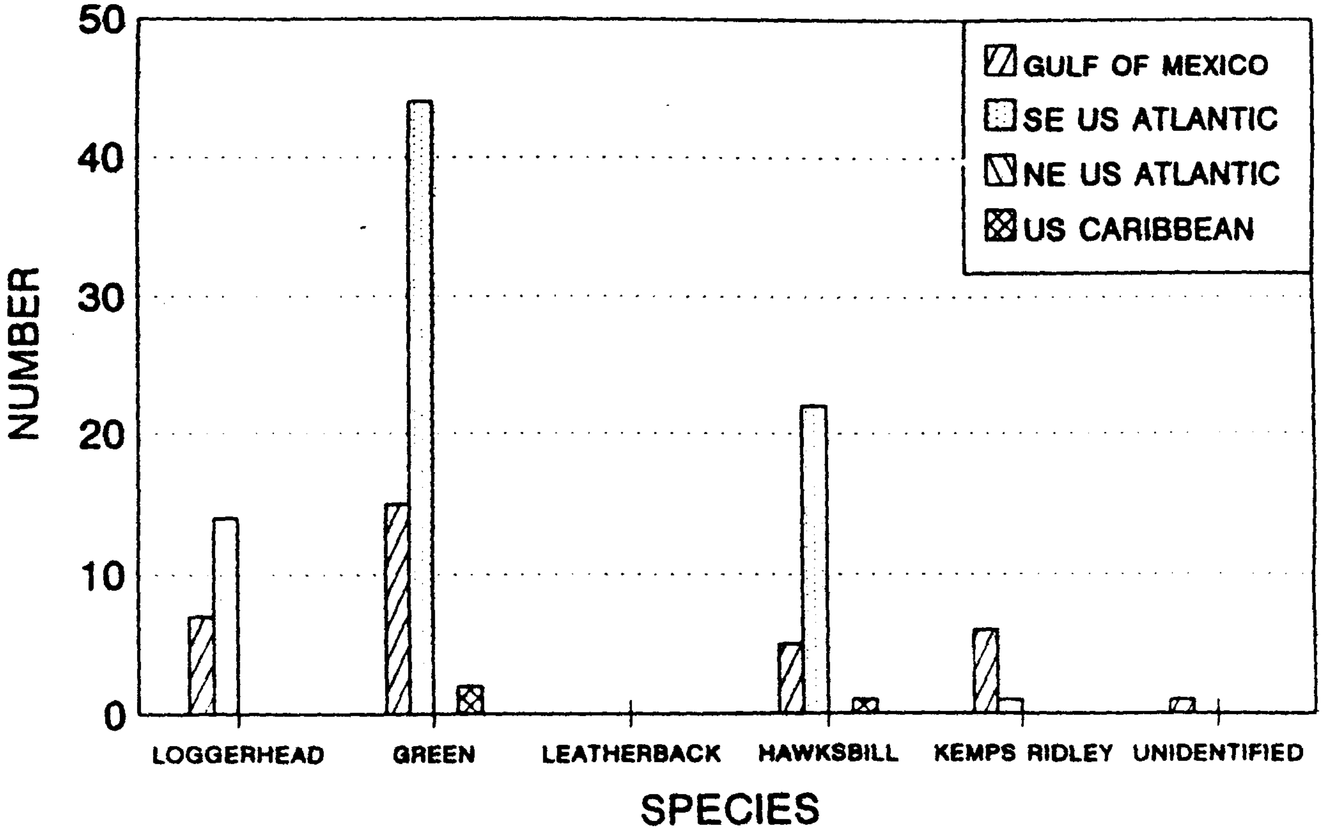

Figure 10. The number of stranded turtles, by species, by area, that were impacted by tar and/or oil.

APPENDIX 1

The Occurrence and Effects of Debris and Entanglement on Sea

Turtles: A Bibliography

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