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TITLE: Relationship of trauma to sea turtles stranded on
Cumberland Island, Georgia, 1986 - 1987.

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INTRODUCTION

This study was initiated to define the frequency of antemortem and postmortem trauma to stranded sea turtles from a geographic area of relatively frequent strandings. This information could be used to evaluate changes in the amount of human-induced trauma following implementation of turtle excluder devices (TED's) in shrimp trawls as mandated for 1989 and 1990. Additionally, it provides the first data on trauma to a large series of sea turtles and includes indirect evidence of interactions with shrimp trawling activities. Such evidence is presently unavailable in the literature.

The use of TED's in shrimp trawls should reduce human-sea turtle contact and consequently, human-induced trauma. To measure the effectiveness of the devices, or the enforcement of TED use, some index of the number of stranded turtles and the amount of human-induced trauma prior to the use of TED's is necessary. This report furnishes some of those data for turtles stranded on Cumberland Island in 1986 and 1987.

We monitored sea turtle strandings on Cumberland Island,

Georgia, at least weekly from 1978 to the present. During that time we examined over 1000 stranded turtles. This report deals with the 133 sea turtles stranded during the years 1986 and 1987, and details information on trauma incurred by the stranded animals.

In 1979, a state stranding network was organized in an attempt to quantify sea turtle mortality in Georgia waters. The National Marine Fisheries Service assumed responsibility for this network in 1980, and established networks in other coastal states. By 1986, all eastern coastal states were reporting strandings, and the Southeast coastline was divided into zones to facilitate data management (Schroeder, 1987). Cumberland Island is within Zone 30, from which the highest number of sea turtle strandings was reported during the years 1986 and 1987.

Most stranded sea turtles are decomposing when washed ashore. Unless skeletal material is prepared, many signs of antemortem trauma or pathological conditions may be overlooked. There are few literature records of antemortem wounds or the condition of stranded turtles, but we were able to provide information on these parameters from necropsies and subsequent examination of skulls and, occasionally, other skeletal parts. Advanced decomposition or postmortem trauma may limit information available from stranded carcasses. Data

relating the mortality to shrimp fishing efforts may be evident in gut contents.

METHODS

The 27 km beach of Cumberland Island, Georgia, was patrolled at least weekly during 1986 and 1987. In addition, strandings reported by island residents and National Park Service personnel were investigated immediately, resulting in more frequent beach patrols. This system insured investigation of all stranded animals. Necropsies were performed on all carcasses, but some animals lacked body parts; consequently, some necropsies were necessarily incomplete. Basic data recorded included size (curved carapace length and width), sex (based on gonad examination or caudal vertebral morphology of adults), carapace laminae counts, epibiota, gut contents, condition of abdominal organs, trachea condition, head condition, and obvious trauma. Measurements were rounded to the nearest 0.5 cm. Gut contents, including those in the esophagus, were collected, washed over screens, dried, and sorted. Undigested or partially digested soft items were preserved in 10% formalin. Photographs of specimens, injuries, and unusual features were made.

The data collected were categorized according to kind and possible cause of trauma, estimated time of occurrence, body part involved, and evidence of human-induced trauma. Data were

entered into a dBase III Plus format as detailed in Appendix 1.

The descriptions of causes of trauma were subjectively determined. In some cases, such as multiple propeller strikes to a carapace, or damage done by sharks, the cause of the trauma was obvious. If the carapace was crushed or cracked in a single location, assignment to a more general trauma category was made.

Time of trauma (antemortem, at death, postmortem) was assigned according to evidence of healing processes, severity of fresh wounds other than shark or boat damage, and evidence of damage by scavengers. Human mutilation of carcasses on the beach was assigned to carcasses with clean-cut severance of the head and eye-witness accounts.

The kinds of trauma are self-explanatory. Bone erosion may be related to pathological conditions unrelated to trauma; hence, we assigned bone erosion only to situations associated with obvious trauma. Barnacles may cause pockmarks in bone, but these were not included in our categories for trauma. Damage by barnacles is especially common in unhealthy turtles, but it was not always possible to account for the amount of barnacles on an individual.

Association with shrimp trawlers was made on the basis of occurrence of fresh shrimp, squid and/or fish in the esophagus and stomach. The presence of only a few fish bones in the gut contents was not considered sufficient evidence for trawler association. No judgment could be made on the possible association with shrimp trawlers if the esophagus and stomach were missing.

Decisions regarding natural or anthropogenic trauma were subjective. Antemortem damage to the skull was attributed to natural causes if the tomium or mandible and adjacent bones were involved. Severe unilateral damage to the skull was assigned an anthropogenic cause. In some cases the damage to these bones was by sharp-bladed instruments.

RESULTS

Data on numbers of strandings of all species are presented in Table 1. Loggerheads (Caretta caretta) constituted the majority of strandings (88%), with Kemp's ridley turtles (Lepidochelys kempii) accounting for 9%, and green sea turtles (Chelonia mydas) and leatherbacks (Dermochelys coriacea) 1.5% each. One loggerhead was removed from the beach before we were able to examine it, and 14 loggerheads were in such poor condition that we were able to derive only limited information

from them for this report. One Kemp's ridley was illegally taken and held by a National Park Service employee for several weeks before we were able to examine it. Consequently, we could not fully assess the quality of damage. When we examined the carcass it was dried with the head missing. Of the 119 carcasses which could be assessed for trauma, 70.6% (84/119) suffered some sort of trauma prior to necropsy.

Dates of strandings by species are presented in Table 1. Sex of stranded animals is presented in Table 2. Occurrence of trauma was not correlated with species, date of stranding, sex, or size of turtle. Summaries of trauma frequency to head, trunk (including carapace and plastron), and limbs and whether trauma was judged as antemortem, at death, or postmortem are presented in Table 3. Some carcasses had antemortem trauma to one or two of the three body areas and postmortem trauma to one or more of the other parts. Of course, we could not determine antemortem trauma in missing parts (e.g. heads); hence, our sample size for that category was reduced. In addition, we did not routinely prepare appendicular skeletal material, therefore, total antemortem trauma was not fully assessed. The percentage of animals with postmortem trauma was 65% (49/75), antemortem 44% (33/75), and at-death, 4%. Eight individuals had both antemortem and postmortem trauma and are included in both totals. Probable causes of the trauma are presented in Table 4. The greatest amount of trauma was attributed to

sharks.

The shark trauma to dead sea turtles reduced the possibility of our observing some antemortem damage to body parts, especially heads. Of those loggerheads with heads, 24.3% (17/70) had suffered antemortem damage, of which 11 were assigned to unknown causes, 5 to severe impact, and 1 to a blow with a sharp object. Antemortem trauma to the heads of all species combined was 22.6% (21/93). Shark damage was greatest to limbs. Thirty-seven loggerhead carcasses were missing limbs attributable to shark attack, while 32% (39/119) of all species combined suffered removal by sharks.

Although "removal" was the most frequent kind of trauma, and often associated with shark bites, fractures and lacerations were the next most frequent types (Table 5). Severe impacts and unknown causes were responsible for most of the fractures and lacerations. We found no evidence of trauma from bullets or sport fishing gear (entanglement in lines or hooks in gut) as observed in other years.

Photographs of specimens illustrating time, cause, and kind of trauma are shown in figures 1 to 10. The photographs are from specimens used in this study (1986 and 1987). The importance of skeletal preparation is evident in the figures where both stranded animal condition and skeletal preparation are shown.

Of all the loggerhead specimens with either partial or complete digestive tracts, 44.4% contained intact shrimp and/or fishes (Table 6), suggesting recent feeding in shrimp trawls. Such food items are not normally obtained by sea turtles (Shoop and Ruckdeschel, 1982). Corresponding percentages for stranded ridley turtles was 14.3% (Table 6). Probably, because of different dietary habits, no shrimp or fishes were found in the other species.

DISCUSSION

The large percentage of stranded animals exhibiting trauma may have several ramifications and interpretations. The high frequency of shark attack on carcasses could result in skewed size distributions of stranded animals since small turtles might be more likely to be totally consumed when sharks are present; hence, seasonal stranding patterns of smaller individuals (especially ridleys) may reflect shark abundance rather than relative size structure of the sea turtle assemblage near shore. The low frequency of shark-caused trauma on ridleys, which strand more commonly in the colder months, compared to loggerheads that strand more frequently in the warmer months, supports this view, although ridleys may be present in larger numbers when sharks are less abundant near shore.

Shark damage to limbs of dead sea turtles is quite likely; 32% of the stranded carcasses had limbs removed by sharks. Since tagging systems utilize limbs most frequently, some change in location of tags could result in higher tag recovery from stranded animals. As we noted at the 1988 Sea Turtle Research Workshop, the placement of transponder tags in flippers does nothing to improve the survivability of tags on dead animals. The data on limb loss of stranded animals supports our view.

Although antemortem trauma was partially obscured by shark damage of carcasses, approximately one-quarter of the stranded animals with heads had suffered antemortem trauma involving fractures and lacerations. The frequency of such trauma seems unlikely to stem from natural causes. In some cases, several of the skull bones were involved and damage had been severe.

The information we collected from necropsies and limited skeletal preparations of stranded turtles on Cumberland Island suggest that a portion of antemortem trauma may be human-induced. Antemortem, human-induced trauma adds a new parameter to the problem of fisheries-sea turtle interactions. Recovering or debilitated turtles may be more likely to succumb when entangled in fishing gear than would healthy animals, thus

augmenting the incidental catch rate or fishery induced mortality. The proportion of animals that suffer antemortem trauma has never been reported. While direct evidence linking antemortem, human-induced trauma of stranded sea turtles to commercial fishing is lacking, we believe the indirect evidence of shrimp trawler association with stranded animals makes association of antemortem trauma to human activities likely.

There are few data to compare with our results. Deraniyagala (1939) noted that fishermen often subdued loggerheads with blows to the head, but no supporting evidence of head trauma was presented. Kaufmann (1966) also reported that some loggerheads were damaged in collisions with boats and by humans. Examination of skulls in museum collections could provide additional historical data on trauma suffered by sea turtles, as could study of the additional material we have collected since 1978.

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TABLE 1. Strandings on Cumberland Island, Georgia, 1986 and 1987. Abbreviations: Cc = Caretta caretta; Cm = Chelonia mydas; Dc = Dermochelys coriacea; Lk = Lepidochelys kempii.

Species	Yr	Month												Total
		J	F	M	A	M	J	J	A	S	O	N	D	
Cc	86				6	4	12	6	14	2	3	5	1	53
Cc	87	1			1	29	6	12	8	4	1	2		64
														117
Cm	86													0
Cm	87					1		1						2
														2
Dc	86													0
Dc	87				1							1		2
														2
Lk	86			1			1				2	2		6
Lk	87						2	1				3		6
														12
Total strandings														133

TABLE 2. Sex of sea turtles stranded on Cumberland Island, Georgia, 1986 and 1987. Cc = Caretta caretta; Cm = Chelonia mydas; Dc = Dermochelys coriacea; Lk = Lepidochelys kempii.

Species	Male	Female	Unknown
Cc	32	53	32
Cm			2
Dc	1		1
Lk	5	2	5

Table 3. Trauma frequency to head, trunk, and limbs and estimated time of trauma on sea turtles stranded on Cumberland Island, Georgia, 1986 and 1987. am = antemortem; pm = postmortem; d = at death; N = sample size.

SPECIES	BODY PART AFFECTED	TIME OF TRAUMA (N)		
		am(N)	pm(N)	d(N)
	HEAD			
Cc		17(70)	35(102)	2(70)
Cm		1(2)	1(2)	0(2)
Dc		0(1)	1(1)	0(1)
Lk		3(11)	2(11)	0(11)
	TRUNK			
Cc		19(103)	12(103)	1(103)
Cm		0(2)	0(2)	0(2)
Dc		0(2)	1(2)	1(2)
Lk		0(12)	1(12)	0(12)
	LIMBS			
Cc		3(86)	34(103)	1(86)
Cm		0(2)	0(2)	0(2)
Dc		0(1)	1(2)	0(1)
Lk		0(12)	1(12)	0(12)

TABLE 4. Probable causes of trauma to sea turtles stranded on Cumberland Island, Georgia, 1986 and 1987. N = number with trauma.

SPECIES (N)	CAUSE	BODY PART AFFECTED		
		Head	Trunk	Limbs
Cc (75)	Boat	1		
	Severe impact	6	3	
	Shark(s)	27	5	37
	Humans	3		
	Carrion			
	feeder(s)	3	1	
	Sharp object	1	2	
	Unknown	16	18	5
Cm (2)	Unknown	2	2	
Dc (2)	Boat		1	
	Severe impact		1	
	Shark(s)	1	1	1
Lk (5)	Severe impact	1		
	Shark(s)	1	1	1
	Carrion			
	feeder(s)	1		
	Unknown	1		

TABLE 5. Kinds of trauma to sea turtles stranded on Cumberland Island, Georgia, 1986 and 1987. N = number with trauma.

SPECIES (N)	KIND	BODY PART AFFECTED		
		Head	Trunk	Limbs
Cc (75)	Erosion	3	1	
	Fracture	8	9	
	Laceration	6	9	1
	Removal	32	7	37
	Superficial laceration	1		
	Unknown	3	5	
	Other	1*		
Cm (2)	Erosion	1		
	Removal	1		
Dc (2)	Fracture		1	
	Removal	1	1	1
Lk (5)	Fracture	2		
	Laceration	2		
	Removal	1	1	1

* = hypertrophy of bone as a result of trauma.

TABLE 6. Number of sea turtles stranded on Cumberland Island, Georgia, 1986 and 1987, with shrimp, fishes, and/or squid in the esophagus or stomach.

SPECIES	(N)	PRESENCE OF INDEX ITEMS		
		Yes	No	Not applicable
<i>Caretta caretta</i>	117	36	45	36
<i>Chelonia mydas</i>	2	0	1	1
<i>Dermochelys coriacea</i>	2	0	1	1
<i>Lepidochelys kempii</i>	12	1	6	5
Total	133	37	53	43

Figure 1. Photograph showing postmortem trauma to rear of skull and lower jaw. Cause: shark; kind: fracture. Caretta caretta, 86.06.21.01.

Figure 2. Photograph showing antemortem trauma to supraoccipital. Cause: severe impact; kind: fracture. Caretta caretta, 87.09.17.01.

A

B

Figure 3. Photographs showing antemortem trauma to skull. A. Top of skull. Cause: unknown; Kind: erosion and laceration. Caretta caretta, 86.06.11.01. B. Side of skull. Cause: severe impact; kind: fracture. Caretta caretta, 86.11.28.01.

A

B

Figure 4. Photographs of specimen and skull with antemortem trauma. A. Skull. Cause: severe impact; kind: fracture. B. Carcass with no sign of trauma. Caretta caretta, 86.10.18.01.

Figure 5. Photograph of head and neck with visible wounds as found on beach. Caretta caretta, 87.07.07.01. Skull shown in Figure 6.

Figure 6. Photograph of Caretta skull showing antemortem trauma.
Cause; sharp cutting object; kind: laceration. 87.07.07.01. From
specimen shown in Figure 5.

A

B

Figure 7. Photographs of postmortem trauma to carapace and appendages. A. Caretta, 86.04.17.02. Cause: unknown; kind: fracture. B. Dermochelys, 87.04.23.01. Causes: boat and shark; kind: fracture and removal.

A

B

Figure 8. Photographs of severe antemortem trauma to carapace. Caretta, 87.05.29.01. A. Carapace with laminae removed. Cause: severe impact; kind: fracture. B. Close-up of laminae showing healing.

Figure 9. Photograph showing antemortem trauma to rear of carapace.
Cause: unknown; kind: fracture. Caretta caretta, 86.04.05.01.

A

B

Figure 10. Photographs of trauma to limbs. A. Antemortem trauma to left front flipper. Cause: unknown; kind: removal. Caretta caretta, 86.08.10.03. B. Postmortem trauma. Cause: shark; kind: removal. Caretta caretta, 87.05.27.02.

