Asian Fisheries Science **13**(2000): 287-296
Asian Fisheries Society, Manila, Philippines

https://doi.org/10.33997/j.afs.2000.13.3.011

Turtle Incidences in Shrimp Trawl Nets During the 1997-1998 Shrimp Season in Bahrain Waters

E.A.A. ABDULQADER

Bahrain Center for Studies and Research
P.O. Box 496
Bahrain

Abstract

In 1985, the Directorate of Fisheries (Bahrain) initiated a fishing log scheme to collect shrimp trawl fishery data. In the 1997-1998 season, fishermen were instructed to report on turtle catching incidences in standard fishing logs. The current work highlights the 1997-1998 fishing log information on turtle incidence. The percentage of boats reporting on turtle incidence ranged from 20.3 to 35.3% for different months. Fishermen use a single local name for all marine turtles found in Bahrain waters. This may indicate the abundance of a single species, which most likely is the green turtle. Turtles were reported in 12 out of the 20 grounds fished during the 1997-1998 season. The highest turtle incidence and fishing effort values were found in October 1997. Higher incidence rates were found in the Green Buoy, Aljarim, Tugailib, Mishtan, and Alshiekh fishing areas. The highest total seasonal incidence was found in Qumais, which was the second highest in terms of fishing effort. Lowest incidence rates were found in January 1998. This study is the first attempt to assess turtle incidence in shrimp fishery in the Arabian Gulf area.

Introduction

Bahrain's shrimping fleet has considerably expanded since the mid 1980s. From about 40 boats in 1980, this fleet has expanded to about 400 boats in the 1998-1999 shrimp season (Abdulqader 1999). This dramatic increase in the number of vessel has attracted the attention of resource managers. Their concern is the possible impact of the shrimp fishery on the local turtle population. This study is the first attempt to assess turtle incidence in shrimp fishery in the Arabian Gulf area.

The fishing log scheme was introduced in 1985 to collect shrimp trawl data (Abdulqader 1988). This scheme required daily recording of the area fished, number of hauls made in a day, average duration of a haul, and catches in kilograms of shrimp and other important species. Starting from the 1997-1998 season, all fishermen were instructed to record turtle presence in their catch. This work is an initial assessment of turtle incidence in shrimp trawls in Bahrain.

Materials and Methods

The fishery

Fishermen use local names to identify Bahrain shrimp fishing grounds. Locations of these grounds were determined by Abdulqader and Mehic (1996). These grounds are geographically grouped into three main areas: western, northern, and southern areas (Fig. 1).

Fishing boats range from 5 to 23 m in total length. They operate in depths from 2 to 20 m. The shrimp fleet include wooden and fiberglass boats, with in-board or out-board engines of 50 to 450 hp. About 86% of these boats use winches to haul their nets. Fishing is conducted using in each boat a single Gulf of Mexico flat otter trawl net. Net sizes range from 10 to 40 m. Mesh size at cod end is 30 mm.

Several regulations have been implemented to manage Bahrain's shrimp fishery. These include: boat registration and licensing, fishing ban period, minimum mesh size, and minimum harvestable size. Ban period extended from 15 March to 30 June in 1997. The 1997-1998 shrimp season was nine months, from 1 July 97 to 31 March 98.

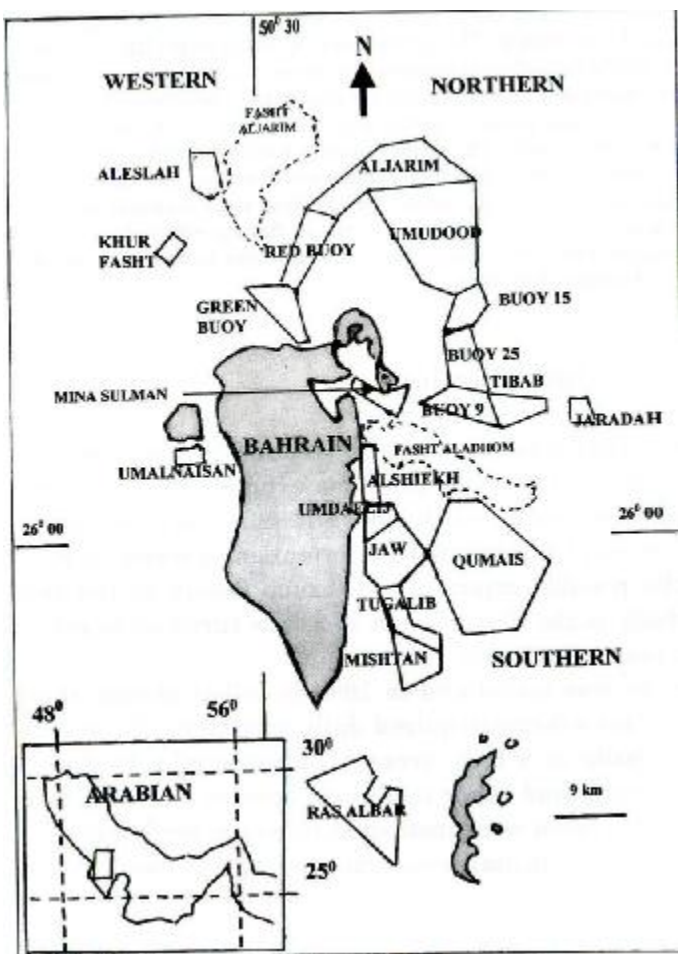

Fig. 1. Map of Bahrain shrimp grounds geographically grouped into western, northern, and southern grounds, with specific areas fished (outlined by solid line) in the 1997-1998 season identified by their local names. Major coral reefs (Fasht Aljarim, Fasht Aladhom) are outlined by dotted lines.

Modification of report forms

In the 1997-1998 shrimp season, an additional column was introduced into the shrimp fishing log-sheet. In this column, fishermen were instructed to note down the number of turtles found in their catches during a fishing day. The 'X' symbol was used to indicate turtle absence during a fishing day. Since local fishermen only have one local name for sea turtles, it was not possible to differentiate the species.

Monthly estimates of turtle incidences, fishing effort, and turtle incidence rate

Only 20.3 to 35.3% of the total number of active boats reported turtle catches (n_r) (Table 1). These boats were considered as a subpopulation from the total number of active boats (N). Among the active boats, there were numbers of nonworking boats. The number of working boats (N_{wm}) for a given month was calculated as follows:

$$N_{wm} = (n_{wm} / (n_{wm} + n_{nwm})) \times N$$

where n_{wm} is the number of working boats for month m, and n_{nwm} is the number of nonworking boats for month m.

Monthly turtle incidence (Imi) per fishing area (i) was calculated by multiplying the total number of working boats (N_{wm}) by the ratio of summation of individual turtle incidence per I fishing ground divided by the number of boats that reported this catch, using the following equation;

$$I_{mi} = (\Sigma I_{ijm} / n_{rim}) * N_{wm}$$

where, n_{rim} is the number of boats reporting turtle catches in the fishing area (i) during month (m). I_{ijm} is the number of turtle incidences in i fishing ground, for j boat, reporting for month m.

Table 1. Number of active boats, and number and percentage of boats reporting on turtle incidence by month for the 1997-1998 shrimp season.

Month	JUL 97	AUG 97	SEP 97	OCT 97	NOV 97	DEC 97	JAN 98	FEB 98	MAR 98
No. of active boats (N)	256	242	236	236	249	256	240	233	241
No. boats reporting on turtle incidence (n_r)	59	50	48	52	71	74	75	71	85
% of boats reporting on turtle incidence (n_r)	23.0	20.7	20.3	22.0	28.5	28.9	31.3	30.5	35.3

Monthly fishing effort (f_{mi}) per fishing ground was calculated using the following equation;

$$f_{mi} = (\Sigma f_{ijm} / n_{rim}) * N_{wm}$$

where, f_{ijm} is the fishing days in i fishing ground, for j boat, reporting for m month.

Results

Fleet haul duration

Haul duration monthly means were calculated based on the boats reported (n_r) on turtle incidence (Table 2). Fishing duration ranged between a minimum of 0.3 to a maximum of 3.0 hours, while means ranged from 1.3 to 1.7 hours during the season. Scheffe Multiple Range test indicated a significant difference between July and December 1999 means.

Total incidences by month and area

Total turtle incidences in shrimp trawl fishery for the 1997-1998 season was estimated to be 1,229 from 54,831 fishing days for all boats. Out of the 20 fished areas during the 1997-1998 season, turtles were found in only 12 of these grounds (Figs. 1 and 2). The "Umudood" area received most of the fishing effort, and was the second highest in estimated total turtle catches. The highest turtle incidence was found in the "Qumais" fishing area, which had the second highest number of fishing effort. The lowest incidence was from the Buoy 15 and Buoy 9 areas (Fig. 2).

Turtles were not found in the western grounds, including the 'Aleslah' and 'Khur Fasht' areas (Figs. 1 and 2). Turtles were also not found in other areas, including 'Buoy 25', 'Jaradah', 'Mina Sulman', 'Jaw', 'Ras Albar', 'Umalnaisan', and 'Tibab'.

The highest turtle incidence and fishing effort were found in October 1997 (Fig. 3). Turtle incidence declined in the following months, and were at a minimum by February 1998 (Fig. 3). Fishing effort also showed a similar declining trend during these months but by a smaller magnitude. Turtles were found in the shrimping ground throughout the season (Fig. 3). Spatial and temporal variations in turtle incidence were found statistically significant (Table 3) based on the data provided in the individual boat reports (n_r).

Monthly turtle incidences, fishing effort, and catch rates

During the 1997-1998 season, efforts were distributed mainly between the northern and southern grounds, while the western grounds received smaller efforts (Figs. 1 and 4). 'Umudood', and 'Qumais', received most of the

fishing effort (Figs. 1, 2 and 4). The 'Tugailib' and 'Mishtan' areas were fished from October 1997 to January 1998 with a little amount of fishing effort (Figs. 1 and 4). Turtles were found in these areas from October to December 1997. In November 1997, fishing effort extended further south to the Ras Albar area (Figs. 1 and 4). Small amounts of fishing effort were

Table 2. On monthly basis, haul duration mean, mean standard deviation, maximum, minimum, and number of reported boats for the 1997-1998 season.

Month	*Number of boats (n_r)	Minimum duration (hrs)	Maximum duration	Mean duration	Standard deviation
July 97	57	0.3	2.0	1.3_a	.5056
August 97	48	0.5	2.0	1.4	.4978
September 97	48	0.5	2.0	1.5	.4566
October 97	52	0.7	2.0	1.6	.4362
November 97	68	0.3	2.0	1.5	.4260
December 97	71	0.7	3.0	1.7_b	.4569
January 98	75	0.7	2.5	1.6	.4741
February 98	70	0.5	2.5	1.6	.5140
March 98	81	0.7	2.5	1.6	.4909

* some boats did not report on their haul duration.
a, b pairs with different letters are all significantly different (at $P<0.05$) from each other, determined by Scheffe Multiple Range test.

Table 3. Result of the analysis of variance indicating significant (at alpha > 0.05) differences in turtle incidences within months and fishing grounds. (Based on individual reports, n_r)

Source	Type III sum of squares	df	Mean square	F	Sig.
Area	1.453	19	7.649E-02	13.829	.000
Month	.776	8	9.694E-02	17.528	.000
Area Month	3.511	106	3.312E-02	5.989	.000
Error	5.536	1001	5.531E-03		
Total	11.483	1135			
Corrected total	11.163	1134			

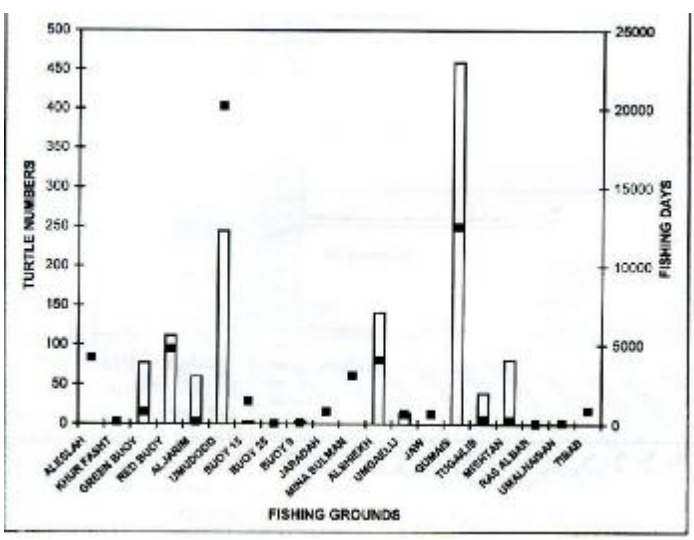

Fig. 2. Comparison of total turtle incidences in shrimp trawl (bars), and total fishing days per fishing ground (solid square) during the 1997-1998 shrimping season.

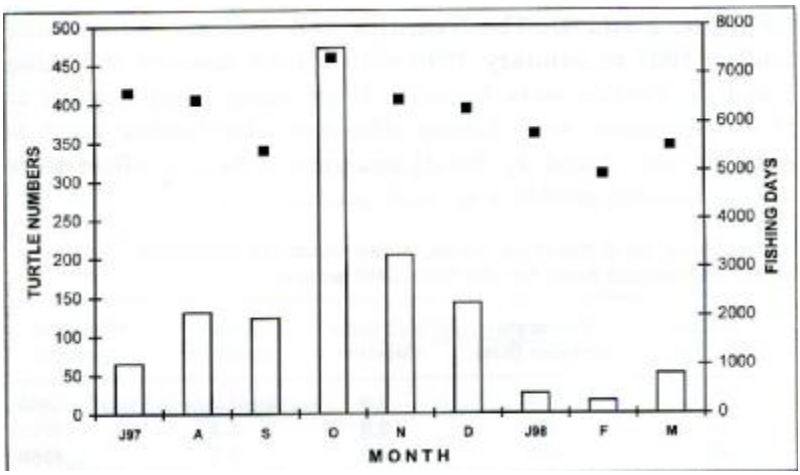

Fig. 3. Total monthly turtle (I_{mi}) incidences (bars), and total fishing (f_{mi}) effort (solid squares) during the 1997-1998 shrimp season, aggregated for all fishing areas.

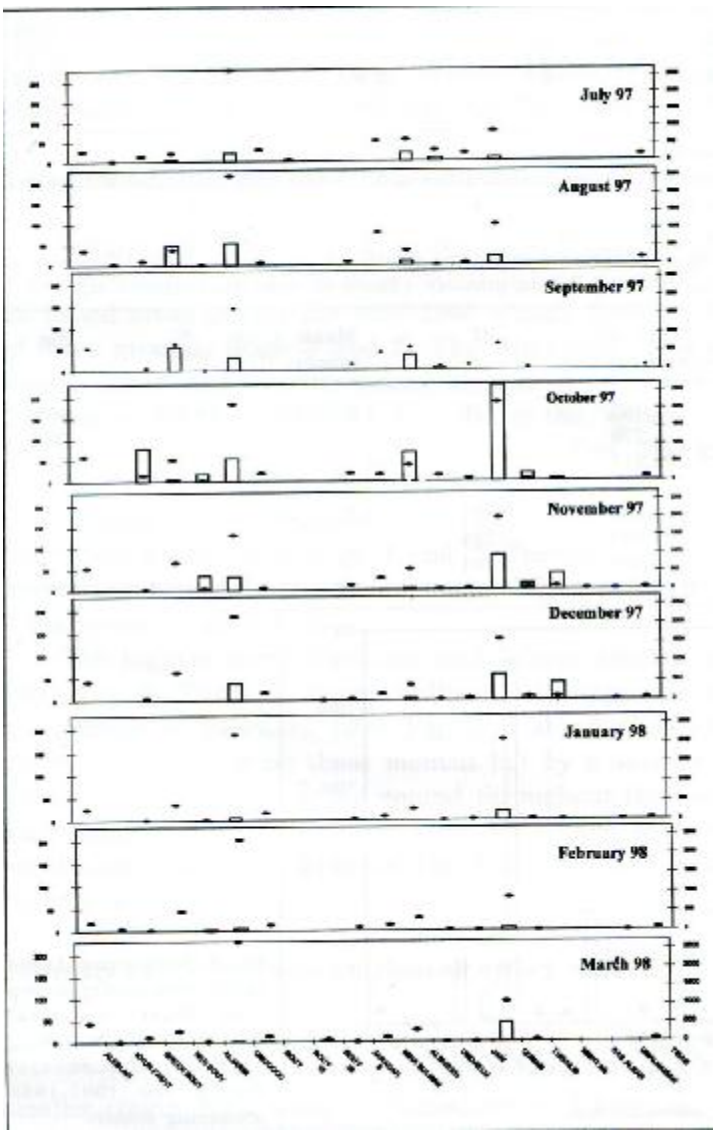

Fig. 4. Turtle (I_{mi}) incidence (Bars, left y-axis), and fishing (square, right y-axis) days (f_{mi}) per fishing area, for the 1997-1998 shrimp season by month.

spent at the 'Umalnaisan' area off Bahrain's west coast between November 1997 and February 1998 (Figs. 1 and 4).

Turtles were found at higher incidence rates, and in more areas in October 1997 (Figs. 4 and 5). During this month, turtle incidence rates were higher at the 'Green Buoy' and 'Aljarim' areas in the northern area, and in 'Tugailib', 'Mishtan', and 'Alshiekh' of the southern area (Figs. 1 and 5). The turtle incidence pattern was similar in November and December 1997, with a decline or disappearance of turtles in some areas (Fig. 5). These fishing grounds received little amount of fishing effort (Fig. 4). Low incidence rates were estimated for the 'Umudood' and 'Qumais' areas, which received the highest amount of fishing effort (Figs. 4 and 5). The lowest incidence rate was found in January 1998 (Fig. 5).

Discussion

This work does not detail turtle incidence on a species basis since local fishermen have a single local name for all sea turtles. The single name may have resulted from their inability to recognize different species, or that only

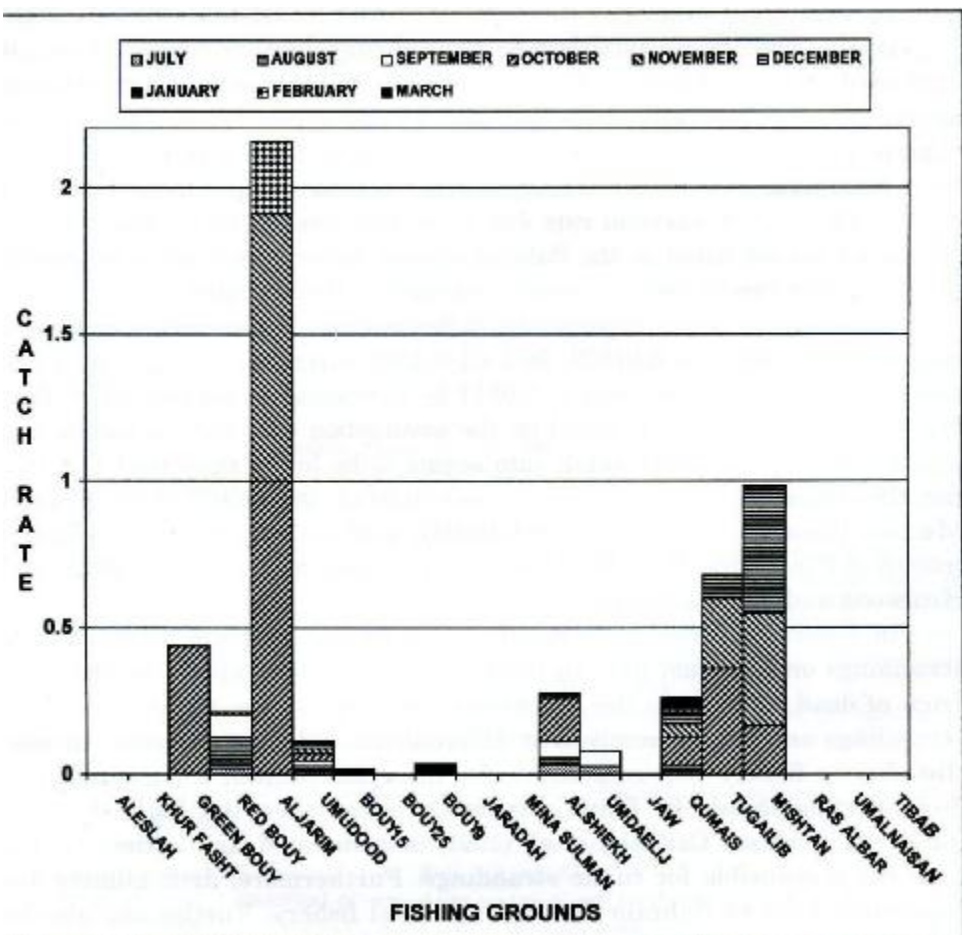

Fig. 5. Turtle incidence rate (number per fishing day) per fishing ground and per month.

a single species normally appeared in shrimp trawls most of the time. Studies conducted along the Saudi coasts revealed the presence of two species in the Arabian Gulf waters, i.e., the green turtle, *Chelonia mydas* (Linnaeus 1758), and hawksbill turtle *Eretmochelys imbricata* (Linnaeus 1776). The former species is found in higher abundance (Miller 1989, Basson et al. 1981). Miller (1989) suggested a ratio of one hawksbill turtle to 23 green turtles. This suggests that the single local name is probably due to the abundance of green turtles compared with hawksbill turtle. This also suggests that primarily green turtles were found in the Bahrain shrimp trawl fishery.

According to Carpenter et al. (1997), other turtle species that occasionally visit the Arabian Gulf include the loggerhead, *Caretta caretta* (Linnaeus 1758), the leatherback, *Dermochelys coriacea* (Vandeli 1761), and the olive ridley, *Lepidochelys olivacea* (Eschscholtz 1829).

In the Australian northern prawn fishery 5,503 and 5,238 turtles were caught during 27,049 and 25,746 fishing days in 1989 and 1990 respectively (Poiner and Harris 1996).

In this study, an estimated 1,229 turtles were caught during 54,831 fishing days. This suggests a lower reported turtle incidence rate in Bahrain waters compared to the Australian northern shrimp fishery.

In the Australian northern fishery, shrimp hauls duration typically extended to three hours in the case of tiger fishery, where 21% delayed mortality was determined in the case of the green turtle (Poiner and Harris 1996). In Bahrain, haul duration ranged from a minimum of 0.3 to a maximum of 3 hours, while monthly means ranged from 1.3 to 1.7 hours. The higher survival rate due to shorter haul duration might be expected for turtles found in the Bahrain shrimp fishery. Fishermen informally reported that turtles were normally released to the sea alive.

Based on individual reports (n_r), Bahrain mean turtle catch rate for the season is calculated as 0.01678, 95% CI=0.1969 turtle per fishing day. Mean catch rate on an hourly basis is 0.0017 by assuming an average of 10 fishing hours per day. This is based on the assumption that shrimp fishing is a night activity. The latter catch rate seems to be lower than that reported for the Australian North fishery (mean=0.0113, 95% CI=0.0012), Gulf of Mexico (mean=0.0031, 95% CI=0.0008), and southern North Atlantic (mean=0.0487, 95% CI=0.0041) noted by Poiner and Harris (1996), and Henwood and Stuntz (1987).

In Bahrain, there is no regular monitoring program on sea turtle strandings on the coast line. In most cases, the public reports on the presence of dead animals to the concerned authority. A few reports on turtle strandings are usually received at different times during the year. In case the shrimp fishery was responsible for these mortalities, a big number of dead turtles should be found during October, when the highest turtle incidence occurred. Caillouet et al. (1991) demonstrated that shrimp fishing was not responsible for turtle strandings. Furthermore, drift gillnets are commonly used in Bahrain Spanish mackerel fishery. Turtles can also be caught in gillnets (Cheng and Chen 1997).

An aerial survey indicated that the Bahrain coast did not contain turtle nesting areas (Miller 1989). In the Arabian Gulf, nesting areas are restricted to Karan, Kurayan, Jana, Jurayd, and Harqus islands found off the Saudi coasts (Miller 1989). Long distance nesting movements are common in the case of sea turtles. Hawksbill sea turtle have been reported to undertake movements up to 3680 km (Pritchard 1976, Meylan 1999, Starbird et al. 1999). Turtles caught in Bahrain were probably immature adults and subadults. Their feeding grounds probably overlapped with the shrimp fishing grounds. This is supported by Hildebrand (1982, and 1983), Miller et al. (1989), and Epperly et al. (1995) who stated that shrimp grounds are foraging habitats for sea turtles.

Acknowledgments

Thanks to Mr. Jassim Al Qaseer, The Director of Fisheries for his full assistance to this work. Thanks also to Mr. Jaffar Mansoor and Mr. Abbas Kasim (Directorate of Fisheries) for their efforts in collecting and sorting the fishing log data. Special thanks to Dr. Roger Uwate, Adviser–Directorate of Fisheries for reviewing the first and second drafts of this paper. Lastly, thanks to all the shrimp fishermen who provided information on turtle incidence.

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Manuscript received 12 July 1999; Accepted 17 April 2000.