keep an eye on the island. As for the turtles, the Sabah Wildlife Department has ordered new tags and applicators, and these have since been used in the field. The rangers who patrol the island several times during the night inform the military personnel of their activities before each patrol.

Research and Conservation

Universiti Malaysia Sabah has been working closely with the Sabah Wildlife Department to manage and conserve the treasured turtle resources of Sipadan. The origin of these turtles are presently being looked into by conducting genetic studies, specifically microsatellites of the nesting females. At present a small scale disease monitoring programme is also being carried out. It is hoped that this programme will be expanded to include all sea turtles in Sabah. Efforts are also being made to have joint research programmes with foreign institutions to look into other aspects of sea turtle conservation and science.

CONCLUSIONS

The presence of human inhabitants has led to a decline of sea turtle landings in Sipadan. Egg collection, incidental drownings, and habitat destruction are among the more serious problems that have arose. The concerted efforts from the authorities, academic institutions and the private sector must be taken in order to undo the damage that has been done, and to ensure that the sea turtle population of Sipadan will not be lost to extinction.

Acknowledgements:

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POST-HOOKING SURVIVAL OF SEA TURTLES TAKEN BY PELAGIC LONGLINE FISHING IN THE NORTH PACIFIC

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INTRODUCTION

Determining the post-hooking survival of sea turtles captured in longline fisheries is important for management and conservation of sea turtles worldwide. Injury and mortality of sea turtles resulting from capture in various commercial fisheries has been an issue for their recovery for several decades. Cases of sea turtles ingesting baited longline hooks, or becoming entangled or externally hooked, have been known to the scientific community. However, only limited data exist on numbers of turtles caught by longline fishing and the immediate or consequent injury and mortality that takes place. Deep ingestion of a hook by a turtle would intuitively seem to be devastating to the animal due to possible puncture of vital organs. However, preliminary work summarized by Aguilar et al. (1995) recording post-hooking survival of loggerheads caught in the Spanish swordfish longline fishery in the Western Mediterranean during 1986-1991 gave an unexplained contrary indication. Aguilar et al. (1995) documented that some turtles with deep ingested hooks, and some having ingested more than one hook, could take as long as 285 days in captivity to expel the hook. Many turtles survived and were released alive after 4 months without expulsion of the hook with no observable adverse affects.

Numbers of turtles caught and brought up dead or alive in the Hawaii-based pelagic longline fishery have been summarized by the National Marine Fisheries Service (NMFS). Impacts on turtle stocks due to incidental capture have been estimated through various modeling procedures. However, the level of mortality due to post-hooking injury is still a key issue of continuing concern and investigation.

Satellite telemetry was suggested by G. Balazs (1994) and also S. Eckert (1994) in 1993 as a means to determine survivability of post-hooked turtles after their release. From 1997 to mid-2000, NMFS observers attached satellite transmitters to pelagic loggerheads, olive ridleys, and green turtles taken alive as by-catch in the Hawaii-based longline fishery of the North Pacific. The post-hooking movements of these turtles were examined to determine survival differences between turtles lightly hooked and ones that had deep ingested hooks. This paper reports the results of transmission times and distances traveled, comparing the two hooking groups of turtles by species and for all species combined. Surface times for deeply and lightly hooked turtles are also compared.

METHODS

Turtles taken as by-catch in the Hawaii-based pelagic longline fishery were brought on board commercial vessels by NMFS observers, if possible with the aid of a large scoop net. Straight carapace length (SCL) was measured and hooking status determined for each turtle. The turtle was lightly hooked if solely entangled in monofilament line or if the hook was external or in the beak and could be easily removed. A hook was deeply ingested when lodged deep in the mouth or throat and removal might cause further injury. For such cases, the monofilament leader was cut as close to the hook as possible. Argos-linked Telonics ST-10/18 transmitters were attached to the turtles' carapace using fiberglass cloth and polyester resin. Turtles were released alive often in what was described as vigorous condition for both hooking categories.

Duration of tracking was calculated from the date of deployment to the day the last signal was received. Distance traveled was calculated with the most accurate positions (LC 1's, 2's and 3's) using a great circle distance formula. On average, one position every two days was used for the calculations, although one position per day was used if possible. For 13 transmitters with a duty cycle of 24-hours on and 216-hours off only one position every 10 days could be used. A tracking was considered to be "successful" if the tracking lasted more than one month.

The Student's t-test was used to determine significant differences in variables between lightly and deeply hooked turtles. T-tests were done by species and also for all species combined for both the duration of tracking and the distance traveled. T-tests were also conducted to determine if differences existed in carapace size between deeply and lightly hooked turtles. A Chi-squared test was also used to compare the duration of tracking between light and deep hooked turtles.

Percent time on surface was calculated using data received from the ST10/18 "surface time counter" (see Telonics website: http://www.telonics.com). The percent time on surface is just an estimate of the minimum time the turtle spent there as heavy seas and excessive wave wash over the transmitter might artificially lower this number. However, unless radically different environmental conditions persisted over the times of the tracks between turtles, the affect of this wave wash might be presumed to be similar for all turtles.

RESULTS AND DISCUSSION

A total of 54 transmitters were deployed from 1997-2000. As of February 2001, four of these transmitters are still transmitting and are not included in the analyses. Of the remaining 50 transmitters, 35 were attached to loggerheads, 12 on olive ridleys and three on green turtles. Fifteen transmitters produced few or no transmissions. Eleven of these were deeply hooked and four were lightly hooked. Thirteen of these 15 turtles were loggerheads and two were olive ridleys. For the 35 turtles with "successful" tracks, 22 were loggerheads, ten olive ridleys and three green turtles. Of these 35 turtles, 15 were lightly hooked and 20 had hooks deep ingested. As hooking site may be of some interest for the lightly hooked turtles, we determined that 15 turtles were hooked in the mouth or jaw, three in the front flipper, one was hooked in the neck, and one was entangled in the fishing line. Movements of post-hooked pelagic turtles against weak geostrophic currents were reported by Balazs et al. (2000) and Polovina et al. (2000) on a sub-sample of nine of the loggerheads. Subsequent analysis of the 22 loggerheads in this study showed that all of them from both hooking categories also swam against geostrophic currents occurring in the North Pacific.

For all species combined with successful tracks, the mean and standard deviations for duration of tracking was 4.2 ± 2.4 months for light hooked, and 3.7 ± 2.2 months for deep ingested hooks. Distance traveled by lightly hooked turtles was approximately 2500 km and 2600 km for deeply hooked turtles. There was no significant difference ($P>0.05$) between deeply or lightly hooked turtles in duration of tracking or distances traveled, whether the 15 turtles that produced few to no transmissions were included or excluded from the analysis. However, means and standard deviations were slightly lower for both hooking categories when all tracks were combined. This was true for analyses done with all species combined and for each species done individually. For loggerheads, using only successful trackings, the mean duration was 4.2 months for lightly hooked and 3.6 months for deeply hooked turtles, and the distance traveled for both hooking categories was approximately 2300 km. Olive ridleys had a mean duration of 4.4 ± 2.3 months for deeply hooked and 3.1 ± 2.6 months for lightly hooked turtles. Deep hooked turtles traveled a mean of 3600 km and light hooked traveled 2500 km, but the difference was not significant. Green turtles had a small sample size (N=3, 1 deep hooked and 2 lightly hooked) so a t-test to detect difference wasn't possible (deep = 1.8 months and 1800 km, light = mean of 6.7 months and 3200 km).

A Chi-square for 34 loggerheads and for all species combined (48 turtles) also showed no significant difference in the duration of tracking between lightly and deeply hooked turtles. The Chi-square was initially done because it seemed that deeply hooked loggerheads (42% of the 34) had a higher percentage of "failure" (those that transmitted less than one month) than lightly hooked loggerheads (27% of the 34). However, the Chi-square analysis supports the findings from the t-test analyses that there is no statistical difference between lightly and deeply hooked turtles in duration of tracking for loggerheads or all species combined.

Excluding the 15 "unsuccessful" tracks, there was no significant difference in carapace size between deeply and lightly hooked for species individually or with all species combined. Including the 15 turtles with few to no transmission in the analysis, there was no significant difference in size between light and deep hooked olive ridleys and for all species combined. But loggerheads showed a significant difference in carapace size between deep ingested and lightly hooked turtles ($P = 0.02$). These data indicate that larger loggerheads are probably more likely to ingest hooks than smaller loggerheads. This information may be useful in determining a hook size to use in the commercial longline fishery to reduce the incidental catch of loggerheads.

Comparison of transmitter surface time data was conducted on a sub-sample of 18 turtles yielding sufficient data for this analysis. The last 30 days of transmission was focused upon because differences in surfacing or submergence times from debilitation or death of the turtle might be expected during this time. However, no significant difference was detected in percent surface time between the nine lightly hooked (mean: 30.0 ± 14.5%, range: 12 - 53%) and nine deeply hooked turtles (mean: 34.1 ± 14.7%, range: 19 - 66%, P=0.6). Percent time on surface data collected by four satellite depth recording (SDR) transmitters (Wildlife Computers, Inc.) deployed during this study were compared to the surface counter data from the 18 turtles. These data show that the range and means calculated from the 18 turtles are within the range and mean of actual percent surface times measured. The actual mean percent time on surface from the four SDR's was 31.6+/-20.9% and the range was 15-61%.

Although there seemed to be a high percent of turtles which had few to no transmissions in the deeply hooked category that might be assumed as mortality, there was no significant difference between lightly and deeply hooked turtles in duration of tracking and distances traveled. Also one can not attribute all of these "failures" to turtle mortality. A small percentage of the "failure" of transmitters with few to no transmissions could be due to electronics failure of the batteries, possible factory defects in the transmitters, or shipboard conditions causing poor transmitter attachment. This latter category is suggested by NMFS observer records showing deployment of two transmitters on the same trip where the turtles had swam away vigorously, yet both transmitters produced few to no transmissions.

Currently, the study reported herein is the largest known data set of its kind. NMFS has taken into account the results of this study in the estimation of mortality rates for the U.S. longline fisheries. Aguilar et al. (1995) estimated a 20% mortality using Mediterranean data. Our data suggests a 20-40% mortality rate depending on hook status. Looking at a combination of duration, distance traveled, and time on surface may give a better indication of turtle survival if compared with data from non-hooked turtles. Studies should be continued using satellite telemetry to help determine the survival of turtles captured in longline fisheries and also with other fishing gear, such as shrimp trawls, where the turtles brought to the surface are often not dead.

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CAPTURE AND TRADE OF MARINE TURTLES AT SAN ANDRES, SOUTHERN PERU

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INTRODUCTION

The Pisco- Paracas area (13° 40' - 14° 20' S) has been recognized as a foraging ground for sea turtles in inshore Peruvian waters (Hays Brown and Brown,1982). Besides, a high mortality by interactions with fisheries have been reported historically at San Andrês port (13° 44' S), also recognized as the main locality for the Peruvian marine turtle fishery (Frazier,1979; Aranda and Chandler, 1989; Vargas et al 1994).

Although protected since 1977, current studies reveal that mortality never stop at this location. In 1999 a program was established to monitor this interaction. The present study summarize results of a continuous monitoring on the hunting and trade of marine turtles at San Andrês port for the period July 1999 - June 2000.

MATERIALS AND METHODS

A systematic survey was conducted at San Andrês port (Fig 1). Direct observations and counts of complete individuals or carapaces found at beaches allowed estimation of a daily catch rate for each species, stratified by month, that led to estimation of catch levels and corresponding standard errors for the whole study period according to Cochran (1964). Remains were considered to be the result of fisheries interaction if they were found at port, beaches and places with evident human use of the meat, or if observed in fishing markets.

For each specimen, the basic data included date, species, number, measurements and, when possible, reproductive status, stomach contents, presence of barnacles and circumstances of death. Straight carapace length was taken in metric units with a tape meausure from nucal scute to the posterior tip of the supracaudals (SCLn-t, Bolten 1999). Stomach contents were identified by comparison with a reference collection. Algae items were identified following Acleto (1980) and Acosta (1977) and preserved in 10% formaline. Information on the trade of sea turtles was obtained through interviews with fishermen, middle people and owner of restaurants.

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