Public release of a tagged loggerhead sea turtle in Libya - see pp. 7-9 (photo: A. Hamza).

Articles:
Flags Reduce Sea Turtle Nest Predation by Foxes in NE Brazil..................................................G Longo et al.
Acclimating Captive Hawksbills to Sea Prior to Release..............................................................B Whitman
Inter-nesting Dive and Surface Behaviour of Green Turtles at Raine Island.....................................I Bell et al.
Sea Turtles Tagging in Libya...........................................................................................................A Hamza et al.
Shifting Patterns of Nocturnal Emergence Events of Nesting Loggerhead Turtles .......................R Welsh & A Tucker
Notes:
Foraging by a Gravid Green Turtle During the Internesting Interval in Guadeloupe.....................E Delcroix et al.
A Leatherback Turtle Encountered in El Nido, Palawan, Philippines...........................................R Salinas et al.

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Book Review
News & Legal Briefs
Recent Publications
Shifting Patterns of Nocturnal Emergence Events of Nesting Loggerhead Turtles (*Caretta caretta*)

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The reproductive biology of nesting female loggerhead turtles (*Caretta caretta*) is typically nocturnal but can be influenced by lunar phase, intertidal exposures from beach slopes and correlated tidal amplitudes, and responses to anthropogenic disturbances (Fritts & Hoffman 1982, Frazer 1983). The tendency of most larger-bodied forms of sea turtles to nest at night is linked to thermal tolerances and inertias correlated with large body size (Spotila & Standora 1985). However, the time domain of nocturnal nesting events and emergences receives scant attention within the literature, particularly the nocturnal times of emergence on the nesting beach. The perceived lack of analysis on turtle emergence events is puzzling since there is no paucity of data on this aspect. Data on temporal distribution of emergence events can have conservation and management value in determining the anthropogenic potential for disturbance of nesting females. New information on nesting emergences defines a scope for interaction with human activities that occur adjacent to beaches, or for beaches where beach or off-road driving is a legal or cultural norm.

This present note on emergence events reviews 21 seasons of nightly beach patrols for nesting loggerheads on the southern 6 km of Casey Key in Sarasota County, Florida (27.13N, -82.47W). The beach is not yet subject to beach nourishment (Rumbold et al. 2001) or ecotourism (Wilson & Tisdell 2001) as factors that might influence turtle nesting. Patrols by ATV occurred hourly from approximately 2000 hours to 0500 hours for the main nesting months of June and July. Time of each emergence event was recorded for 93.3% (2535/2717) of the turtles that were encountered. Each encounter was classed to the following categories: 1) Pre-Oviposition which included the following behaviors: beach approach, body pitting, nest cavity construction; 2) Oviposition; and 3) Post-Oviposition which included the following behaviors: covering/camouflaging, and leaving the nest.

The emergence events had a strongly bimodal pattern with an increase after dusk to a peak at 2300 hr, a drop for the 0000 hour, and a second peak at 0100 hr, then decreasing until dawn (Fig. 1). The timing of emergence events was significantly different from a normal distribution (Kolmogorov-Smirnov goodness of fit, $D = 0.818$). The behavioral activity when encountered was recorded for 52.6% (1334/2535) of the emergence events (Fig. 2) and the bimodality was found in all three of the defined nesting behaviors.

Both graphs (Figs. 1, 2) suggested that emergence events were comprised of two events, a first peak arriving around the 2200 and 2300 hours accounting for 44% of the nesting activity and a second smaller peak around the 0100 and 0200 hours representing 29% of the nesting activity. Overall, nesting activities were concentrated between 2200 to 0200 hr., with 81.9% of the defined activities. However, emergence events were still found, although in declining numbers, during the remaining hours of the nocturnal period. Interestingly, 1.4% of turtle encounters were around dusk (1900-2000 hrs), but there were no recorded observations of turtles arriving to nest during the dawn hours (0600-0700 hrs). These data for 6 km of Casey Key are supported by anecdotal observations for the 56 km of beach monitored daily at dawn by Mote Marine Laboratory.
Taking the same data from a different perspective produced a temporal contrast of nesting behavior across years, as we compared the percents of females arriving before and after midnight (Fig. 3). From 1987-2000 the females typically emerged before midnight (2400 hr), which contrasted with a change in 2003 as females shifted to nesting predominantly after midnight.

Our results for a peak of emergence activity from 2200 to 2300 hr confirm earlier findings from Sanibel Island, Florida (LeBuff 1990). However, a notable difference is a secondary peak of activity on Casey Key that was absent in Sanibel loggerheads. Casey Key has people present on the beach most nights, particularly on weekends near public access areas in contrast with the Sanibel Island studies that were conducted over 30 years ago on a relatively remote beach. One might suspect a difference in patrol coverage if monitoring patrols were concluded earlier on Sanibel and so did not detect a secondary peak, but accounts in LeBuff (1998) appear to rule that out. A more plausible scenario may be of altered turtle behavior with the secondary peak on Casey Key as a possible behavioral artifact, resulting from a non-nesting emergence early in the evening and a postponed return of the same turtle.

Tidal influences can be discounted as a determinant in determining female emergence times, in the manner explored by other papers (Fritts & Hoffman 1982, Frazer 1983, Azanza et al. 2003) because, Casey Key generally has tides of less than 1 meter. It remains unclear what factors may be associated with a behavioral shift that began around 2003 for females emerging later at night than in previous years (Fig. 3). Some factors can be discounted, such as usage of ATVs for night patrols, as this patrol method without lights has occurred throughout the study (J. Foote, pers. comm.).

Nevertheless, there is an unquestionable increase in coastal development and human use on beaches over the time frame of monitoring. Consequently, a shift in emergence times may be associated with more people on the beaches especially during the hours of dusk, in which sunset watching and continued use is a popular activity on the western coast of Florida. This is a pragmatic hypothesis, but at the present time there are no corresponding data on human activity to test that premise. A need exists for further studies to understand if behavioral shifts of emergence timing are related to human activities on the beach.

In conclusion, a peak of nesting female emergence activity occurs in the 2300 hour with sea turtle activity occurring through the night though rarely before dusk or after dawn. For beaches where there are potentials for overlap of human activities and nesting turtles, new studies should evaluate the potential for anthropogenic disturbance to females approaching the nesting beaches (Waayers et. al. 2006). For beaches hosting traffic by foot or vehicle, the form of distribution of nesting emergences may offer new data to test the hypothesis of anthropogenic disturbance. Although we presented no data here on hatchling emergence times (however, see Witherington et. al. 1990), such data may also be critical for better informed management decisions relating to human activity on the beaches (Lamont et al. 2002).

Acknowledgments: We are grateful to all staff, interns, and volunteers who assisted with the nocturnal tagging patrols. ATV storage at Casey Key is facilitated by Sarasota County Parks and Recreation. J. Foote shared essential details concerning the early history of the tagging program on Casey Key.


A female green turtle (*Chelonia mydas*) was found dead stranded on the outskirts of the town of Gosier, on the southern end of the island of Grande-Terre in Guadeloupe, French West Indies (16.205122, -61.49564), on 01 November 2009. The carcass appeared to be 3-4 days post-mortem, thus we extrapolated date of death being 28-29 October 2009. The turtle measured 111.5 cm curved carapace length and 101 cm curved carapace width, and bore an inconel tag on the trailing edge of each of her front flippers (Numbers FWI 3079/FWI 2659) that had been placed there on 20 August 2008 by volunteers patrolling Les Galets beach on the island of Marie Galante, about 40 km southeast from where the stranding was observed. After being tagged, this turtle was observed nesting again on 01 September and 14 September 2008, on the same nesting beach. A 12-13 day internesting interval is common to other green turtle nesting sites (Miller 1997).

We necropsied the turtle, but found no gross signs of injury, lesion or illness. Her body condition was good, and her gastro-intestinal tract was full of sea grasses, primarily *Syringodium filiforme*, which is a primary food source for green turtles (Mortimer 1981, 1982). Given that she appeared healthy and was eating just prior to death, we assume that the cause of death was drowning due to accidental capture in a submerged fishing net. Each year, incidental capture in fishing gear in Guadeloupe causes the death of 800 – 1000 marine turtles (Delcroix unpub data).

This turtle also had 30-40 unshelled eggs in her oviduct, which suggests that she had been foraging during the nesting season. These unshelled eggs likely would have been part of a final nest that she would have laid, although it is also possible that the eggs may have been in the process of being resorbed. Green turtles can lay between 1 and 8 nests in a single nesting season (Alvarado-Diaz et al. 2003), and in the case of the stranded green turtle, if her first nest was indeed 20 August and she maintained a 12-13 days internesting interval, the eggs remaining in the turtle’s oviduct may represent the 6th or 7th nest of the season. Also, green turtles are commonly observed to migrate long distances between nesting and foraging grounds (Solé 1994, Hirth 1997, Harrsion 2006). This has also been the case for post-nesting green turtles tracked using satellite tags: two green turtles from Les Galets beach moved between 144 and 200 km at the end of the nesting season (Delcroix et al. 2008). This stranded green turtle was found <40 km from its nesting beach, and possibly died even closer but floated away during the 3-4 days before it was found.

The question of foraging by green turtles during the nesting season remains unresolved. In Ascension Island, Hays et al. (2002) found...
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ACKNOWLEDGEMENTS

Publication of this issue was made possible by donations from the following individuals: Dimitris Margaritoulis, Frank J. Schwartz, Judson M Parsons & Diana V. Gardener, Clifford Jones, Dr. Sandra E. Shumway and organizations: Conservation International, International Sea Turtle Society, IUCN - Marine Turtle Specialist Group, Sirtrack Ltd., US National Marine Fisheries Service-Office of Protected Resources, Western Pacific Regional Fishery Management Council, Wildlife Computers.

The MTN-Online is produced and managed by Michael Coyne.

The opinions expressed herein are those of the individual authors and are not necessarily shared by the Editors, the Editorial Board, Duke University, NC Wildlife Resources Commission, or any individuals or organizations providing financial support.
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