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Home range of immature hawksbill turtles (*Eretmochelys imbricata* (Linnaeus)) at two Caribbean islands

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Abstract

Distances between capture and recapture locations of tagged immature hawksbill turtles *Eretmochelys imbricata* (Linnaeus) are analyzed for four near-shore survey sites at Mona and Monito Islands, Puerto Rico. Data were obtained for 87 turtles ranging in size from 20.0 to 56.7 cm straight-line carapace length. Net displacements by individual turtles averaged 0.45 km (S.D. = 0.66, range 0.00–5.22) for mean inter-capture intervals of 465 days (S.D. = 331, range 9–1118). Measured displacements were not correlated with turtle size and did not differ significantly between survey sites. Movements of three immature turtles fitted with sonic tags were monitored by acoustical tracking in reef habitats along the southwestern coast of Mona Island. The area utilized by the turtles during the 11–16 days of tracking measured 0.07–0.21 km^2. It is concluded that immature hawksbill turtles maintain a limited home range area and appear resident at the feeding grounds of Mona and Monito Islands for periods of at least several years.

Keywords: *Eretmochelys imbricata*; Hawksbill turtle; Home range; Migration; Movement

1. Introduction

The hawksbill turtle (*Eretmochelys imbricata* (Linnaeus)) is a medium sized marine turtle found in shallow, tropical waters worldwide (Márquez, 1990). After a pelagic post-hatchling life phase, juvenile hawksbill turtles of 20–25 cm carapace length are

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thought to take up residence in benthic habitats (Carr et al., 1966), typically coral reefs (Pritchard and Trebbau, 1984). Juveniles and adults of the species are known to feed primarily on benthic invertebrates (den Hartog, 1980; Márquez, 1990), and notably in the Caribbean, on sponges (Meylan, 1988; Anderes Alvarez and Uchida, 1994; Van Dam and Diez, in press a). Females come to shore to nest in areas with sandy beaches, which frequently lie in close proximity to immature hawksbill turtle feeding grounds (Witzell, 1983).

Meylan (1982), in reviewing the available information on the movements of hawksbill turtles, concluded that the database was still insufficient to establish whether the species is migratory. Since 1982, further reports have become available that address movement of immature hawksbill turtles, either relating records of long range (>5 km) travel (Kamezaki, 1987; Boulon, 1989; Marcovaldi and Filippini, 1991), fidelity to specific sites (Boulon, 1984; Limpus, 1992), or both (Bjorndal et al., 1985; Moncada Gavilan, 1994). This paper enlarges the body of knowledge concerning the movements of *Eretmochelys* by examining immature turtles in densely populated near-shore areas at two Caribbean islands.

2. Materials and methods

2.1. Study area

Immature hawksbill turtles were studied at Mona and Monito Islands, Puerto Rico (18°05′N, 67°56′W). The study area comprised two major habitat types at four non-contiguous survey sites named: Mujeres, Sardinera, El Norte, and Monito Island (Fig. 1). Mujeres and Sardinera are dominated by reef structures extending 2.1 and 1.2 km^2 in area, respectively. A description of these reef sites is given in Van Dam and Diez (in press b). El Norte and Monito Island are dominated by vertical cliff wall structures rising from a hardbottom seafloor at 20–40 m depth. Coastline length at the cliff wall sites of El Norte and Monito Island are 8.9 and 1.6 km, respectively (from 1:20 000 map tracing). Habitat characteristics of the cliff wall sites are further described in Van Dam and Diez (1996).

2.2. Turtle capture, tagging and reobservation

Surveys of immature hawksbill turtles were conducted during visits to the study area in the period from June 1992 to January 1996. The survey sites were selected for turtle abundance and accessibility by boat. Turtles were hand-captured during surveys made snorkeling or with SCUBA, and brought aboard a boat and/or taken ashore for tagging and measurement. Plastic and metal flipper tags and injectable passive integrated transponder (PIT) tags were used for turtle identification. Measurements taken include straight-line carapace length (nuchal notch to posteriormost marginal scute) and body mass. Hawksbill turtles with carapaces 65 cm or shorter were considered immature (criterion in Witzell, 1983). A dot of orange paint was applied to the carapace of turtles to enable the recognition of recently handled animals and avert their recapture. These

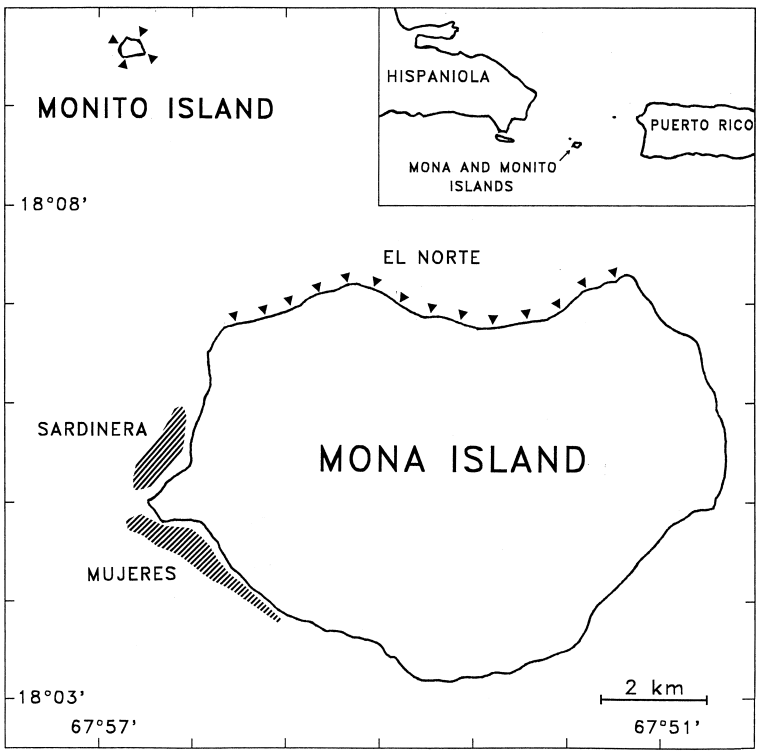

Fig. 1. Map of the study area at Mona and Monito Islands, Puerto Rico, with location and approximate extension of the hawksbill turtle survey sites. Hatched areas indicate reef habitats studied, triangles point to cliff wall areas.

paint marks were found to have worn off within 1 month of turtle release. Turtles were released at the location of capture. Data on home range were obtained through recapture and re-observations. Re-observations are in-water observations of tagged or otherwise identifiable turtles for which location information was recorded.

2.3. Location determination and distance measurement

Latitude and longitude of most turtle observation and capture locations were determined by Global Positioning System (GPS) receiver (Magellan NAV5000D, used in 2D non-differential mode). Other localizations were obtained by estimating relative distance and direction to nearby landmarks with known coordinates. Landmarks were used primarily at El Norte where terrain blocked GPS signal reception. GPS location accuracy under field conditions was 34 m (determined by comparing fixed point localizations measured on 30 occasions with 2 h minimum period between measurements, S.D. = 22.2 m, range 5–115 m).

Distances between turtle capture locations were calculated from location coordinates (using the arc-distance formula in Fitzpatrick and Modlin, 1986). Where point-to-point

lines intersected land, distances were adjusted by substituting the length of the minimum along-shore route (from land contour map tracings) for the land segment.

2.4. Acoustical tagging and tracking

Three immature hawksbills were fitted with sonic tags (model CHP87-L, Sonotronics, Tucson AZ, USA) to enable short term (11–16 days) tracking of the animals. Sonic tags were attached to the posterior margin of the carapace using epoxy and a plastic coated wire running through two holes drilled in the non-living tissue of marginal scutes. Turtles were tracked from a boat using an acoustic receiver (model N15A235B, Dukane, St. Charles IL, USA) from a distance of 25–200 m. Turtle location coordinates were calculated from (1) the relative distance and direction to the boat (determined by sonic signal strength) and (2) the position of the boat indicated by GPS receiver. Turtle locations were recorded at 1–4 day intervals and during one day for each turtle, at hourly intervals from dawn to dusk. Study animals were identifiable by the emitted pulse sequence of the sonic tags. Upon completion of the tracking study, the turtles were recaptured and sonic tags removed. Individual home range area was calculated from the area enclosed by the smallest polygon containing all known locations visited by a turtle.

3. Results

3.1. Distance moved between captures

Information on movement within the study area was obtained by recapture/reobservation for 87 immature hawksbill turtles, ranging in size from 20.0 to 56.7 cm straight-line carapace length (at initial capture). Turtles of the 20.0–29.9 cm size class were best represented in the sample (Fig. 2). Following initial capture, tagging and release, the turtles were recaptured or reobserved on average 2.3 times (range 1–9).

Net turtle displacements between first capture and last capture/observation averaged 0.45 km with mean intervals of 465 days (Table 1). The frequency distribution of net displacements (Fig. 3) is strongly leptokurtic and skewed. Net displacements were not significantly correlated with the length of the inter-capture time intervals (Pearson product moment, $R = 0.05$, $P = 0.63$; Fig. 4), indicating that turtles did not drift from one feeding site to one adjacent over time. The mean of individual maximum displacements (distance between the pair of most separated points at which an individual was observed) was 0.58 km.

The extent of turtle movements varied considerably between turtles at the survey sites (see Table 1), with net and maximum displacement data sets not significantly different between survey sites (pairwise Mann-Whitney U-tests, $P > 0.05$). Correlations of net and maximum displacements were not significant with turtle carapace length (Pearson product moment, $R = 0.13$, $P = 0.23$ and $R = 0.06$, $P = 0.55$, respectively) or with turtle body mass (Pearson product moment, $R = 0.13$, $P = 0.22$ and $R = 0.08$, $P = 0.46$, respectively), indicating that the observed variations were not attributable to turtle size. A prominent outlier in the data set is the measured displacement of 5.22 km by turtle

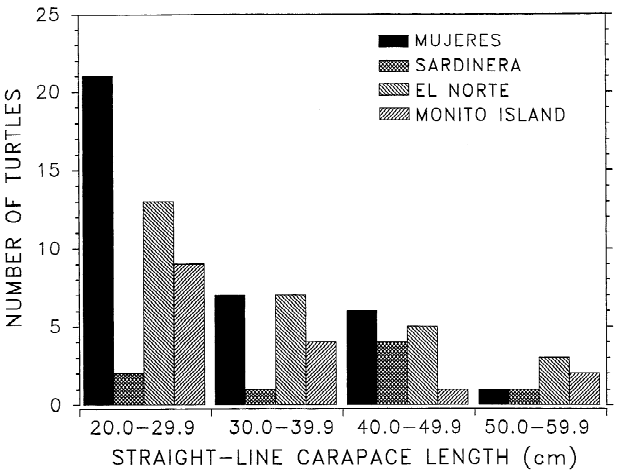

Fig. 2. Size distribution by survey site of 87 immature hawksbill turtles for which movement data was obtained. Turtle size is straight carapace length at first capture.

94-132. This 25.7 cm carapace length hawksbill turtle traveled to the El Norte section of Mona Island from Monito Island. Only one other turtle was observed to have moved between survey sites (turtle 92-023 moved from Sardinera a distance of 1.66 km to Mujeres); we found no instances of immature hawksbill turtles having moved between reef and cliff wall habitat types.

3.2. Acoustical tracking

Systematic tracking of three sonic tag equipped turtles in the reef areas of Mujeres

Table 1
Number of immature hawksbill turtles captured, marked and subsequently recaptured at each of four nearshore survey sites at Mona and Monito Islands, Puerto Rico

Survey site	Number of turtles in sample	Time between first and last capture $x \pm$S.D. (days) min–max	Distance moved between first and last capture $x \pm$S.D. (km) min–max	Distance between most separated points $x \pm$S.D. (km) min–max
Mujeres	35	584±376 14–1107	0.40±0.35 0.00–1.35	0.57±0.38 0.06–1.35
Sardinera	8	613±326 307–1072	0.46±0.49 0.11–1.66	0.60±0.55 0.05–1.66
El Norte	28	301±198 9–724	0.44±0.52 0.02–2.28	0.59±0.63 0.02–2.39
Monito Island	16	419±300 42–1118	0.54±1.3 0.02–5.22	0.69±1.2 0.02–5.22
All sites	87	465±331 9–1118	0.45±0.66 0.00–5.22	0.58±0.69 0.02–5.22

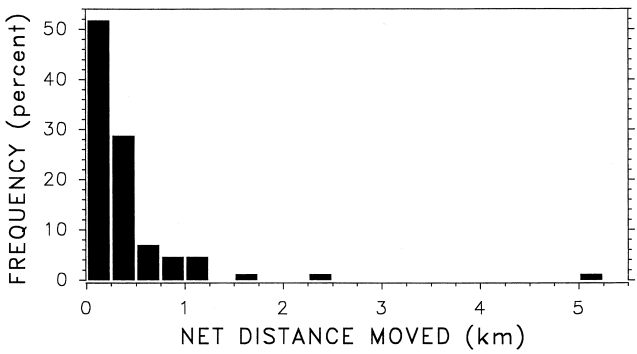

Fig. 3. Frequency distribution of the net distance moved by 87 immature hawksbill turtles between first capture and last recapture/reobservation.

and Sardinera provided more detailed information on the extent of daily movements. The animals started moving shortly after dawn and ceased activity before dusk. Maximum displacement recorded for a single day ranged from 0.31 to 0.87 km (see Table 2). During the sonic tag deployment period, turtles restricted their movements to home range areas measuring 0.07–0.14 km^2 (Table 2). The terrain covered by turtles during the single day, dawn-to-dusk tracking effort was smaller than the total home range area, indicating that turtles did not follow identical movement patterns each day. The substantially greater displacement exhibited by turtle 94-031 (but with an unexceptional home range area) is attributable to the locally elongated shape of the habitat available to hawksbill turtles; towards the south, the Mujeres reef becomes a narrow shelf (as little as 150 m wide), bordered on one side by the shore line and truncated on the other by a vertical drop-off to deep water.

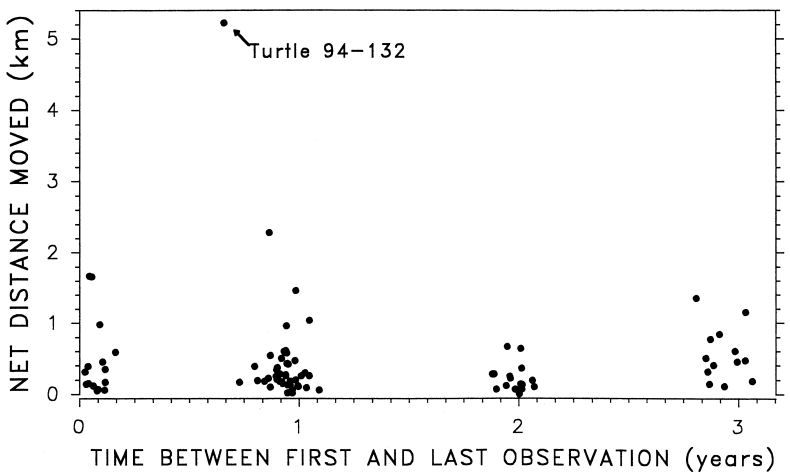

Fig. 4. Relationship between net displacement and inter-capture interval for 87 immature hawksbill turtles.

Table 2
Sonic tag deployment data and tracking results of three immature hawksbill turtles in reef habitats along the southwestern coast of Mona Island

Turtle number	94-064	94-031	92-025
Carapace length (cm)	37.6	46.7	50.4
Body mass (kg)	5.4	10.3	11.6
Survey site	Mujeres	Mujeres (south)	Sardinera
Sonic tag deployed	15-Dec-95	15-Dec-95	16-Dec-95
Deployment duration (days)	15.9	10.8	15.1
Maximum displacement observed in one day (km)	0.59	0.87	0.31
Maximum displacement observed in all days (km)	0.69	1.42	0.87
Area of home range (km^2)	0.14	0.14	0.07

4. Discussion

The importance of the near-shore areas of Mona Island for hawksbill turtles was recognized by Thurston (1976), who observed numerous turtles surfacing at the base of the island's northeastern cliffs. She suggested that the individual turtles sighted repeatedly and identified by their distinctive carapace marks, were resident to the area. Her observations are similar to those made of immature hawksbill turtles in the U.S. Virgin Islands (Boulon, 1984), Miskito Cays, Nicaragua (Bjorndal et al., 1985) and at Heron Island, Australia (Limpus, 1992), and are in close agreement with the results of our study.

Pritchard and Trebbau (1984) stated in their summary of the habits of *Eretmochelys* that hawksbill turtles appear to be relatively sedentary once they have found a good feeding area. Whereas the conditions that make an area good for foraging hawksbill turtles require further definition, the observed adherence of immature turtles to specific sites is indicative of at least satisfactory foraging opportunities in the Mona and Monito Island study area. The two gross habitat types represented by the survey sites (reef and cliff wall habitats) are notably different in terms of the species composition in turtle diet, turtle diving behavior and growth rates (Van Dam and Diez, 1996; Van Dam and Diez, in press a,b, and unpublished data). Although conditions (especially prey abundance) appear to favor hawksbill turtles in the cliff wall habitats (Van Dam and Diez, in press a), we detected no movement of immatures between different habitat types. Two turtles that were observed to have moved to a different site, did so without changing habitat type.

The observed adherence of immature hawksbill turtles to specific locations stands in sharp contrast to long distance displacements that occur with some frequency (e.g., Boulon (1989), Marcovaldi and Filippini (1991)). What mechanisms might prompt hawksbill turtles to abandon their benthic habitats and venture well beyond their habitual home range? One possible explanation lies in the investigative process itself, the way in which turtles are initially captured, tagged and released. The animals may become disoriented if they are captured at one site and released at another, which is a common practice wherever a group of people (often fishermen) are asked to bring turtles to the researcher onshore. After processing, the turtles are typically released from shore at

some distance from the site of original capture (Van Dam and Diez, personal observations). Such disorientation was evident in a relocation experiment involving 30 hawksbill turtles brought to Heron Island Reef (Australia) from adjacent reefs (Limpus, 1992). Only one turtle was subsequently seen at the location of its original capture and none became residents of Heron Island Reef. Of 93 turtles originally captured and released on Heron Island Reef, however, 61 were recaptured there and none were observed at the adjacent reefs. In our own study, one displacement record stands out as probably investigator-induced and concerns the 5.22 km distance traveled by the 25.7 cm hawksbill turtle 94-132 (from Monito Island to El Norte). After initial capture and processing at Monito Island, the turtle was released close to the island's cliff wall. However, the animal's behavior was unusual as it did not submerge immediately; efforts to retrieve the turtle failed. We suspect that the animal then drifted away from Monito Island propelled by the strong currents there, and eventually made its way to Mona Island.

Whereas immature hawksbill turtles at Mona and Monito Islands appear to remain sedentary for long periods of time, recent genetic evidence suggests that upon reaching adulthood these turtles may become migratory. A comparison of the occurrence of mtDNA polymorphisms in feeding ground turtles from the study area (mostly immatures) with the polymorphisms of females nesting on Mona Island has demonstrated that turtles on the feeding grounds are likely to have originated from a variety of nesting colonies in the Caribbean (Bowen et al., 1996). Female green turtles (*Chelonia mydas*) are known to return to their natal beaches for reproduction (Bowen et al., 1992) and should hawksbill turtles exhibit similar behavior, then many of the turtles that are now immatures at Mona and Monito Islands may eventually make long range migrations.

5. Conclusions

Immature hawksbill turtles sighted repeatedly at Mona and Monito Islands appear to be residents of specific areas for periods of at least several years. Net distances traveled by turtles are not related to turtle size and seldom exceed 1 km. The short term home range of immature hawksbill turtles in reef habitats is of very limited area (< 0.25 km^2). Turtles that are captured and tagged for research purposes should be released as close as possible to the location of capture to minimize the risk of turtle disorientation.

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